Year One Monitoring Report

FINAL

GROUNDHOG HOLLOW PROJECT

NCDMS Project #100049 (Contract #7417) | RFP 16-007277 (Issued 6/21/2017)

USACE Action ID: SAW-2018-00450 | DWR Project #20180666

Alexander County, North Carolina
Catawba River Basin
HUC 03050101

Provided by:

Resource Environmental Solutions, LLC
For Environmental Banc & Exchange, LLC

Provided for:
NC Department of Environmental Quality
Division of Mitigation Services

February 2022

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February 8, 2022

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RE: Groundhog: Year 1 Monitoring Report (NCDMS ID 100049)

Listed below are comments provided by DMS on January 18, 2022 regarding the Groundhog Mitigation Site: Year 1 Report and RES' responses highlighted in blue.

General: Please confirm that the areas of fencing identified within the conservation easement in the MY0 Record Drawings (Sheet 1, Sheet 2, and Sheet 12) have been relocated outside of the conservation easement or to the conservation easement line. Please point out these relocated fence areas on the CCPV map sheets and discuss in the MY1 report text.

The fencing issues outlined in the Groundhog MY0 report will be addressed in early 2022. RES will provide photographic evidence in the MY2 (2022) monitoring report and appendices.

General: In the MY0 report comment responses, RES committed to including additional photo points at each project crossing location to document crossing stability and function in MY1 (2021) and during the remaining monitoring term. If possible, please provide the additional crossing photos in the revised MY1 (2021) report. If not available, please include these supplemental crossing photos in the MY2 (2022) report and future monitoring reports.

These photos are now included in Appendix B.

Section 1.1 – Project Location and Description: "*Funding will be supplied by the responsible party on a yearly basis until such time an endowment is established.*" Please clarify or remove this sentence.

This sentence was removed.

Section 1.6 Construction and As-Built Conditions: If available, please include the repair plans from the May 2021 repair in the report appendices and reference them in the report text.

The 2021 repair plan set is now included in Appendix F.

Section 1.6 Construction and As-Built Conditions: This section notes that a supplemental planting effort will take place in the 2021/ 2022 dormant season. If available, please provide the date/s that the site will be supplementally planted. Please make sure to document the supplemental planting effort in the MY2 (2022) report and appendices.

No specific date is available at this time however this task will be resolved in the dormant season and more details will be provided in the MY2 (2022) monitoring report.

Section 1.7 Monitoring Performance (MY1): "*These problem areas will be monitored and if addressed if they continue to worsen in MY2.*" Please correct.

This sentence was deleted and the overarching paragraph rewritten to provide a more accurate depiction of site conditions.

Section 1.7 Monitoring Performance (MY1)_Stream Hydrology: In the report text, please review and provide additional discussion regarding the numerous bankfull events reported in a normal rainfall year. Are the number of bankfull events reported on the site considered a project concern?

Wordage was added to provide context to the out of bank events. RES is not currently concerned with the number of bankfull events.

Appendix B - CCPV Map: The CCPV map and legend should identify the vegetation plot that is not currently meeting the interim success criteria. Typically, plots meeting the interim success criteria are shown as green and non-meeting plots shown as red. Please update the figure accordingly.

Done. The failing random vegetation plot is now orange to show plot failure and passing random plots are now shown in pink. Fixed vegetation plots will still be shown in red and green depending on their meeting of the interim success criteria.

Table 5 & Table 6: Please include the date that the project was visually assessed at the top of each table. This was an IRT request at the 2021 credit release meeting. Please also label the Visual Stream Stability Assessment tables as Tables 5a-c.

Done.

Table 5 (Visual Stream Stability Assessment): Section 1.7 Monitoring Performance (MY1) reports various minor issues with the projects stream geomorphology. Please confirm that the report text, CCPV maps, and visual stability assessment table are consistent and accurate.

This section was rewritten to more accurately depict site conditions. While some areas could potentially develop into issues, RES believes vegetation and over all site conditions could stabilize these areas. Photos were kept in the Problem Area Photo log to provide reference for future years.

Appendix B - Groundhog Hollow Monitoring Device Photos & Monitoring Year 1 – 2021 Problem Area Photos: Please provide dates that the photos were taken. If exact dates are not available, please provide the applicable month and year.

Done.

Appendix D – Cross Section 12: The footnotes for this cross section are misaligned in the draft received. Please correct.

Done.

Appendix E: Please provide graphs to substantiate the bankfull events reported in the text.

Done.

Digital Support File Comments:

• Please include line features that characterize the repaired areas.

Done. These are now included in the digital support files. Titled “Stream Repairs”

• Please include polygon features that characterize the invasive treatment areas.

Done

• The submitted CVS entry tool does not produce a Table 7 export or simple export that matches Table 9 in the report. Please ensure that the CVS data supports the table included in the report.

Fixed.

• Note that the table for cross section 11 excludes the MY1 metrics.

Done.

Table of Contents

1.0 Project Summary

1.1 Project Location and Description

The Groundhog Hollow Project ("Project") is located within a rural watershed in Alexander County, North Carolina approximately three and a half miles northwest of Taylorsville. Water quality stressors affecting the Project included livestock production, agricultural production, and lack of riparian buffer. The Project presents stream restoration and enhancement generating 4,093.95 Warm Stream Mitigation Units (SMU).

The Project's total easement area is 20.58 acres within the overall drainage area of 156 acres. Grazing livestock historically had access to all the stream reaches within the Project. The lack of riparian buffer vegetation, deep-rooted vegetation, and unstable channel characteristics contributed to the degradation of stream banks throughout the Project area.

The stream design approach for the Project was to combine the analog method of natural channel design with analytical methods to evaluate stream flows and hydraulic performance of the channel and floodplain. The analog method involved the use of a reference reach, or "template" stream, adjacent to, nearby, or previously in the same location as the design reach. The template parameters of the analog reach were replicated to create the features of the design reach. The analog approach is useful when watershed and boundary conditions are similar between the design and analog reaches. Hydraulic geometry was developed using analytical methods to identify the design discharge.

The Project has been constructed and planted and will be monitored on a regular basis throughout the seven-year post-construction monitoring period, or until performance standards are met. The Project 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.

1.2 Project Goals and Objectives

Through the comprehensive analysis of the Project's maximum functional uplift using the Stream Functions Pyramid Framework, specific, attainable goals will be realized by the Project. These goals clearly address the degraded water quality and nutrient input from farming that were identified as major watershed stressors in the 2009 (amended 2018) Upper Catawba River Basin Restoration Priorities (RBRP). These goals and objectives reflect those stated in the Groundhog Hollow Project Final Mitigation Plan.

The Project goals are:

- Improve water transport from watershed to the channel in a non-erosive manner in a stable channel;
- Improve flood flow attenuation on site and downstream by allowing for overbank flows and connection to the floodplain;
- Improve instream habitat;
- Reduce sediment, nutrient, and fecal coliform inputs into stream system;
- Restore and enhance native floodplain vegetation; and
- Indirectly support the goals of the 2009 Upper Catawba RBRP to improve water quality and to reduce sediment and nutrient loads

The Project goals were addressed through the following project objectives:

- Designed and reconstructed stream channels that convey bankfull flows while maintaining stable dimension, profile, and planform;
- Added in-stream structures and bank stabilization measures to protect restored streams;
- Installed habitat features such as brush toes, constructed riffles, woody materials, and pools of varying depths to restored streams;
- Increased forested riparian buffers to at least 50 feet on both sides of the channel along the Project reaches with a hardwood riparian plant community;
- Installed approximately 12,000 linear feet of livestock exclusion fencing along the easement boundary to ensure livestock will no longer have stream access;
- Treated exotic invasive species; and
- Established a permanent conservation easement on the Project that will exclude future livestock from stream channels and their associated buffers and prevent future landuse changes.

Functional uplift, benefits, and improvements within the Project area, as based on the Function Based Framework, are outlined in the Mitigation Plan**.**

1.3 Project Success Criteria

The success criteria for the Project follows the 2016 USACE Wilmington District Stream and Wetland Compensatory Mitigation Update, the Groundhog Hollow Project Final Mitigation Plan, and subsequent agency guidance. Cross section and vegetation plot monitoring takes place in Years 0, 1, 2, 3, 5, and 7. Stream hydrology and visual monitoring takes place annually. Specific success criteria components are presented below.

Stream Restoration Success Criteria

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.

There should be little change in as-built cross sections. If changes do take place, they should be evaluated to determine if they represent a movement toward a less stable condition (for example down-cutting or erosion) or are minor changes that represent an increase in stability (for example settling, vegetative changes, deposition along the banks, or 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. Bank height ratio shall not exceed 1.2, and the entrenchment ratio shall be above 1.4 within restored riffle cross sections. Channel stability should be demonstrated through a minimum of four bankfull events documented in the seven-year monitoring period.

Digital images are used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of erosion control measures. Longitudinal images should not indicate the absence of developing bars within the channel or an excessive increase in channel depth. Lateral images should not indicate excessive erosion or continuing degradation of the banks over time. A series of images over time should indicate successional maturation of riparian vegetation.

Specific Project reaches will be monitored to document intermittent or seasonal surface flow. Intermittent reaches must demonstrate a minimum of 30 consecutive days of flow.

Vegetation Success Criteria

Specific and measurable success criteria for plant density within the riparian buffers on the Project follow IRT Guidance. The interim measures of vegetative success for the Project is the survival of at least 320 planted three-year old trees per acre at the end of Year 3, 260 trees per acre with an average height of seven feet at the end of Year 5, and the final vegetative success criteria is 210 trees per acre with an average height of ten feet at the end of Year 7. Volunteer trees are counted, identified to species, and included in the yearly monitoring reports, but are not be counted towards the success criteria of total planted stems until present for greater than two seasons. Moreover, any single species can only account for up to 50 percent of the required number of stems within any vegetation plot. Any stems in excess of 50 percent will be shown in the monitoring table but will not be used to demonstrate success.

<table>
<tr><th>Level</th><th>Treatment</th><th>Objective</th><th>Monitoring Metric</th><th>Performance Standard</th></tr>
<tr><td>1 Hydrology</td><td>Convert land-use of Project reaches from pasture to riparian forest</td><td>Improve the transport of water from the watershed to the Project reaches in a non-erosive way</td><td>NA</td><td>NA</td></tr>
<tr><td rowspan="4">2 Hydraulic</td><td rowspan="4">Reduce bank height ratios and increase entrenchment ratios by reconstructing channels to mimic reference reach conditions</td><td rowspan="4">Improve flood bank connectivity by reducing bank height ratios and increase entrenchment ratios</td><td>Stage recorders:
Inspected quarterly</td><td>Four bankfull events occurring in separate years</td></tr>
<tr><td>Flow gauge:
Inspected quarterly</td><td>At least 30 days of continuous flow each year</td></tr>
<tr><td rowspan="2">Cross sections: Surveyed in
Years 1, 2, 3, 5 and 7</td><td>Entrenchment ratio shall be no less than 1.4 within restored reaches</td></tr>
<tr><td>Bank height ratio shall not exceed 1.2</td></tr>
<tr><td rowspan="5">3 Geomorphology</td><td rowspan="5">Establish a riparian buffer to reduce erosion and sediment transport into project streams. Establish stable banks with livestakes, erosion control matting, and other in stream structures.</td><td rowspan="5">Limit erosion rates and maintain channel stability

Improve bedform diversity (pool spacing, percent riffles, etc.

Increase buffer width to 50 feet</td><td>As-built stream profile</td><td>NA</td></tr>
<tr><td>Cross sections: Surveyed in
Years 1, 2, 3, 5 and 7</td><td>Entrenchment ratio shall be no less than 1.4 within restored reaches</td></tr>
<tr><td>Visual monitoring</td><td>Bank height ratio shall not exceed 1.2</td></tr>
<tr><td>Visual monitoring:
Performed at least semiannually</td><td>Identify and document significant stream problem areas; i.e. erosion, degradation, aggradation, etc.</td></tr>
<tr><td>Vegetation plots:
Surveyed in
Years 1, 2, 3, 5 and 7</td><td>MY 1-3: 320 trees/acre
MY 5: 260 trees/acre (7 ft. tall)
MY 7: 210 trees/acre (10 ft. tall)</td></tr>
<tr><td rowspan="2">4 Physicochemical</td><td rowspan="2">Exclude livestock from riparian areas with exclusion fence, conservation easement, and plant a riparian buffer</td><td rowspan="2"><u>Unmeasurable Objective/Expected Benefit</u>
Establish native hardwood riparian buffer and exclude livestock.</td><td>Vegetation plots:
Surveyed in
Years 1, 2, 3, 5 and 7
(indirect measurement)</td><td>MY 1-3: 320 trees/acre
MY 5: 260 trees/acre (7 ft. tall)
MY 7: 210 trees/acre (10 ft. tall)</td></tr>
<tr><td>Visual assessment of established fencing and conservation signage:
Performed at least semiannually
(indirect measurement)</td><td>Inspect fencing and signage. Identify and document any damaged or missing fencing and/or signs</td></tr>
</table>

1.4 Project Components

The Project area is comprised of a 20.58-acre easement involving four unnamed tributaries which drain directly into the Lower Little River which eventually drains into the Catawba River. These four Project streams are split into nine reaches based on treatment type and/or changes in flow: GF1-A, GF1-B, GF2-A, GF2-B, GF3-A, GF3-B, GF4-A, GF4-B, and GF5.

Due to landowner and utility requirements, there are four easement breaks within the project. One break is for an existing utility easement; fencing was installed across the utility easement in order to provide contiguous livestock exclusion to the stream. The other three are locations for current agricultural crossings. These easement breaks will allow landowners to continue current land-use and access throughout the property as needed.

Through stream restoration and enhancement, the Project presents 6,129 LF of stream, generating 4,093.95 Warm Stream Mitigation Units (SMU). The stream mitigation components are summarized below. Mitigation credits presented below are based upon the Approved Mitigation Plan. To account for areas of more or less than minimum 50-foot buffer widths, credits were adjusted using the USACE Wilmington District Stream Buffer Credit Calculator.

Mitigation Approach	Linear Feet	Ratio	Warm SMU
Restoration	2,851	1	2,851.00
Enhancement I	306	1.5	204.00
Enhancement II	2,338	2.5	935.20
Enhancement II	253	5	5060
Enhancement II	381	7.5	50.80
Total	**6,129**		**4,091.60**
Non-standard Buffer Width Adjustment			**+2.35***
Total Adjusted SMUs			**4,093.95**

* Credit adjustment for Non-standard Buffer Width calculation using the Wilmington District Stream Buffer Credit Calculator issued by the USACE in January 2018.

1.5 Stream Design/Approach

The Project includes Priority I and II Restoration and Enhancement Levels I and II. Stream restoration incorporates the design of a single-thread meandering channel, with parameters based on data taken from reference sites, published empirical relationships, regional curves developed from existing project streams, and NC Regional Curves. Analytical design techniques were also a crucial element of the project and were used to determine the design discharge and to verify the design as a whole. For livestock exclusion, woven wire fencing with one strand of barbed wire at the top was installed.

The following treatments were performed on the Project reaches:

Reach GF1-A
An Enhancement Level II approach was performed for this reach to address areas of bed instability, bank erosion, and buffer impacts. Enhancement activities included:

- Stabilizing a 2-foot knick-point located near station 00+70 by installing two rock sills,
- Removal and regrading of an existing culvert crossing near station 03+50,
- Bank stabilization beginning near station 05+75 by installing a log vane and brush toe,
- Stabilizing a 5-foot headcut located near station 07+10 by installing a rock step-pool,
- Livestock exclusion,

- Riparian planting,
- Invasive vegetation treatment.

Reach GF1-B

An inline restoration approach was used for the upstream portion of the reach to address eroding banks, channel entrenchment, and buffer impacts. Restoration activities included:

- Raising the channel bed with a mix of log sill, log vanes, riffle grade controls, and clay plugs,
- Normalizing the existing channel alignment to reduce channel stress,
- Establishing a riffle pool sequence throughout the reach,
- Installing brush toe protection on meander bends,
- Transitioning existing vertical channel banks to a minimum 5:1 floodplain slope,
- Livestock exclusion,
- Riparian planting,
- Invasive vegetation treatment.

An offline priority I restoration approach was performed for the middle portion of the reach to address, eroding banks, channel entrenchment, and channel braiding. Restoration activities included:

- Regrading a new single thread channel in the existing floodplain,
- Installing log and rock structures to provide grade control and habitat,
- Establishing a riffle pool sequence throughout the reach,
- Installing brush toe protection on meander bends,
- Filling the existing channel,
- Replacing an existing ford crossing with a culvert crossing,
- Livestock exclusion,
- Riparian planting.

An offline priority II restoration approach was performed for the downstream potion of the reach to address, eroding banks, channel entrenchment, and channel braiding. Restoration activities included:

- Regrading a new single thread channel and floodplain,
- Installing log and rock structures to provide grade control and habitat,
- Establishing a riffle pool sequence throughout the reach,
- Installing brush toe protection on meander bends,
- Filling the existing channel,
- Livestock exclusion,
- Riparian planting.

Enhancement Level II was performed along the portion of the reach that ties into the Lower Little River and is within its non-encroachment area. Enhancement activities included:

- Livestock exclusion,
- Riparian planting,
- Invasive vegetation treatment.

Reach GF2-A

An Enhancement Level II approach was perfomed for this reach to address areas of bed instability, bank erosion, and buffer impacts. Enhancement activities included:

- Stabilizing a 9-foot headcut located near station 01+30 by installing log sills and a log step pool,
- Bed stabilization beginning near station 05+00 by installing a double log drop,
- Bank stabilization beginning near station 07+50 by installing a log vane and brush toe,
- Livestock exclusion,
- Riparian planting,
- Invasive vegetation treatment.

Reach GF2-B

A mix of offline and inline restoration was performed for this portion of the reach to address eroding banks, channel entrenchment, historic impoundment, and buffer impacts. Restoration activities included:

- Regrading a new single thread channel in the existing floodplain,
- Installing log and rock structures to provide grade control and habitat,
- Establishing a riffle pool sequence throughout the reach,
- Installing brush toe protection on meander bends,
- Removing the relic earthen dam and relic pond,
- Filling the existing channel,
- Replacing an existing ford crossing with a culvert crossing,
- Livestock exclusion,
- Riparian planting.

Reach GF3-A

An Enhancement Level I approach was performed for this reach to address areas of bank erosion, and buffer impacts. Enhancement activities included:

- Stabilizing the left bank near station 08+75 by installing a brush toe,
- Stabilizing the left bank near station 10+25 by installing a brush toe,
- Bank stabilization beginning near station 09+40 and 09+80 by installing a log vane,
- Floodplain grading,
- Livestock exclusion,
- Riparian planting,
- Invasive vegetation treatment.

Reach GF3-B

An offline restoration approach was performed for this portion of the reach to address eroding banks, channel entrenchment, and buffer impacts. Restoration activities included:

- Regrading a new single thread channel in the existing floodplain,
- Installing log and rock structures to provide grade control and habitat,
- Establishing a riffle pool sequence throughout the reach,
- Installing brush toe protection on meander bends,
- Filling the existing channel,
- Replacing an existing ford crossing with a culvert crossing,
- Livestock exclusion,
- Riparian planting.

Reach GF4-A

An Enhancement Level II approach was performed for this reach to address areas of bed instability, bank erosion, and buffer impacts. Enhancement activities included:

- Stabilizing head cut near station 00+50 by grading a vegetated swale,
- Stabilizing banks near station 01+50 by grading back channel banks,
- Bed stabilization beginning near station 03+30 by installing a rock step-pool,
- Removing and replacing the two existing 24” Corrugated Metal Pipes,
- Livestock exclusion,
- Riparian planting,
- Invasive vegetation treatment.

Reach GF4-B

A limited Enhancement Level II approach was performed for this reach at a reduced credit ratio. Enhancement activities included:

- Livestock exclusion,
- Riparian planting,
- Trash removal,
- Invasive vegetation treatment.
    - To ensure bank stability, Chinese privet was flush cut and sprayed; therefore, subsoil was not disturbed. Roots will remain intact while plantings establish roots.

Reach GF5
An Enhancement Level II approach was performed for this reach to address buffer impacts and protect multiple spring heads. Enhancement activities included:

- Livestock exclusion,
- Riparian planting,
- Removal of existing concrete tank,
- Invasive vegetation treatment.

1.6 Construction and As-Built Conditions

Stream construction was completed in September 2020 and planting was completed in December 2020. The Groundhog Hollow Project was built to design plans and guidelines. However, in May 2021, approximately 200 linear feet of channel (three percent of the total stream length) and 10 structures underwent repairs. Generally, the problem areas were step pools, sills, banks, and old channel erosion that failed during extreme high flows that occurred before vegetation could be established. Banks were regraded and matting was added, sills were replaced, repaired, or added to reestablish proposed bed elevations, and check dams were installed in the old channel to discourage concentrated flow. Repair areas were livestaked in May 2021 and will be livestaked again if needed during the next dormant season. Additionally, bareroot supplemental planting will be performed next dormant season in the areas affected by the repairs if existing vegetation is insufficient. The locations of stream repairs are called out in **Figure 2** and structure repair specifics are displayed in **Appendix F.**

Fencing locations that encroach into the conservation easement will be rerouted in Q1 of 2022. Supplemental planting is not currently planned however temporary and permanent seeding will be applied if bare areas occur due to any of rerouted fences.

Planting plan changes included the removal of black gum (*Nyssa sylvatica*) and hackberry (*Celtis occidentalis*). Hackberry was replaced with sugarberry (*Celtis laevigata*) and the quantities of the other planted species were increased to compensate for not planting black gum. These changes were based on bare root availability. Minor monitoring device location changes were made during as-built installation; however, the quantities remained as proposed in the Final Mitigation Plan.

1.7 Monitoring Performance (MY1)

The Groundhog Hollow Monitoring activities were performed in November 2021. All monitoring year one data is present below and in the appendices. The Project is on track to meeting interim success criteria.

Vegetation

Monitoring of the nine fixed vegetation plots and three random vegetation plots was completed on November 10th and 11th, 2021. Vegetation data is in **Appendix C**, associated photos are in **Appendix B,** and plot locations are in **Appendix B**. MY1 monitoring data indicates that all but one of the plots are exceeding the interim success criteria of 320 planted stems per acre. Planted stem densities ranged from 445 to 688 planted stems per acre with a mean of 540 planted stems per acre across all fixed plots. Stem densities ranged from 40 to 364 planted stems per acre with a mean of 300 planted stems per acre across random plots. Total average stem density across all plots is 465 stems per acre. Random plot one (R1) failed to meet success criteria, the plot and surrounding area of GF4 will be replanted in MY2. A total of seven species were documented within the plots. Volunteer species were not noted at monitoring year one but are expected to establish in upcoming years. Chinese privet (*Ligustrum sinensis*) along GF4-B, approximately 0.21 acres, was flush cut but not excavated to promote bank stability in December, 2021 of MY1. This area will be monitored for vegetative succession, and treated again if deemed necessary. The average planted stem height in the vegetation plots was 1.7 feet.

Visual assessment of vegetation outside of the monitoring plots indicates that the herbaceous vegetation is becoming well established throughout the project.

Stream Geomorphology

A total of 22 cross sections were installed on January 27, 2021 and geomorphology data collection for MY1 was conducted on November 10, 2021. Summary tables and cross section plots are in **Appendix D**. Overall the cross sections and profile relatively match the proposed design. Slight degradation is being observed on pool cross section six and pool cross section 13, this is believed to be due to sediment loads moving through the system. Riffle cross sections above and below cross sections six and 13 remain stable and close to design parameters. These pool cross sections are not considered a concern at this time but will be monitored closely in MY2. The monitoring year one conditions show that shear stress and velocities have been reduced for all restoration/enhancement reaches. All reaches were designed as gravel bed channels and remain classified as gravel bed channels post-construction.

Visual assessment of the stream channel was performed to document signs of instability, such as eroding banks, structural instability, or excessive sedimentation. Two structures are beginning to show wear on GF2-A, where the stream is potentially beginning to add stress to the banks around the log sills. On enhancement reach GF4-A a log sill is beginning to scour out a pool below. These potential problem areas will be monitored and if addressed if they continue to worsen in MY2, but it is anticipated that site vegetation will anchor these structures. Problem areas are cataloged in **Appendix B**. The channel over all is transporting sediment as designed and will continue to be monitored for aggradation and degradation.

Stream Hydrology

Three stage recorders and one flow gauge were installed on February 4, 2021: one stage recorder on GF1-B, one stage recorder on GF2-B, one stage recorder on GF3-B, and one flow gauge on GF4-A. The stage recorders are in place to document bankfull events and the flow gauge to document at least intermittent flow. The stage recorder on GF1-B had 15 bankfull events with the highest reading being 1.90 feet above the top of bank. The stage recorded on GF2-B recorded six bankfull events with the highest reading being 1.58 feet above top of bank. The stage recorded on GF3-B recorded eight bankfull events with the highest reading being 1.68 feet above top of bank. Despite the large number of out of bank events the areas surrounding the gages are stable with vegetation already established and were designed for out of bank events. The flow gauge on GF4-A recorded one flow event lasting 184 consecutive days. This flow was reset after the stream and structure repairs done in May 2021, resulting in accurate readings. Gauge locations can be found on **Figure 2** and photos are in **Appendix B**.

2.0 Methods

Stream cross section monitoring was conducted using a Topcon GTS-312 Total Station. Three-dimensional coordinates associated with cross-section data were collected in the field (NAD83 State Plane feet FIPS 3200). Morphological data were collected at 22 cross-sections. Survey data were imported into CAD, ArcGIS®, and Microsoft Excel® for data processing and analysis. The stage recorders include an automatic pressure transducer placed in PVC casing in a pool. The elevation of the bed and top of bank at each stage recorder are used to detect bankfull events. The flow gauge was also installed in a pool and records flow conditions at an hourly interval. Water level data from the flow gauge is corrected using the height of the downstream riffle to detect stream flow events.

Vegetation success is being monitored at nine fixed monitoring plots and three random monitoring plot. Vegetation plot monitoring follows the CVS-EEP Level 2 Protocol for Recording Vegetation, version 4.2 (Lee et al. 2008) and includes analysis of species composition and density of planted species. Data are processed using the CVS data entry tool. In the field, the four corners of each plot were permanently marked with PVC at the origin and metal conduit at the other corners. Photos of each plot are to be taken from the origin each monitoring year. The random plots are to be collected in locations where there are no permanent vegetation plots. Random plots will most likely be collected in the form of 100 square meter belt transects with variable dimensions. Tree species and height will be recorded for each planted stem and the transects will be mapped and new locations will be monitored in subsequent years.

3.0 References

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Lee Michael T., Peet Robert K., Roberts Steven D., and Wentworth Thomas R., 2008. *CVS-EEP Protocol for Recording Vegetation Level*. Version 4.2

Peet, R.K., Wentworth, T.S., and White, P.S. (1998), *A flexible, multipurpose method for recording vegetation composition and structure*. Castanea 63:262-274

Resource Environmental Solutions (2019). Groundhog Hollow Project Final Mitigation Plan.

Schafale, M.P. 2012. Guide to the Natural Communities of North Carolina, Fourth Approximation. North Carolina Natural Heritage Program, Division of Parks and Recreation, NCDENR, Raleigh, NC.

USACE. (2016). Wilmington District Stream and Wetland Compensatory Mitigation Update. NC: Interagency Review Team (IRT).

Appendix A

Background Tables

Table 1. Groundhog Hollow (100049) - Mitigation Assets and Components

Project Segment	Existing Footage or Acreage	Mitigation Plan Footage or Acreage	Mitigation Category	Restoration Level	Priority Level	Mitigation Ratio (X:1)	Mitigation Plan Credits		As-Built Footage or Acreage	Comments
GF1-A	1,192	1,206	Warm	EII	N/A	2.50000	482.400		1202	Bed and bank stabilization, riparian planting, livestock exclusion (Powerline easement: STA 12+34 to 12+70)
GF1-A	62	62	Warm	EII	N/A	2.50000	24.800		63	Bed and bank stabilization, riparian planting, livestock exclusion
GF1-B	1034	1,020	Warm	R	P1/P2	1.00000	1020.000		1031	Channel restoration, riparian planting, livestock exclusion (Stream crossing: STA 23+52 to STA 24+12)
GF1-B	936	986	Warm	R	P1/P2	1.00000	986.000		994	Channel restoration, riparian planting, livestock exclusion
GF1-B	130	130	Warm	EII	N/A	2.50000	52.000		133	Riparian planting, livestock exclusion
GF2-A	642	642	Warm	EII	N/A	2.50000	256.800		636	Bed and bank stabilization, riparian planting, livestock exclusion
GF2-B	442	451	Warm	R	P1/P2	1.00000	451.000		459	Channel restoration, riparian planting, livestock exclusion (Stream crossing: STA 12+80 to STA 13+10)
GF2-B	167	83	Warm	R	P1/P2	1.00000	83.000		84	Channel restoration, riparian planting, livestock exclusion
GF3-A	311	306	Warm	EI	N/A	1.50000	204.000		306	Bed and bank stabilization, riparian planting, livestock exclusion (Stream crossing: STA 10+75 to STA 11+07)
GF3-B	270	311	Warm	R	P1	1.00000	311.000		311	Channel restoration, riparian planting, livestock exclusion
GF4-A	283*	298	Warm	EII	N/A	2.50000	119.200		283	Bed and bank stabilization, riparian planting, livestock exclusion (Stream crossing: STA 3+54 to STA 3+88)
GF4-B	381	381	Warm	EII	N/A	7.50000	50.800		383	Riparian planting, livestock exclusion
GF5	253	253	Warm	EII	N/A	5.00000	50.600		249	Riparian planting, livestock exclusion

Note: All crossings and utility easements have been removed from credit calculations.

Project Credits

Restoration Level	Stream			Riparian Wetland		Non-Rip Wetland	Coastal Marsh
	Warm	Cool	Cold	Riverine	Non-Riv		
Restoration	2851.000						
Re-establishment							
Rehabilitation							
Enhancement							
Enhancement I	204.000						
Enhancement II	935.200						
Enhancement II (5:1)	50.600						
Enhancement II (7.5:1)	50.800						
Creation							
Preservation							
NSBW	2.350						
Total	**4093.950**						

Table 2. Project Activity and Reporting History
Groundhog Hollow Mitigation Project

Elapsed Time Since grading complete: 14 months
Elapsed Time Since planting complete: 11 months
Number of reporting Years[1]: 1

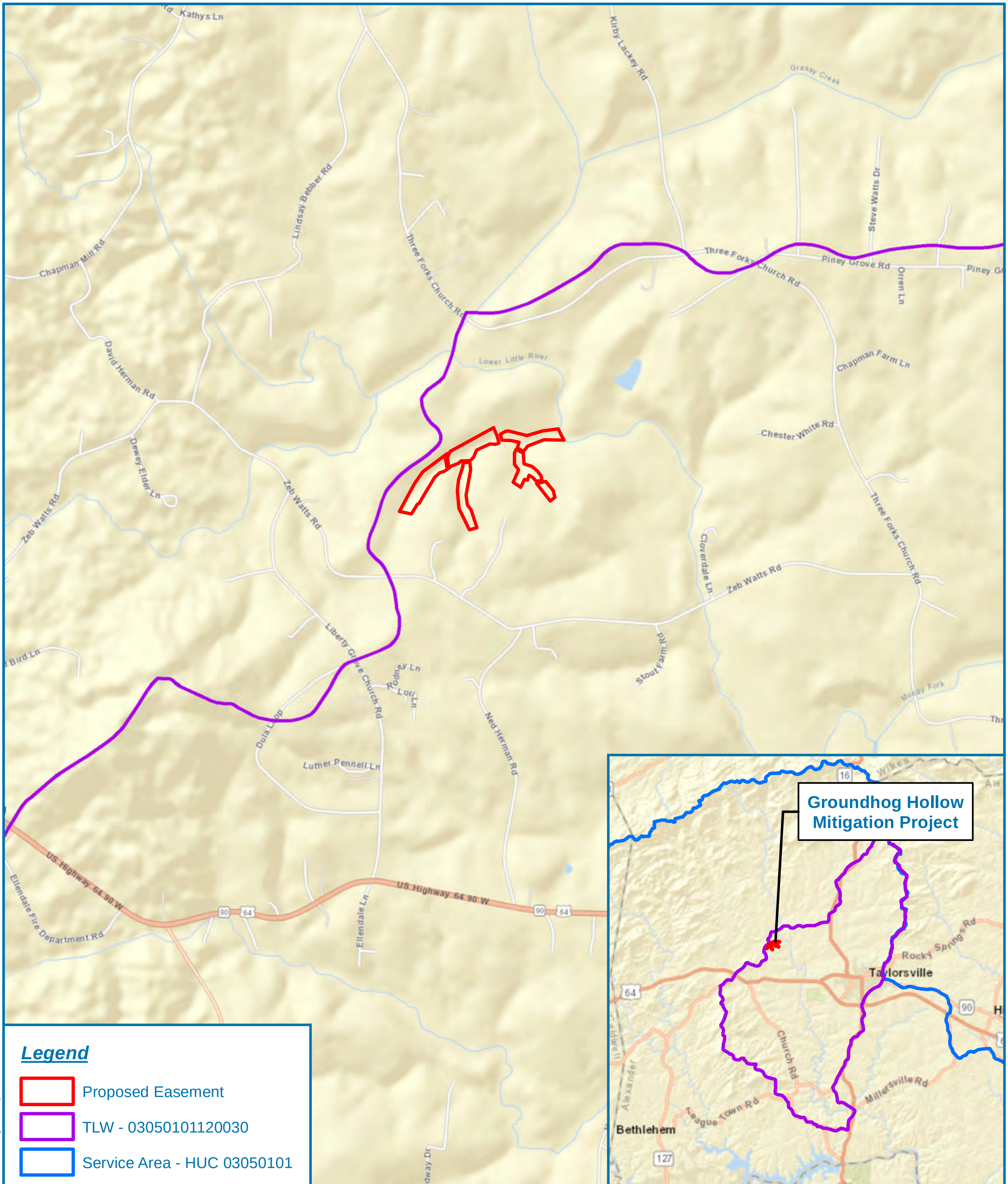
Activity or Deliverable	**Data Collection Complete**	**Completion or Delivery**
Restoration Plan	NA	Dec-19
Final Design – Construction Plans	NA	Jun-20
Stream Construction	NA	Sep-20
Site Planting	NA	Dec-20
As-built (Year 0 Monitoring – baseline)	Feb-21	Jun-21
Stream Channel and Structure Reapirs	NA	May-21
Invasive Plant Treatment	NA	Dec-21
Year 1 Monitoring	Nov-21	Dec-21
Year 2 Monitoring		
Year 3 Monitoring		
Year 4 Monitoring		
Year 5 Monitoring		
Year 6 Monitoring		
Year 7 Monitoring		

1 = The number of reports or data points produced excluding the baseline

Table 3. Project Contacts Table
Groundhog Hollow Mitigation Project

Designer	RES / 3600 Glenwood Ave., Suite 100, Raleigh, NC 27612
Primary project design POC	Ben Carroll, PE
Construction Contractor	Carolina Environmental Contracting Inc. / PO Box 1905 Mount Airy, NC 27030
Construction contractor POC	James Poe
Survey Contractor	WSP USA / 434 Fayetteville St, Suite 1500, Raleigh, NC 27601
Survey contractor POC	Barry Creed, PLS
Planting Contractor	Shenandoah Habitats
Planting contractor POC	David Coleman
Monitoring Performers	RES / 3600 Glenwood Ave, Suite 100, Raleigh, NC 27612
Monitoring POC	Ryan Medric (919) 741-6268

Table 4. Project Background Information									
Project Name	Groundhog Hollow								
County	Alexander								
Project Area (acres)	20.58								
Project Coordinates (latitude and longitude)	35.937201° N, -81.237783° W								
Planted Acreage (Acres of Woody Stems Planted)	14.42								
Project Watershed Summary Information									
Physiographic Province	Northern Inner Piedmont								
River Basin	Catawba								
USGS Hydrologic Unit 8-digit	3050101	USGS Hydrologic Unit 14-digit	3050101120030						
DWR Sub-basin	03-08-32								
Project Drainage Area (Acres and Square Miles)	156 (0.24)								
Project Drainage Area Percentage of Impervious Area	<1%								
CGIA Land Use Classification	Managed Herbaceous Cover, Mixed Upland Hardwoods								
Reach Summary Information									
Parameters	**Reach GF1-A**	**Reach GF1-B**	**Reach GF2-A**	**Reach GF2-B**	**Reach GF3-A**	**Reach GF3-B**	**Reach GF4-A**	**Reach GF4-B**	**Reach GF5**
Length of reach (linear feet)	1,254	2,100	642	609	311	270	283	381	253
Valley confinement (Confined, moderately confined, unconfined)	Moderately confined	Moderately confined/Unconfined	Confined	Moderately confined	Moderately confined	Unconfined	Moderately confined/Unconfined	Confined	Moderately confined
Drainage area (Acres and Square Miles)	42 (0.07)	156 (0.24)	35 (0.05)	45 (0.07)	36 (0.06)	39 (0.06)	16 (0.02)	23 (0.04)	9 (0.01)
Perennial, Intermittent, Ephemeral	Perennial	Perennial	Perennial	Perennial	Perennial	Perennial	Intermittent	Intermittent	Perennial
NCDWR Water Quality Classification	C	C	C	C	C	C	C	C	C
Stream Classification (existing)	F4b	G4c/C4	F4b	F4b	G4	G5/6	G4	F4b	C4/5a
Stream Classification (proposed)	F4b	C4/E4	F4b	C4/E4	G4	C4/E4	G4	F4b	C4/5a
Evolutionary trend (Simon)	III / IV	II / III	IV	III	III / IV	III	IV / V	IV	I
FEMA classification	Zone X	Zone X and Zone AE	Zone X	Zone X	Zone X	Zone X	Zone X	Zone X	Zone X



N W E S 0 1,000 2,000 Feet	**Figure 1 - Site Location Map** **Groundhog Hollow Mitigation Project** **Alexander County, North Carolina**	Date: 9/17/2020 Drawn by: MDD Checked by: BPB 1 inch = 2,000 feet	res

Appendix B

Visual Assessment Data

res

N
W
E
S
0 100 200
Feet

Figure 2

Current Conditions Plan View

MY1 2021

Groundhog Hollow Mitigation Site

Alexander County, NC

Date: 2/8/2022	Drawn by: DD
Lat: 35.937509	Long: -81.234876

LEGEND

- Conservation Easement
- Fixed Veg Plot >320 stems/acre
- Random Veg Plots
  - >320 stems/acre
  - <320 stems/acre
- Cross Section
- As-Built Top of Bank
- Existing Top of Bank
- Existing Wetland
- Stream Mitigation
  - Restoration
  - Enhancement I
  - Enhancement II
  - Enhancement II (5:1)
  - Enhancement II (7.5:1)
  - No Credit
- Stream Structure
- Flow Gauge
- Stage Recorder
- Ambient

Vegetation Condition Assessment

Invasive Species	Target Community: Present	Marginal	Absent
Absent	No Fill		
Present			

Visual Stream Stability Assessment Table 5a

Reach GF1-B
Assessed Stream Length 2006
Assessed Bank Length 4012
Last Site Inspection - Nov 10, 2021

Major Channel Category		**Metric**	**Number Stable, Performing as Intended**	**Total Number in As-built**	**Amount of Unstable Footage**	**% Stable, Performing as Intended**
Bank	**Surface Scour/Bare Bank**	Bank lacking vegetative cover resulting simply from poor growth and/or surface scour			0	100%
	Toe Erosion	Bank toe eroding to the extent that bank failure appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	100%
	Bank Failure	Fluvial and geotechnical - rotational, slumping, calving, or collapse			0	100%
Totals					0	100%
Structure	**Grade Control**	Grade control structures exhibiting maintenance of grade across the sill.	32	32		100%
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in DMS monitoring guidance document)	60	60		100%

Visual Stream Stability Assessment Table 5b

Reach GF2-B
Assessed Stream Length 534
Assessed Bank Length 1068
Last Site Inspection - Nov 10, 2021

Major Channel Category		**Metric**	**Number Stable, Performing as Intended**	**Total Number in As-built**	**Amount of Unstable Footage**	**% Stable, Performing as Intended**
Bank	**Surface Scour/Bare Bank**	Bank lacking vegetative cover resulting simply from poor growth and/or surface scour			0	100%
	Toe Erosion	Bank toe eroding to the extent that bank failure appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	100%
	Bank Failure	Fluvial and geotechnical - rotational, slumping, calving, or collapse			0	100%
Totals					0	100%
Structure	**Grade Control**	Grade control structures exhibiting maintenance of grade across the sill.	15	15		100%
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in DMS monitoring guidance document)	18	18		100%

Visual Stream Stability Assessment Table 5c

Reach GF3-B
Assessed Stream Length 311
Assessed Bank Length 622
Last Site Inspection - Nov 10, 2021

Major Channel Category		**Metric**	**Number Stable, Performing as Intended**	**Total Number in As-built**	**Amount of Unstable Footage**	**% Stable, Performing as Intended**
Bank	**Surface Scour/Bare Bank**	Bank lacking vegetative cover resulting simply from poor growth and/or surface scour			0	100%
	Toe Erosion	Bank toe eroding to the extent that bank failure appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	100%
	Bank Failure	Fluvial and geotechnical - rotational, slumping, calving, or collapse			0	100%
Totals					0	100%
Structure	**Grade Control**	Grade control structures exhibiting maintenance of grade across the sill.	6	6		100%
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in DMS monitoring guidance document)	12	12		100%

Table 6 **Vegetation Condition Assessment**

Planted Acreage[1] **14.42**

Last Site Inspection: Nov 10, 2021

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
1. Bare Areas	Very limited cover of both woody and herbaceous material.	0.1 acres	Red Simple Hatch	0	0.00	0.0%
2. Low Stem Density Areas	Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria.	0.1 acres	Orange Simple Hatch	1	0.22	1.5%
			Total	1	0.22	1.5%
3. Areas of Poor Growth Rates or Vigor	Areas with woody stems of a size class that are obviously small given the monitoring year.	0.25 acres	Orange Simple Hatch	0	0.00	0.0%
			Cumulative Total	1	0.22	1.5%

Easement Acreage[2] **20.66**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Easement Acreage
4. Invasive Areas of Concern[4]	Areas or points (if too small to render as polygons at map scale).	1000 SF	Yellow Crosshatch	0	0.00	0.0%
5. Easement Encroachment Areas[3]	Areas or points (if too small to render as polygons at map scale).	none	Red Simple Hatch	0	0.00	0.0%

1 = Enter the planted acreage within the easement. This number is calculated as the easement acreage minus any existing mature tree stands that were not subject to supplemental planting of the understory, the channel acreage, crossings or any other elements not directly planted as part of the project effort.

2 = The acreage within the easement boundaries.

3 = Encroachment may occur within or outside of planted areas and will therefore be calculated against the overall easement acreage. In the event a polygon is cataloged into items 1, 2 or 3 in the table and is the result of encroachment, the associated acreage should be tallied in the relevant item (i.e., item 1,2 or 3) as well as a parallel tally in item 5.

4 = Invasives may occur in or out of planted areas, but still within the easement and will therefore be calculated against the overall easement acreage. Invasives of concern/interest are listed below. The list of high concern spcies are those with the potential to directly outcompete native, young, woody stems in the short-term (e.g. monitoring period or shortly thereafter) or affect the community structure for existing, more established tree/shrub stands over timeframes that are slightly longer (e.g. 1-2 decades). The low/moderate concern group are those species that generally do not have this capacity over the timeframes discussed and therefore are not expected to be mapped with regularity, but can be mapped, if in the judgement of the observer their coverage, density or distribution is suppressing the viability, density, or growth of planted woody stems. Decisions as to whether remediation will be needed are based on the integration of risk factors by EEP such as species present, their coverage, distribution relative to native biomass, and the practicality of treatment. For example, even modest amounts of Kudzu or Japanese Knotweed early in the projects history will warrant control, but potentially large coverages of Microstegium in the herb layer will not likley trigger control because of the limited capacities to impact tree/shrub layers within the timeframes discussed and the potential impacts of treating extensive amounts of ground cover. Those species with the "watch list" designator in gray shade are of interest as well, but have yet to be observed across the state with any frequency. Those in *red italics* are of particular interest given their extreme risk/threat level for mapping as points where isolated specimens are found, particularly ealry in a projects monitoring history. However, areas of discreet, dense patches will of course be mapped as polygons. The symbology scheme below was one that was found to be helpful for symbolzing invasives polygons, particulalry for situations where the conditon for an area is somewhere between isolated specimens and dense, discreet patches. In any case, the point or polygon/area feature can be symbolized to describe things like high or low concern and species can be listed as a map inset, in legend items if the number of species are limited or in the narrative section of the executive summary.

Groundhog Hollow MY1 Vegetation Monitoring Plot Photos


Vegetation Plot 1 (11/10/2021)


Vegetation Plot 2 (11/10/2021)


Vegetation Plot 3 (11/10/2021)


Vegetation Plot 4 (11/10/2021)

Vegetation Plot 5 (11/10/2021)

Vegetation Plot 6 (11/10/2021)

Vegetation Plot 7 (11/11/2021)

Vegetation Plot 8 (11/11/2021)

Vegetation Plot 9 (11/10/2021)

Random Vegetation Plot 1 (11/10/2021)

Random Vegetation Plot 2 (11/10/2021)

Random Vegetation Plot 3 (11/10/2021)

Groundhog Hollow Monitoring Device Photos

Stage Recorder GF1-B

Stage Recorder GF2-B

Stage Recorder GF3-A

Flow Gauge GF4-A

Monitoring Year 1 – 2021 Problem Area Photos

Low Stem Density Area (R1)

Invasive Species Area – Treated 12/2021 (GF4-B)

Structure Decline - GF4-A

Structure Decline – GF2-A


Structure Decline- GF2-A

Groundhog Hollow Crossing Photos

Crossing GF2-B - Upstream (11/10/2021)

Crossing GF2-B – Downstream (11/10/2021)

Crossing GF1-B – Downstream (11/10/2021)

Crossing GF1-B – Upstream (11/10/2021)

Groundhog Hollow Crossing Photos

Crossing GF3 – Downstream (11/10/2021)

Crossing GF3 – Upstream (11/10/2021)

Crossing GF4 – Downstream (11/10/2021)

Crossing GF2-B - Upstream (11/10/2021)

Appendix C

Vegetation Plot Data

Table 7. Planted Species Summary

Common Name	Scientific Name	Mit Plan %	As-Built %	Wetland Indicator Status	Total Stems Planted
White Oak	*Quercus alba*	15	15	FACU	2,100
River Birch	*Betula nigra*	15	15	FACW	2,100
Sycamore	*Platanus occidentalis*	15	15	FACW	2,100
Willow Oak	*Quercus phellos*	15	15	FAC	2,100
Persimmon	*Diospyros virginiana*	5	10	FAC	1,500
Northern Red Oak	*Quercus rubra*	10	10	FAC	1,500
Yellow Poplar	*Liriodendron tulipifera*	10	10	FACU	1,500
Sugarberry	*Celtis laevigata*	0	10	FACW	1,500
Hackberry	*Celtis occidentalis*	10	0	FACU	0
Blackgum	*Nyssa sylvatica*	5	0	FAC	0
				Total	14,400
				Planted Area	14.42
				As-built Planted Stems/Acre	999

Table 8. Vegetation Plot Mitigation Success Summary

Plot #	Planted Stems/Acre	Volunteer Stems/Acre	Total Stems/Acre	Success Criteria Met?	Average Planted Stem Height (ft)
1	486	0	486	Yes	1.3
2	445	0	445	Yes	1.5
3	486	0	486	Yes	1.7
4	486	0	486	Yes	1.8
5	486	0	486	Yes	2.8
6	526	0	526	Yes	1.8
7	647	0	647	Yes	1.7
8	688	0	688	Yes	1.7
9	607	0	607	Yes	1.3
R1	40	0	40	No	0.8
R2	324	0	324	Yes	2.4
R3	364	0	364	Yes	1.5
Project Avg	**465**	**0**	**465**	**Yes**	1.7

Table 9. Stem Count Total and Planted by Plot Species

			Current Plot Data (MY1 2021)																										
			100049-01-0001			100049-01-0002			100049-01-0003			100049-01-0004			100049-01-0005			100049-01-0006			100049-01-0007			100049-01-0008			100049-01-0009		
Scientific Name	Common Name	Species Type	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Betula nigra	river birch	Tree	4	4	4							2	2	2	6	6	6							4	4	4	6	6	6
Celtis laevigata	sugarberry	Tree	1	1	1				2	2	2							4	4	4	8	8	8	1	1	1			
Diospyros virginiana	common persimmon	Tree										1	1	1															
Platanus occidentalis	American sycamore	Tree							2	2	2	2	2	2	3	3	3				1	1	1	5	5	5	6	6	6
Quercus alba	white oak	Tree				3	3	3	2	2	2							1	1	1	3	3	3	1	1	1			
Quercus phellos	willow oak	Tree	7	7	7							3	3	3	3	3	3							4	4	4	1	1	1
Quercus rubra	northern red oak	Tree				8	8	8	6	6	6	4	4	4				8	8	8	4	4	4	2	2	2	2	2	2
		Stem count	12	12	12	11	11	11	12	12	12	12	12	12	12	12	12	13	13	13	16	16	16	17	17	17	15	15	15
		size (ares)	1			1			1			1			1			1			1			1			1		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02		
		Species count	3	3	3	2	2	2	4	4	4	5	5	5	3	3	3	3	3	3	4	4	4	6	6	6	4	4	4
		Stems per ACRE	486	486	486	445	445	445	486	486	486	486	486	486	486	486	486	526	526	526	647	647	647	688	688	688	607	607	607

Groundhog Hollow			Current Plot Data (MY1 2021)									Annual Means					
			100049-01-R1			100049-01-R2			100049-01-R3			MY1 (2021)			MY0 (2021)		
Scientific Name	Common Name	Species Type	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Betula nigra	river birch	Tree										22	22	22	33	33	33
Celtis laevigata	sugarberry	Tree				1	1	1				17	17	17	18	18	18
Diospyros virginiana	common persimmon	Tree										1	1	1	1	1	1
Platanus occidentalis	American sycamore	Tree				4	4	4				23	23	23	22	22	22
Quercus alba	white oak	Tree										10	10	10	12	12	12
Quercus phellos	willow oak	Tree				3	3	3				21	21	21	26	26	26
Quercus rubra	northern red oak	Tree	1	1	1				9	9	9	44	44	44	41	41	41
		Stem count	1	1	1	8	8	8	9	9	9	138	138	138	153	153	153
		size (ares)	1			1			1			12			12		
		size (ACRES)	0.02			0.02			0.02			0.30			0.30		
		Species count	1	1	1	3	3	3	1	1	1	7	7	7	7	7	7
		Stems per ACRE	40	40	40	324	324	324	364	364	364	465	465	465	516	516	516

Appendix D

Stream Measurement and

Geomorphology Data

Table 10. Baseline Stream Data Summary
Groundhog Hollow Mitigation Site - Reach GF1-B

Parameter	Gauge[2]	Regional Curve			Pre-Existing Condition						Reference Reach(es) Data						Design			Monitoring Baseline					
Dimension and Substrate - Riffle Only		LL	UL	Eq.	Min	Mean	Med	Max	SD[5]	n	Min	Mean	Med	Max	SD[5]	n	Min	Med	Max	Min	Mean	Med	Max	SD[5]	n
Bankfull Width (ft)		---	---	---	4.4	--	6.3	8.3	---	3	4.4	---	---	---	---	1	5.2	5.3	6.8	6.2	6.8	6.4	8.3	0.8	7
Floodprone Width (ft)					6.5	---	8.3	22.5	---	3	12.0	---	---	20.0	---	1	19.2	19.3	20.8	44.8	47.6	47.0	50.6	2.5	7
Bankfull Mean Depth (ft)		---	---	---	0.5	---	0.6	1.1	---	3	0.5	---	---	0.6	---	1	0.5	0.5	0.7	---	---	---	---	---	---
[1]Bankfull Max Depth (ft)					0.9	---	0.9	1.3	---	3	0.8	---	---	0.9	---	1	0.7	0.7	1.0	0.6	1.0	1.0	1.4	0.2	7
Bankfull Cross Sectional Area (ft^2)		---	---	---	2.6	---	4.5	6.8	---	3	2.1	---	---	2.8	---	1	2.5	2.7	5.0	1.9	3.8	3.4	6.2	1.4	7
Width/Depth Ratio					5.9	---	7.6	15.2	---	3	6.9	---	---	9.2	---	1	9.2	10.3	10.7	---	---	---	---	---	---
Entrenchment Ratio					1.3	---	1.5	2.9	---	3	2.7	---	---	4.5	---	1	3.6	3.7	3.9	5.5	7.1	7.3	8.2	1.0	7
[1]Bank Height Ratio					1.3	---	2.3	2.8	---	3	1.0	---	---	2.5	---	1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	7
Profile																									
Riffle Length (ft)					---	---	---	---	---	---	4	---	---	18	---	---	3.9	---	19.8	2	8	7	18	3	84
Riffle Slope (ft/ft)					---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.0	3.1	2.5	11.4	2.3	84.0
Pool Length (ft)					---	---	---	---	---	---	3	---	---	8	---	---	3.2	---	9	3	16	14	87	10	83
Pool Max depth (ft)					---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pool Spacing (ft)					---	---	---	---	---	---	12	---	---	35	---	---	13.1	---	38.8	9	24	22	92	11	83
Pattern																									
Channel Beltwidth (ft)					---	---	---	---	---	---	15	---	---	35	---	---	16.7	---	39	16.7	---	---	39	---	---
Radius of Curvature (ft)					---	---	---	---	---	---	6	---	---	17	---	---	6.7	---	18.7	6.7	---	---	18.7	---	---
Rc:Bankfull width (ft/ft)					---	---	---	---	---	---	1.4	---	---	3.9	---	---	1.2	---	3.3	1.2	---	---	3.3	---	---
Meander Wavelength (ft)					---	---	---	---	---	---	23	---	---	43	---	---	25.3	---	47.7	25.3	---	---	47.7	---	---
Meander Width Ratio					---	---	---	---	---	---	3.4	---	---	8	---	---	4.4	---	8.3	4.4	---	---	8.3	---	---
Transport parameters																									
Reach Shear Stress (competency) lb/f^2					---												---			---					
Max part size (mm) mobilized at bankfull					---												---			---					
Stream Power (transport capacity) W/m^2					---												---			---					
Additional Reach Parameters																									
Rosgen Classification					F4b						E4/5						C4/E4			C4/E4					
Bankfull Velocity (fps)		---	---	---	---						---						---			---					
Bankfull Discharge (cfs)		---	---	---	---												---			---					
Valley length (ft)					1168						842						1535			1535					
Channel Thalweg length (ft)					1350						995						689			689					
Sinuosity (ft)					1.16						1.18						1.17			1.17					
Water Surface Slope (Channel) (ft/ft)					---						---						---			---					
Channel slope (ft/ft)					0.024						0.0033						0.011			0.011					
[3]Bankfull Floodplain Area (acres)					---						---						---			---					
[4]% of Reach with Eroding Banks					---						---														
Channel Stability or Habitat Metric					---						---														
Biological or Other					---						---														

Shaded cells indicate that these will typically not be filled in.

1 = The distributions for these parameters can include information from both the cross-section measurements and the longitudinal profile. 2 = For projects with a proximal USGS gauge in-line with the project reach (added bankfull verification - rare).

3. Utilizing XS measurement data produce an estimate of the bankfull floodplain area in acres, which should be the area from the top of bank to the toe of the terrace riser/slope.

4 = Proportion of reach exhibiting banks that are eroding based on the visual survey for comparison to monitoring data; 5. Of value/needed only if the n exceeds 3

Table 10. Baseline Stream Data Summary (continued)
Groundhog Hollow Mitigation Site - Reach GF2-B

Parameter	Gauge[2]	Regional Curve			Pre-Existing Condition						Reference Reach(es) Data						Design			Monitoring Baseline					
Dimension and Substrate - Riffle Only		LL	UL	Eq.	Min	Mean	Med	Max	SD[5]	n	Min	Mean	Med	Max	SD[5]	n	Min	Med	Max	Min	Mean	Med	Max	SD[5]	n
Bankfull Width (ft)		---	---	---	---	---	7.7	---	---	1	---	---	4.4	---	---	1	---	4.9	---	5.5	6.6	6.8	7.5	1.0	3
Floodprone Width (ft)					---	---	8.1	---	---	1	---	---	12.0	20.0	---	1	---	16.9	---	38.6	44.9	45.4	50.8	6.1	3
Bankfull Mean Depth (ft)		---	---	---	---	---	0.5	---	---	1	---	---	0.5	0.6	---	1	---	0.4	---	---	---	---	---	---	---
[1]Bankfull Max Depth (ft)					---	---	0.8	---	---	1	---	---	0.8	0.9	---	1	---	0.6	---	1.0	1.1	1.1	1.2	0.1	3
Bankfull Cross Sectional Area (ft^2)		---	---	---	---	---	4.0	---	---	1	---	---	2.1	2.8	---	1	---	2.2	---	3.0	3.8	3.7	4.8	0.9	3
Width/Depth Ratio					---	---	14.8	---	---	1	---	---	6.9	9.2	---	1	---	11.1	---	---	---	---	---	---	---
Entrenchment Ratio					---	---	1.1	---	---	1	---	---	2.7	4.5	---	1	---	3.4	---	5.7	6.9	6.8	8.3	1.3	3
[1]Bank Height Ratio					---	---	2.1	---	---	1	---	---	1.0	2.5	---	1	---	1.0	---	1.0	1.0	1.0	1.0	0.0	3
Profile																									
Riffle Length (ft)					---	---	---	---	---	---	4	---	---	18	---	---	3.3	---	16.9	3	9	6	48	9	27
Riffle Slope (ft/ft)					---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.5	3.4	2.5	16.3	3.2	27.0
Pool Length (ft)					---	---	---	---	---	---	3	---	---	8	---	---	2.7	---	7.6	6	12	11	22	4	26
Pool Max depth (ft)					---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pool Spacing (ft)					---	---	---	---	---	---	12	---	---	35	---	---	11.1	---	33	12	21	19	65	11	25
Pattern																									
Channel Beltwidth (ft)					---	---	---	---	---	---	15	---	---	35	---	---	14	---	33	14	---	---	33	---	---
Radius of Curvature (ft)					---	---	---	---	---	---	6	---	---	17	---	---	6	---	16	6	---	---	16	---	---
Rc:Bankfull width (ft/ft)					---	---	---	---	---	---	1.4	---	---	3.9	---	---	1.2	---	3.3	1.2	---	---	3.3	---	---
Meander Wavelength (ft)					---	---	---	---	---	---	23	---	---	43	---	---	30	---	56	30	---	---	56	---	---
Meander Width Ratio					---	---	---	---	---	---	3.4	---	---	8	---	---	6.1	---	11.5	6.1	---	---	11.5	---	---
Transport parameters																									
Reach Shear Stress (competency) lb/f^2					---												---			---					
Max part size (mm) mobilized at bankfull					---												---			---					
Stream Power (transport capacity) W/m^2					---												---			---					
Additional Reach Parameters																									
Rosgen Classification					F4b						E4/5						C4/E4			C4/E4					
Bankfull Velocity (fps)		---	---	---	---						---						---			---					
Bankfull Discharge (cfs)		---	---	---	---												---			---					
Valley length (ft)					573						842						492			492					
Channel Thalweg length (ft)					680						995						53			53					
Sinuosity (ft)					1.19						1.18						1.14			1.14					
Water Surface Slope (Channel) (ft/ft)					---						---						---			---					
Channel slope (ft/ft)					0.031						0.0033						0.02			0.02					
[3]Bankfull Floodplain Area (acres)					---						---						---			---					
[4]% of Reach with Eroding Banks					---						---														
Channel Stability or Habitat Metric					---						---														
Biological or Other					---						---														

Shaded cells indicate that these will typically not be filled in.

1 = The distributions for these parameters can include information from both the cross-section measurements and the longitudinal profile. 2 = For projects with a proximal USGS gauge in-line with the project reach (added bankfull verification - rare).

3. Utilizing XS measurement data produce an estimate of the bankfull floodplain area in acres, which should be the area from the top of bank to the toe of the terrace riser/slope.

4 = Proportion of reach exhibiting banks that are eroding based on the visual survey for comparison to monitoring data; 5. Of value/needed only if the n exceeds 3

Table 10. Baseline Stream Data Summary (continued)
Groundhog Hollow Mitigation Site - Reach GF3-B

Parameter	Gauge[2]	Regional Curve			Pre-Existing Condition						Reference Reach(es) Data						Design			Monitoring Baseline					
Dimension and Substrate - Riffle Only		LL	UL	Eq.	Min	Mean	Med	Max	SD[5]	n	Min	Mean	Med	Max	SD[5]	n	Min	Med	Max	Min	Mean	Med	Max	SD[5]	n
Bankfull Width (ft)		---	---	---	---	---	4.1	---	---	1	---	---	4.4	---	---	1	---	5.3	---	---	---	7.6	---	---	1
Floodprone Width (ft)					---	---	6.2	---	---	1	---	---	12.0	20.0	---	1	---	19.3	---	---	---	25.6	---	---	1
Bankfull Mean Depth (ft)		---	---	---	---	---	0.7	---	---	1	---	---	0.5	0.6	---	1	---	0.5	---	---	---	---	---	---	1
[1]Bankfull Max Depth (ft)					---	---	1.0	---	---	1	---	---	0.8	0.9	---	1	---	0.7	---	---	---	0.9	---	---	1
Bankfull Cross Sectional Area (ft^2)		---	---	---	---	---	2.9	---	---	1	---	---	2.1	2.8	---	1	---	2.7	---	---	---	2.9	---	---	1
Width/Depth Ratio					---	---	5.8	---	---	1	---	---	6.9	9.2	---	1	---	10.3	---	---	---	---	---	---	1
Entrenchment Ratio					---	---	1.5	---	---	1	---	---	2.7	4.5	---	1	---	3.6	---	---	---	3.4	---	---	1
[1]Bank Height Ratio					---	---	1.6	---	---	1	---	---	1.0	2.5	---	1	---	1.0	---	---	---	1.0	---	---	1
Profile																									
Riffle Length (ft)					---	---	---	---	---	---	4	---	---	18	---	---	3.1	---	15.8	3	7	6	12	2	16
Riffle Slope (ft/ft)					---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.1	4.6	4.2	11.8	3.2	16.0
Pool Length (ft)					---	---	---	---	---	---	3	---	---	8	---	---	2.6	---	7.2	7	12	11	23	4	15
Pool Max depth (ft)					---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pool Spacing (ft)					---	---	---	---	---	---	12	---	---	35	---	---	3.8	---	31	10	18	18	27	4	14
Pattern																									
Channel Beltwidth (ft)					---	---	---	---	---	---	15	---	---	35	---	---	13	---	31	13	---	---	31	---	---
Radius of Curvature (ft)					---	---	---	---	---	---	6	---	---	17	---	---	5	---	15	5	---	---	15	---	---
Rc:Bankfull width (ft/ft)					---	---	---	---	---	---	1.4	---	---	3.9	---	---	1	---	2.8	1	---	---	2.8	---	---
Meander Wavelength (ft)					---	---	---	---	---	---	23	---	---	43	---	---	20	---	38	20	---	---	38	---	---
Meander Width Ratio					---	---	---	---	---	---	3.4	---	---	8	---	---	3.8	---	7.2	3.8	---	---	7.2	---	---
Transport parameters																									
Reach Shear Stress (competency) lb/f[2]					---												---			---					
Max part size (mm) mobilized at bankfull					---												---			---					
Stream Power (transport capacity) W/m^2					---												---			---					
Additional Reach Parameters																									
Rosgen Classification					G5/6						E4/5						C4/E4			C4/E4					
Bankfull Velocity (fps)		---	---	---	---						---						---			---					
Bankfull Discharge (cfs)		---	---	---	---												---			---					
Valley length (ft)					253						842						294			294					
Channel Thalweg length (ft)					272						995						343			343					
Sinuosity (ft)					1.08						1.18						1.17			1.17					
Water Surface Slope (Channel) (ft/ft)					---						---						---			---					
Channel slope (ft/ft)					0.021						0.0033						0.013			0.013					
[3]Bankfull Floodplain Area (acres)					---						---						---			---					
[4]% of Reach with Eroding Banks					---						---														
Channel Stability or Habitat Metric					---						---														
Biological or Other					---						---														

Shaded cells indicate that these will typically not be filled in.

1 = The distributions for these parameters can include information from both the cross-section measurements and the longitudinal profile. 2 = For projects with a proximal USGS gauge in-line with the project reach (added bankfull verification - rare).

3. Utilizing XS measurement data produce an estimate of the bankfull floodplain area in acres, which should be the area from the top of bank to the toe of the terrace riser/slope.

4 = Proportion of reach exhibiting banks that are eroding based on the visual survey for comparison to monitoring data; 5. Of value/needed only if the n exceeds 3

Appendix D. Table 11 - Monitoring Data - Dimensional Morphology Summary (Dimensional Parameters – Cross Sections)

Project Name/Number: Groundhog Hollow #100049

	Cross Section 1 (Riffle)							Cross Section 2 (Pool)							Cross Section 3 (Pool)							Cross Section 4 (Riffle)							Cross Section 5 (Riffle)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1103.8	1103.8						1103.5	1103.5						1097.9	1097.9						1097.5	1097.5						1092.7	1092.7					
Bankfull Width (ft)[1]	6.3	5.8						6.4	6.8						8.5	9.5						6.2	6.2						6.3	5.5					
Floodprone Width (ft)[1]	50.0	42.7						-	-						-	-						>50.6	>50.7						45	>45					
Bankfull Max Depth (ft)[2]	0.6	0.6						0.7	0.7						1.6	1.4						1.0	1.1						0.9	1.0					
Low Bank Elevation (ft)	1103.77	1103.9						1103.5	1103.5						1097.9	1097.9						1097.5	1097.6						1092.7	1092.7					
Bankfull Cross Sectional Area (ft^2)[2]	1.9	2.3						2.3	2.3						6.1	5.8						3.3	3.9						2.6	2.7					
Bankfull Entrenchment Ratio[1]	7.9	7.4						-	-						-	-						8.2	>8.2						7.1	>8.2					
Bankfull Bank Height Ratio[1]	1.0	1.1						-	-						-	-						1.0	1.1						1.0	1.0					

	Cross Section 6 (Pool)							Cross Section 7 (Riffle)							Cross Section 8 (Pool)							Cross Section 9 (Riffle)							Cross Section 10 (Pool)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1092.2	1091.9						1085.5	1085.5						1085.2	1085.2						1081.3	1081.4						1081.0	1080.9					
Bankfull Width (ft)[1]	7.9	5.5						6.4	7.3						6.5	8.3						7.6	6.6						6.6	6.0					
Floodprone Width (ft)[1]	-	-						>49.8	>50						-	-						>44.8	>45.4						-	-					
Bankfull Max Depth (ft)[2]	1.2	1.6						1.0	0.9						1.0	1.0						1.1	1.0						1.2	1.5					
Low Bank Elevation (ft)	1092.2	1092.2						1085.5	1085.5						1085.2	1085.2						1081.3	1081.3						1081.00	1081.0					
Bankfull Cross Sectional Area (ft^2)[2]	5.0	7.2						4.7	4.2						4.1	4.1						4.5	3.8						4.7	5.5					
Bankfull Entrenchment Ratio[1]	-	-						7.8	>6.9						-	-						5.9	>6.9						-	-					
Bankfull Bank Height Ratio[1]	-	-						1.0	0.9						-	-						1.0	0.9						-	-					

	Cross Section 11 (Riffle)							Cross Section 12 (Pool)							Cross Section 13 (Pool)							Cross Section 14 (Riffle)							Cross Section 15 (Riffle)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1076.2	1076.3						1076.3	1076.3						1071.6	1071.5						1071.0	1071.1						1119.1	1119.2					
Bankfull Width (ft)[1]	6.4	6.8						5.5	7.1						7.8	7.3						8.3	8.1						6.8	6.7					
Floodprone Width (ft)[1]	>47	>49						-	-						-	-						46.1	46.5						>38.6	>38.6					
Bankfull Max Depth (ft)[2]	0.9	0.8						1.6	1.5						2.5	3.0						1.4	1.4						1.2	1.1					
Low Bank Elevation (ft)	1076.24	1076.2						1076.3	1076.2						1071.6	1071.7						1071.0	1071.1						1119.1	1119.2					
Bankfull Cross Sectional Area (ft^2)[2]	3.4	2.9						5.4	5.4						9.9	9.9						6.2	6.2						4.8	4.5					
Bankfull Entrenchment Ratio[1]	7.3	>7.2						-	-						-	-						5.5	5.7						5.7	>5.8					
Bankfull Bank Height Ratio[1]	1.0	0.9						-	-						-	-						1.0	1.0						1.0	1.0					

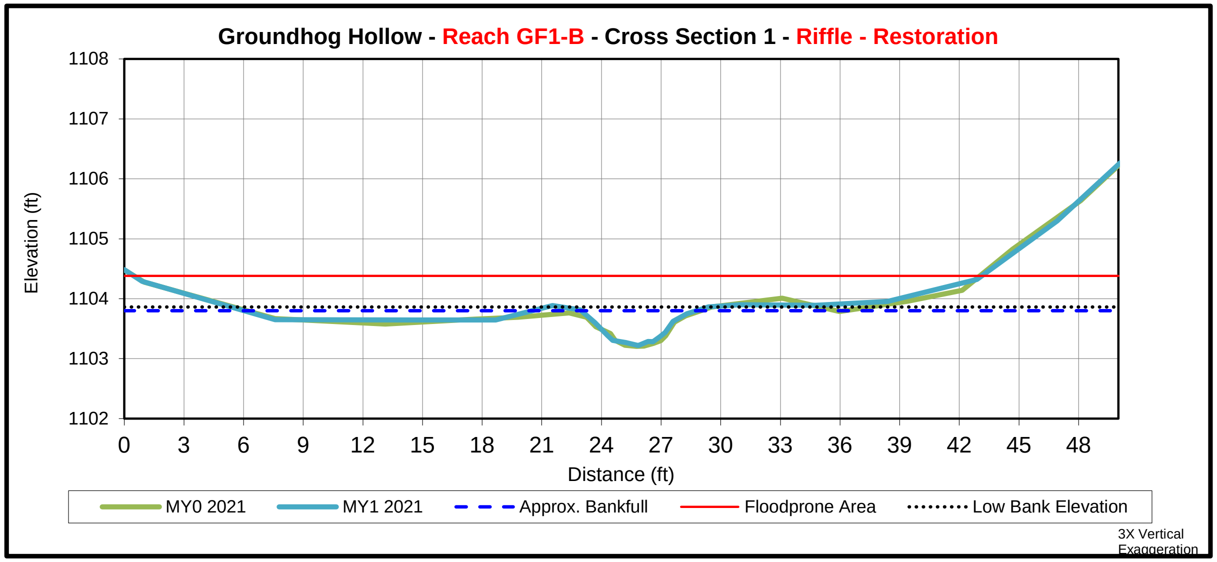
	Cross Section 16 (Pool)							Cross Section 17 (Pool)							Cross Section 18 (Riffle)							Cross Section 19 (Riffle)							Cross Section 20 (Riffle)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1118.6	1119.2						1111.0	1111.0						1110.6	1110.5						1087.0	1087.0						1084.8	1084.9					
Bankfull Width (ft)[1]	8.0	7.2						7.5	7.0						5.5	4.8						4.9	4.7						6.2	6.4					
Floodprone Width (ft)[1]	-	-						-	-						>45.4	>45.3						6.3	6.4						9.6	8.7					
Bankfull Max Depth (ft)[2]	2.3	2.4						1.1	1.3						1.0	1.0						0.8	1.0						0.8	0.7					
Low Bank Elevation (ft)	1118.63	1119.2						1111.0	1111.0						1110.6	1110.5						1089.2	1088.9						1086.2	1086.3					
Bankfull Cross Sectional Area (ft^2)[2]	8.3	8.8						3.7	3.7						3.0	3.0						3.0	3.0						3.0	3.0					
Bankfull Entrenchment Ratio[1]	-	-						-	-						8.3	>9.4						1.3	1.4						1.5	1.4					
Bankfull Bank Height Ratio[1]	-	-						-	-						1.0	1.0						3.6	2.9						2.9	3.0					

	Cross Section 21 (Riffle)							Cross Section 22 (Pool)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1079.8	1079.9						1079.6	1079.8					
Bankfull Width (ft)[1]	7.6	5.5						6.2	5.1					
Floodprone Width (ft)[1]	25.6	27.1						-	-					
Bankfull Max Depth (ft)[2]	0.9	0.8						1.0	0.7					
Low Bank Elevation (ft)	1079.84	1079.8						1079.6	1079.5					
Bankfull Cross Sectional Area (ft^2)[2]	2.9	2.3						3.1	1.9					
Bankfull Entrenchment Ratio[1]	3.4	4.9						-	-					
Bankfull Bank Height Ratio[1]	1.0	0.9						-	-					

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

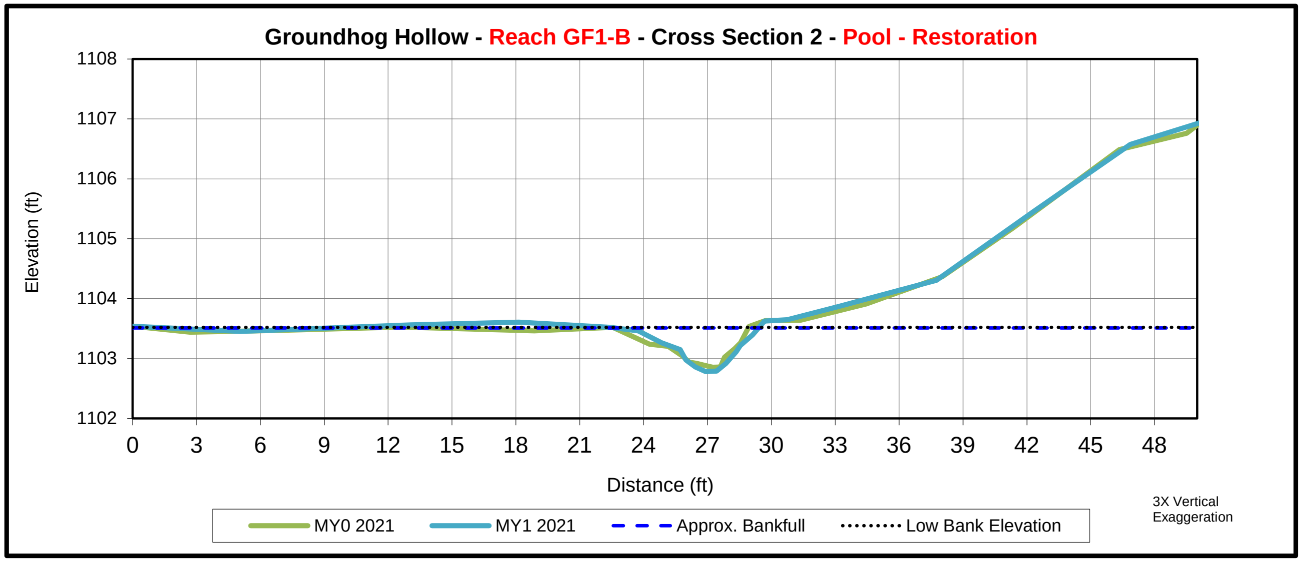


	Cross Section 1 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1103.77	1103.8					
Bankfull Width (ft)[1]	6.3	5.8					
Floodprone Width (ft)[1]	50.0	42.7					
Bankfull Max Depth (ft)[2]	0.6	0.6					
Low Bank Elevation (ft)	1103.77	1103.9					
Bankfull Cross Sectional Area (ft^2)[2]	1.9	2.3					
Bankfull Entrenchment Ratio[1]	7.9	7.4					
Bankfull Bank Height Ratio[1]	1.0	1.1					

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

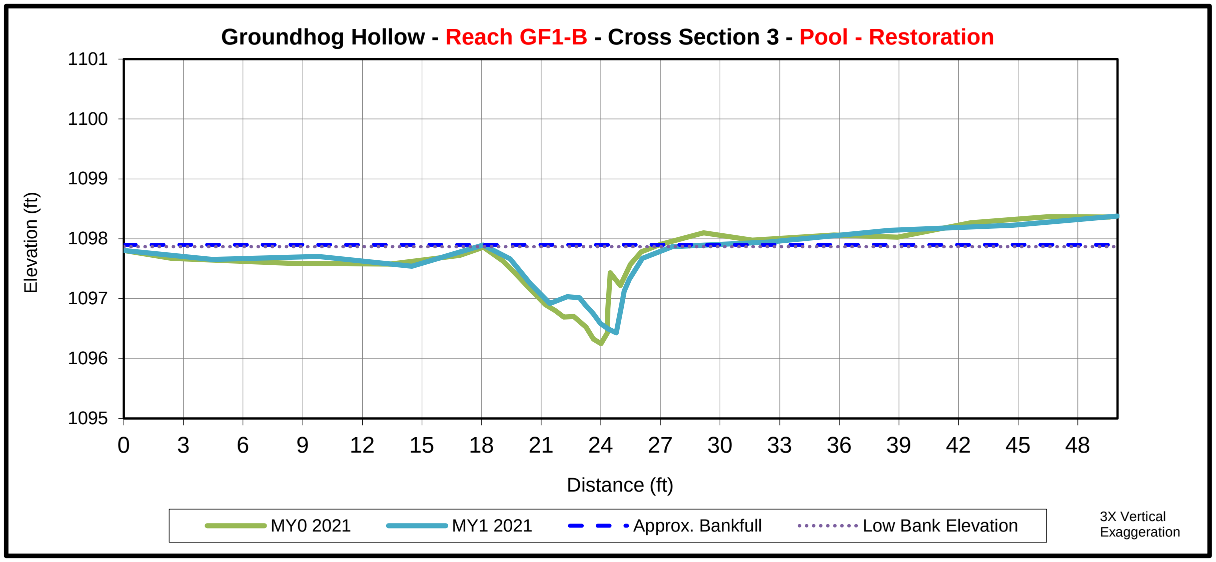


	Cross Section 2 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1103.52	1103.5					
Bankfull Width (ft)[1]	6.4	6.8					
Floodprone Width (ft)[1]	-	-					
Bankfull Max Depth (ft)[2]	0.7	0.7					
Low Bank Elevation (ft)	1103.52	1103.5					
Bankfull Cross Sectional Area (ft^2)[2]	2.3	2.3					
Bankfull Entrenchment Ratio[1]	-	-					
Bankfull Bank Height Ratio[1]	-	-					

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

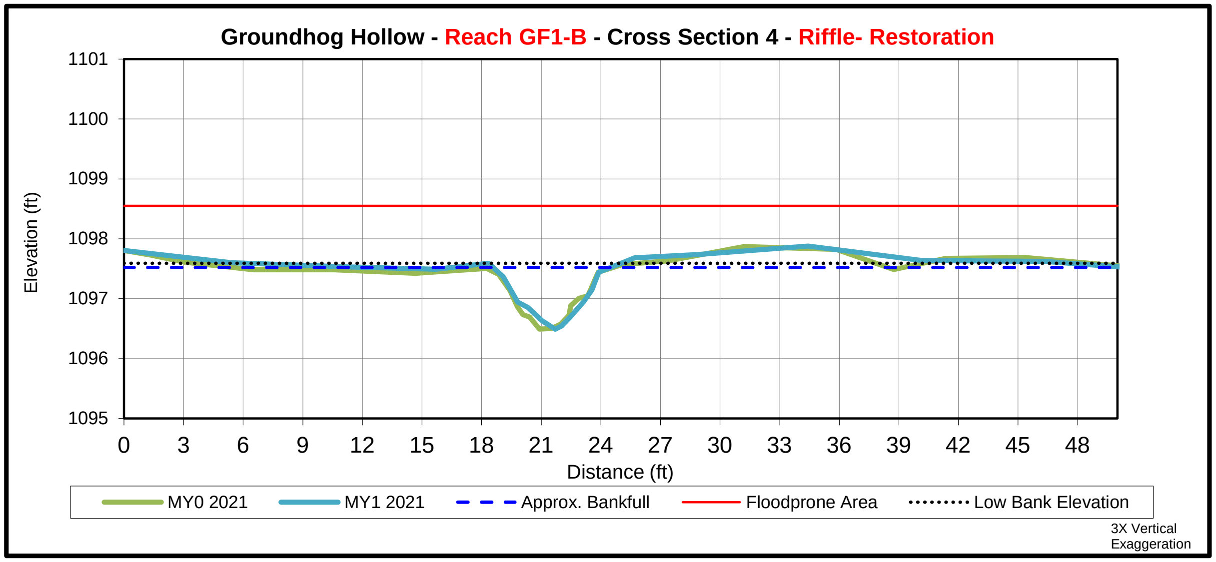


	Cross Section 3 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1097.86	1097.9					
Bankfull Width (ft)[1]	8.5	9.5					
Floodprone Width (ft)[1]	-	-					
Bankfull Max Depth (ft)[2]	1.6	1.4					
Low Bank Elevation (ft)	1097.86	1097.9					
Bankfull Cross Sectional Area (ft^2)[2]	6.1	5.8					
Bankfull Entrenchment Ratio[1]	-	-					
Bankfull Bank Height Ratio[1]	-	-					

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

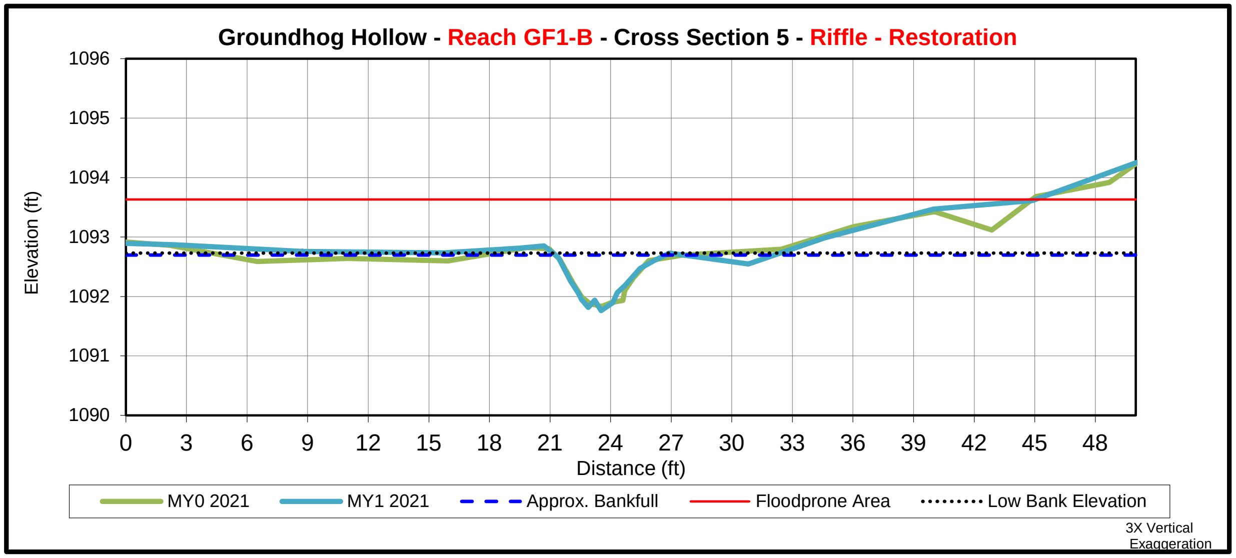


	Cross Section 4 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1097.50	1097.5					
Bankfull Width (ft)[1]	6.2	6.2					
Floodprone Width (ft)[1]	>50.6	>50.7					
Bankfull Max Depth (ft)[2]	1.0	1.1					
Low Bank Elevation (ft)	1097.50	1097.6					
Bankfull Cross Sectional Area (ft^2)[2]	3.3	3.9					
Bankfull Entrenchment Ratio[1]	8.2	>8.2					
Bankfull Bank Height Ratio[1]	1.0	1.1					

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream



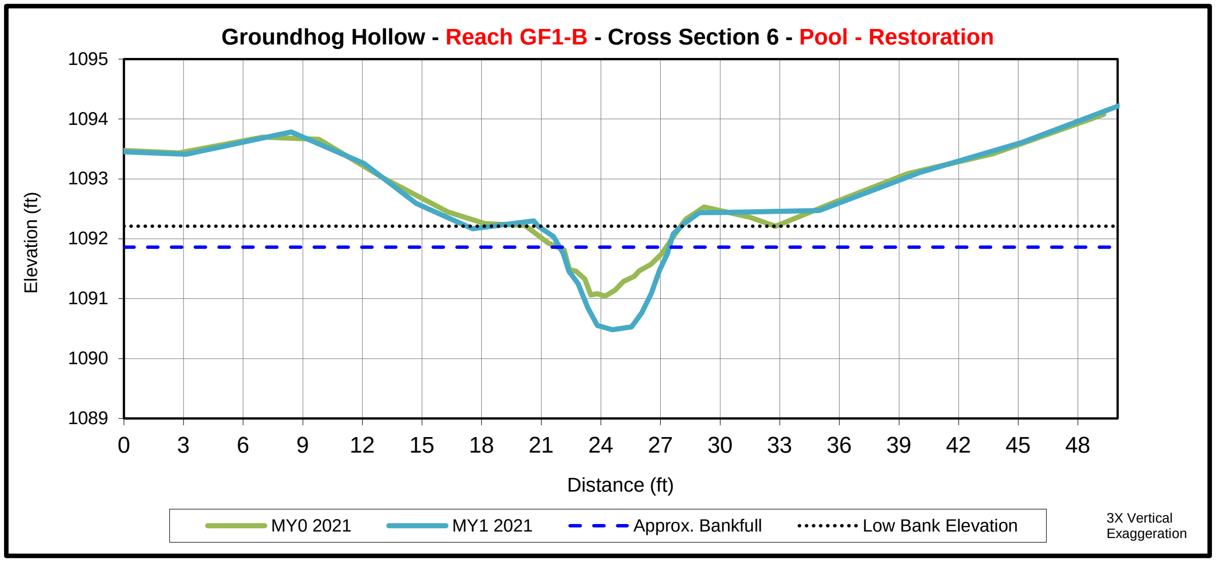
	Cross Section 5 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1092.70	1092.7					
Bankfull Width (ft)[1]	6.3	5.5					
Floodprone Width (ft)[1]	45	>45					
Bankfull Max Depth (ft)[2]	0.9	1.0					
Low Bank Elevation (ft)	1092.70	1092.7					
Bankfull Cross Sectional Area (ft^2)[2]	2.6	2.7					
Bankfull Entrenchment Ratio[1]	7.1	>8.2					
Bankfull Bank Height Ratio[1]	1.0	1.0					

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation

2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream



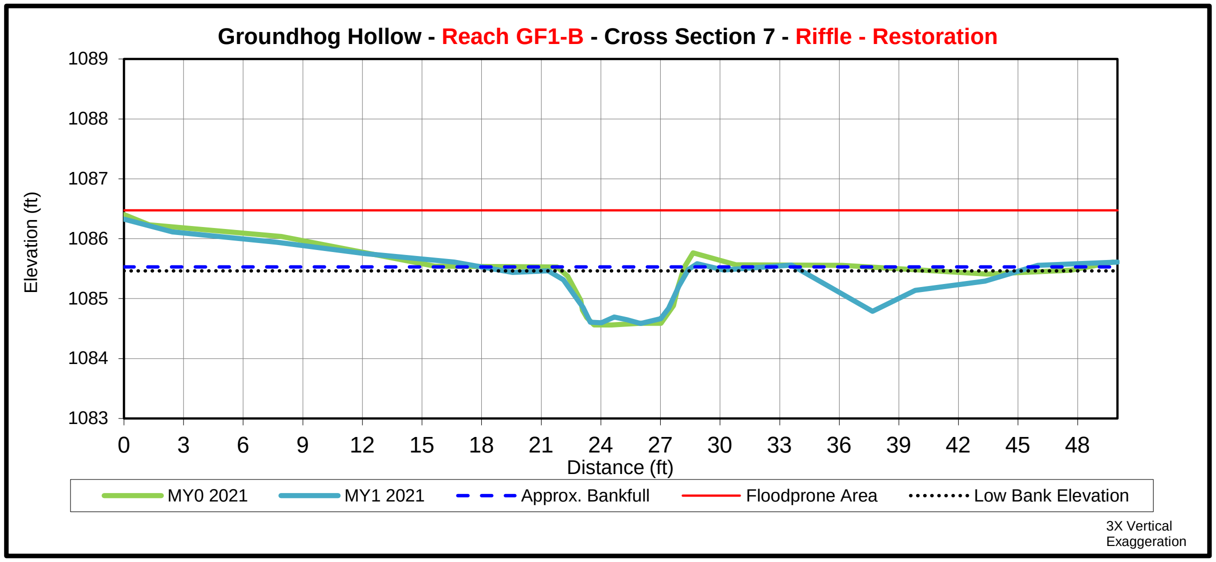
	Cross Section 6 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1092.22	1091.9					
Bankfull Width (ft)[1]	7.9	5.5					
Floodprone Width (ft)[1]	-	-					
Bankfull Max Depth (ft)[2]	1.2	1.6					
Low Bank Elevation (ft)	1092.22	1092.2					
Bankfull Cross Sectional Area (ft^2)[2]	5.0	7.2					
Bankfull Entrenchment Ratio[1]	-	-					
Bankfull Bank Height Ratio[1]	-	-					

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation

2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

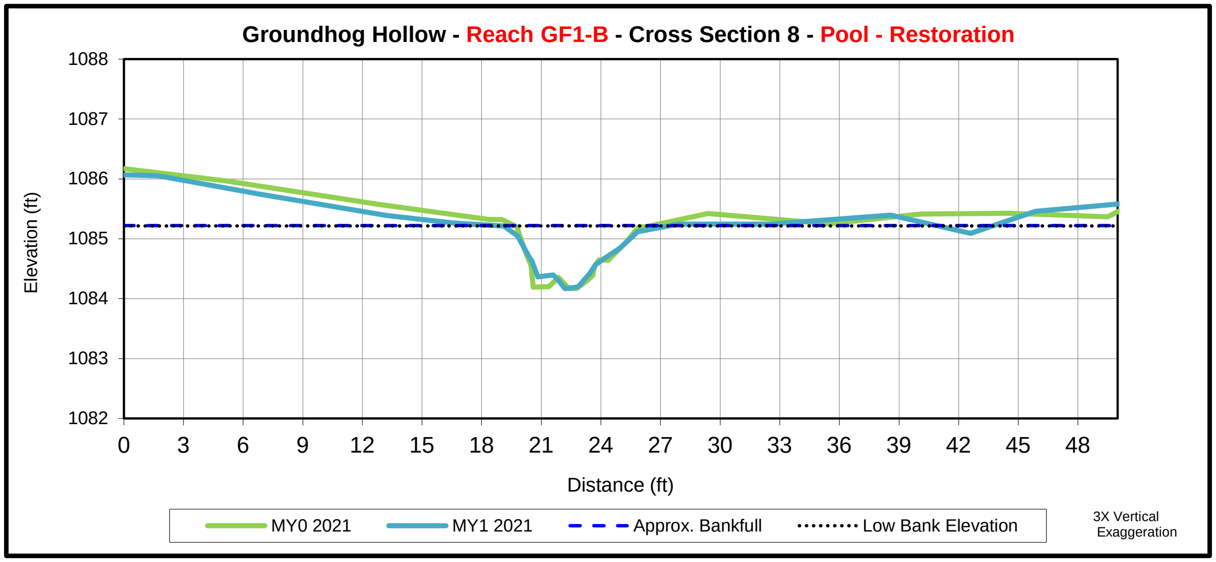


	Cross Section 7 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1085.53	1085.5					
Bankfull Width (ft)[1]	6.4	7.3					
Floodprone Width (ft)[1]	>49.8	>50					
Bankfull Max Depth (ft)[2]	1.0	0.9					
Low Bank Elevation (ft)	1085.53	1085.5					
Bankfull Cross Sectional Area (ft^2)[2]	4.7	4.2					
Bankfull Entrenchment Ratio[1]	7.8	>6.9					
Bankfull Bank Height Ratio[1]	1.0	0.9					

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream



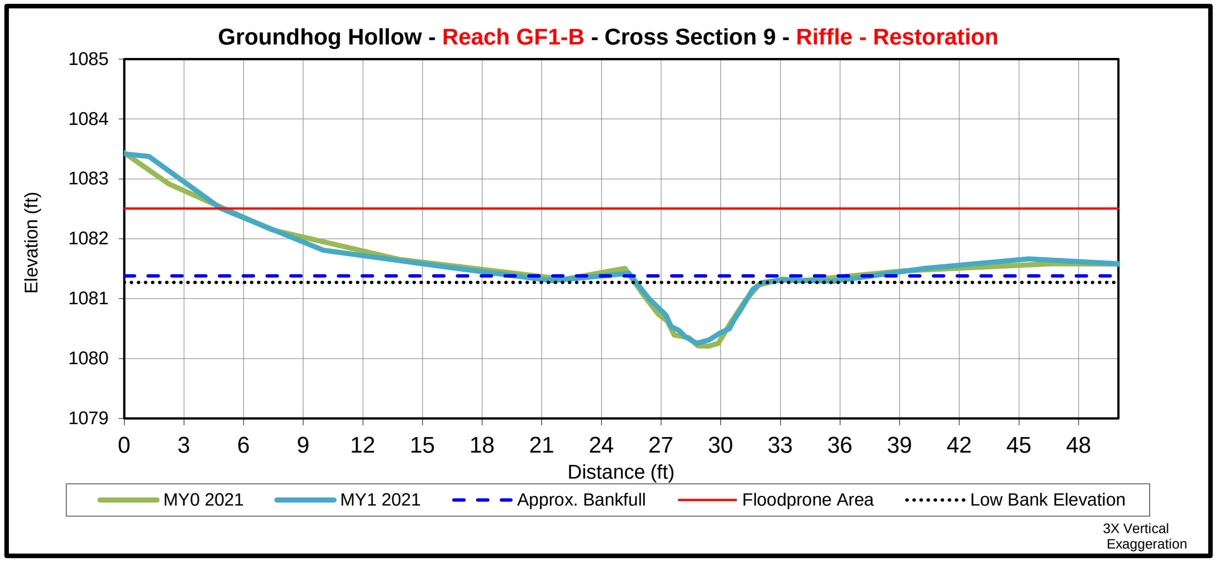
	Cross Section 8 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1085.20	1085.2					
Bankfull Width (ft)[1]	6.5	8.3					
Floodprone Width (ft)[1]	-	-					
Bankfull Max Depth (ft)[2]	1.0	1.0					
Low Bank Elevation (ft)	1085.20	1085.2					
Bankfull Cross Sectional Area (ft^2)[2]	4.1	4.1					
Bankfull Entrenchment Ratio[1]	-	-					
Bankfull Bank Height Ratio[1]	-	-					

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation

2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream



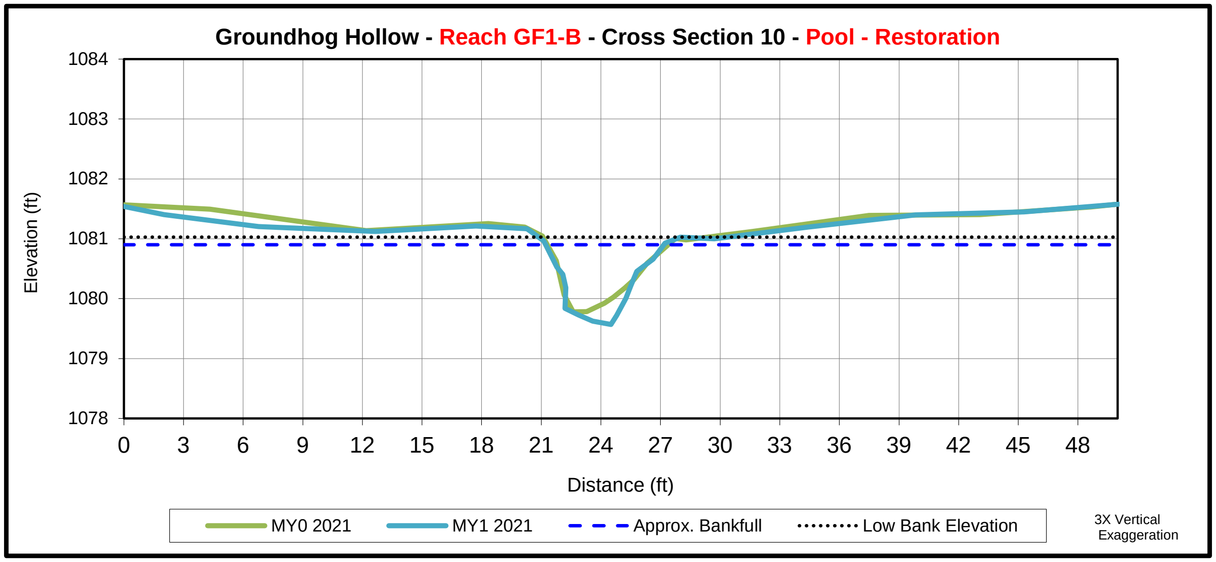
	Cross Section 9 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1081.33	1081.4					
Bankfull Width (ft)[1]	7.6	6.6					
Floodprone Width (ft)[1]	>44.8	>45.4					
Bankfull Max Depth (ft)[2]	1.1	1.0					
Low Bank Elevation (ft)	1081.33	1081.3					
Bankfull Cross Sectional Area (ft^2)[2]	4.5	3.8					
Bankfull Entrenchment Ratio[1]	5.9	>6.9					
Bankfull Bank Height Ratio[1]	1.0	0.9					

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation

2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream



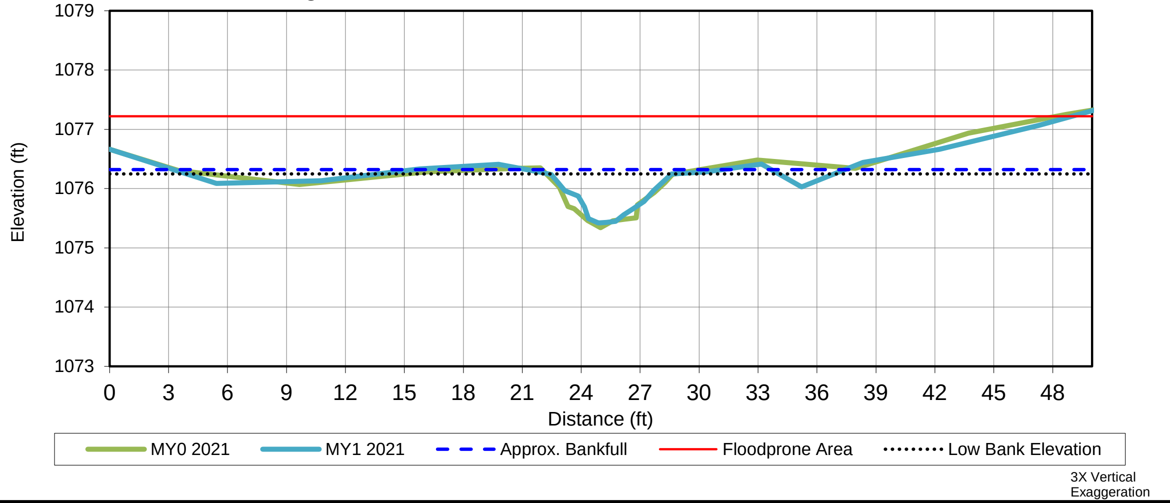
	Cross Section 10 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1081.00	1080.9					
Bankfull Width (ft)[1]	6.6	6.0					
Floodprone Width (ft)[1]	-	-					
Bankfull Max Depth (ft)[2]	1.2	1.5					
Low Bank Elevation (ft)	1081.00	1081.0					
Bankfull Cross Sectional Area (ft^2)[2]	4.7	5.5					
Bankfull Entrenchment Ratio[1]	-	-					
Bankfull Bank Height Ratio[1]	-	-					

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

Groundhog Hollow - Reach GF1-B - Cross Section 11 - Riffle - Restoration

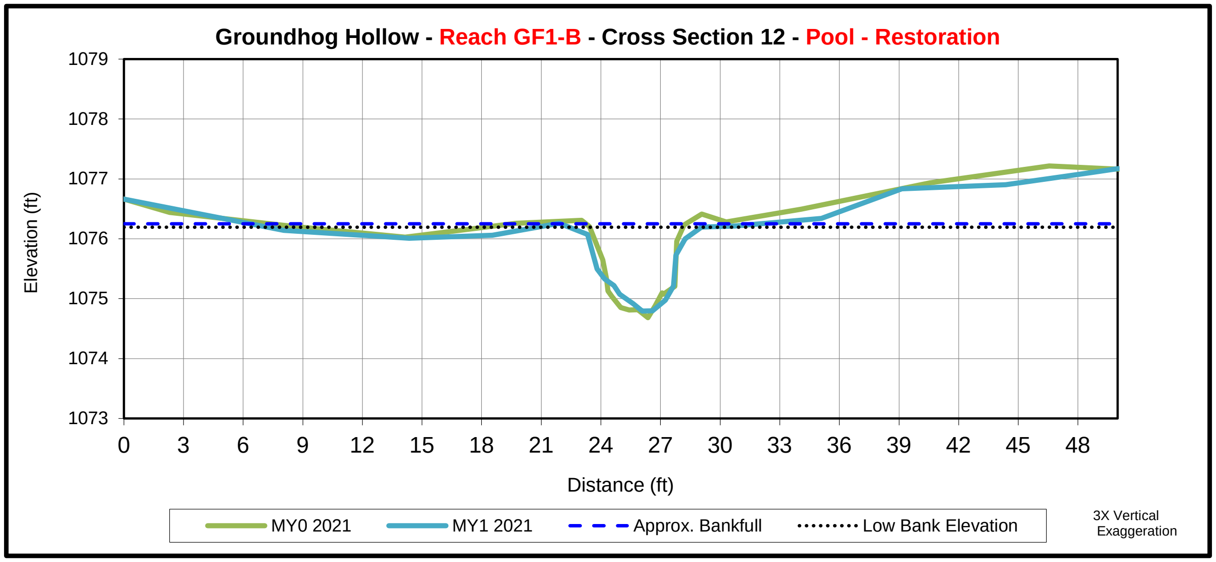


	Cross Section 11 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1076.24	1076.3					
Bankfull Width (ft)[1]	6.4	6.8					
Floodprone Width (ft)[1]	>47	>49					
Bankfull Max Depth (ft)[2]	0.9	0.8					
Low Bank Elevation (ft)	1076.24	1076.2					
Bankfull Cross Sectional Area (ft^2)[2]	3.4	2.9					
Bankfull Entrenchment Ratio[1]	7.3	>7.2					
Bankfull Bank Height Ratio[1]	1.0	0.9					

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream



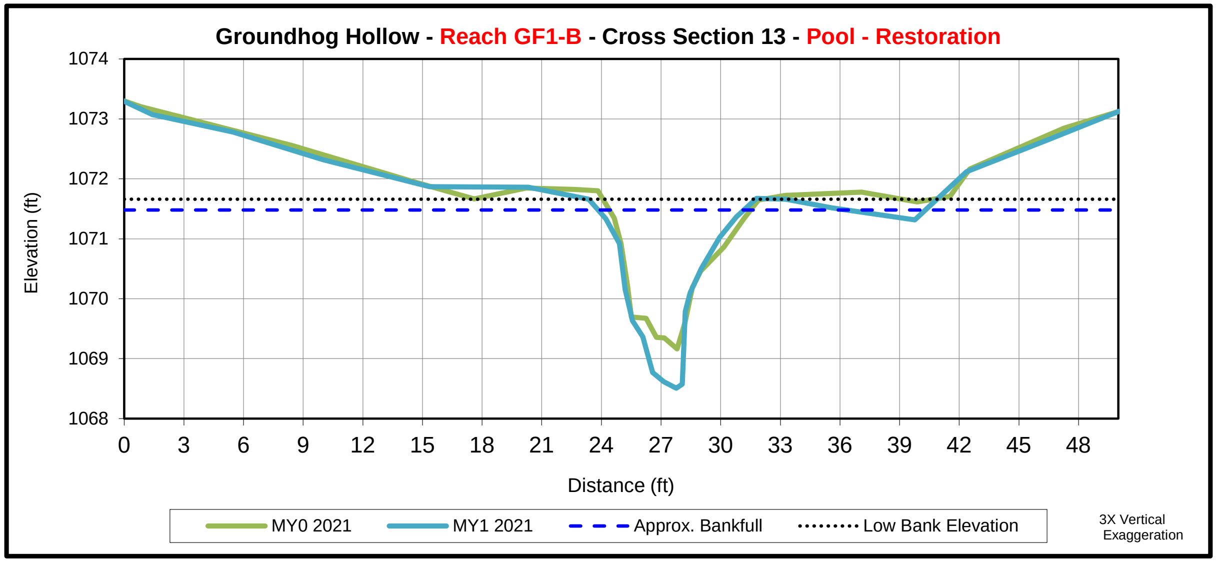
	Cross Section 12 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1076.31	1076.3					
Bankfull Width (ft)[1]	5.5	7.1					
Floodprone Width (ft)[1]	-	-					
Bankfull Max Depth (ft)[2]	1.6	1.5					
Low Bank Elevation (ft)	1076.31	1076.2					
Bankfull Cross Sectional Area (ft^2)[2]	5.4	5.4					
Bankfull Entrenchment Ratio[1]	-	-					
Bankfull Bank Height Ratio[1]	-	-					

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation

2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream



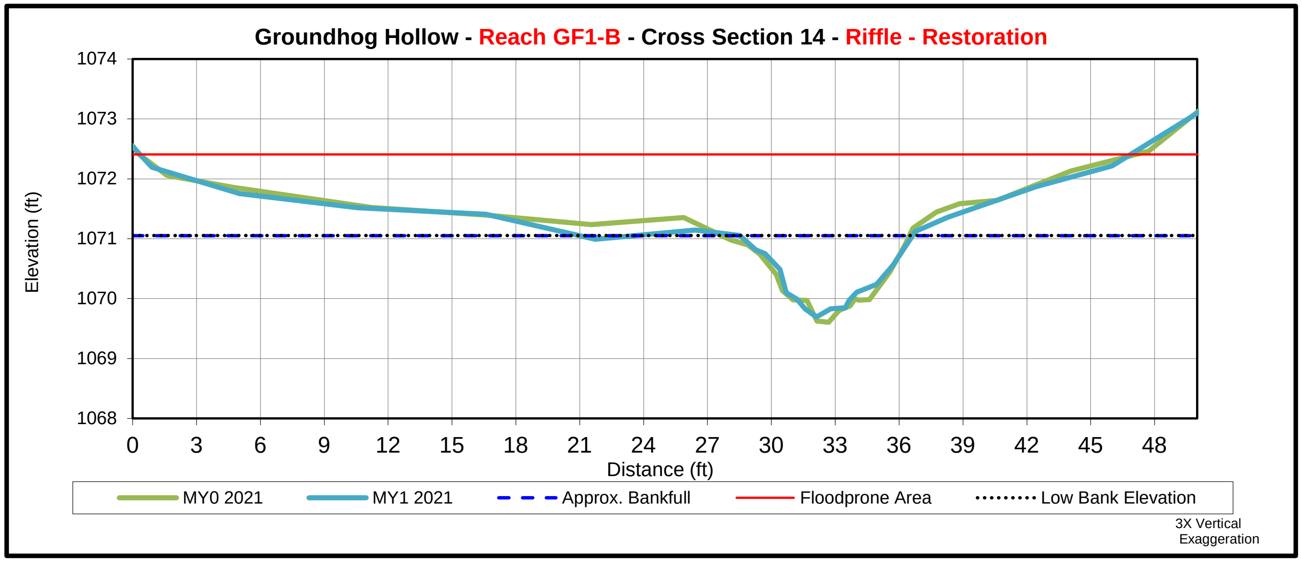
	Cross Section 13 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1071.64	1071.5					
Bankfull Width (ft)[1]	7.8	7.3					
Floodprone Width (ft)[1]	-	-					
Bankfull Max Depth (ft)[2]	2.5	3.0					
Low Bank Elevation (ft)	1071.64	1071.7					
Bankfull Cross Sectional Area (ft^2)[2]	9.9	9.9					
Bankfull Entrenchment Ratio[1]	-	-					
Bankfull Bank Height Ratio[1]	-	-					

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation

2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

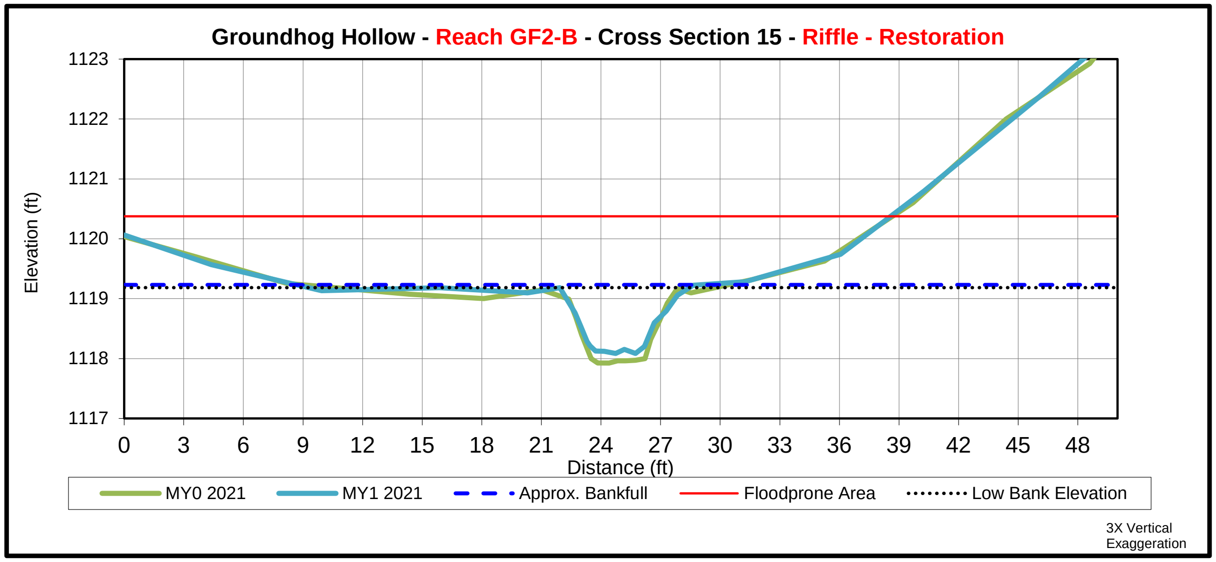


	Cross Section 14 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1070.98	1071.1					
Bankfull Width (ft)[1]	8.3	8.1					
Floodprone Width (ft)[1]	46.1	46.5					
Bankfull Max Depth (ft)[2]	1.4	1.4					
Low Bank Elevation (ft)	1070.98	1071.1					
Bankfull Cross Sectional Area (ft^2)[2]	6.2	6.2					
Bankfull Entrenchment Ratio[1]	5.5	5.7					
Bankfull Bank Height Ratio[1]	1.0	1.0					

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream



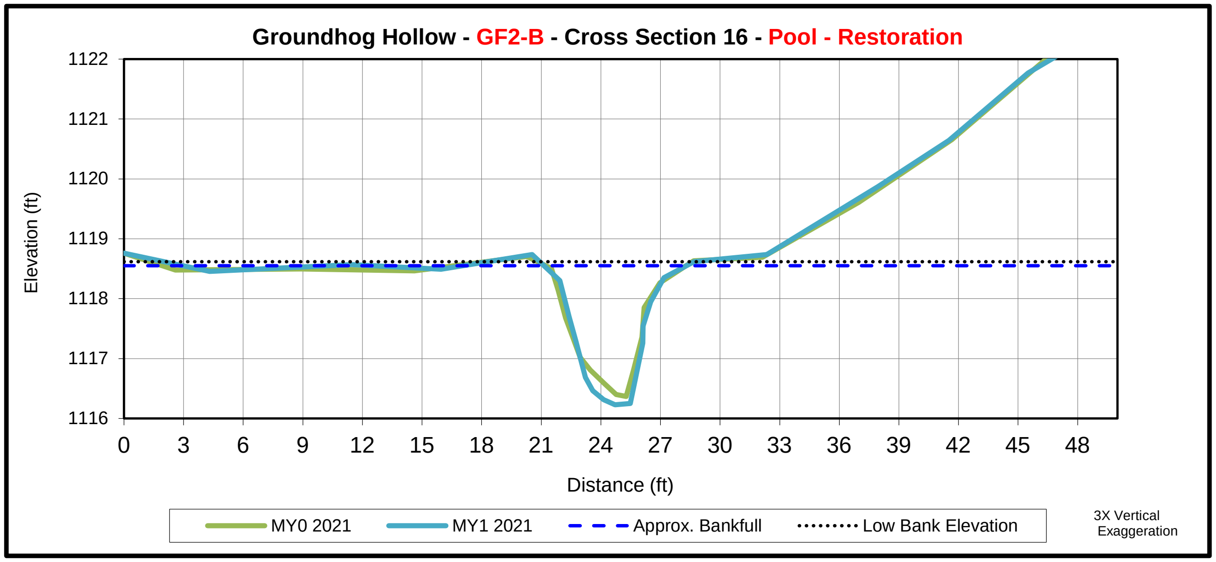
	Cross Section 15 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1119.15	1119.2					
Bankfull Width (ft)[1]	6.8	6.7					
Floodprone Width (ft)[1]	>38.6	>38.6					
Bankfull Max Depth (ft)[2]	1.2	1.1					
Low Bank Elevation (ft)	1119.15	1119.2					
Bankfull Cross Sectional Area (ft^2)[2]	4.8	4.5					
Bankfull Entrenchment Ratio[1]	5.7	>5.8					
Bankfull Bank Height Ratio[1]	1.0	1.0					

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation

2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

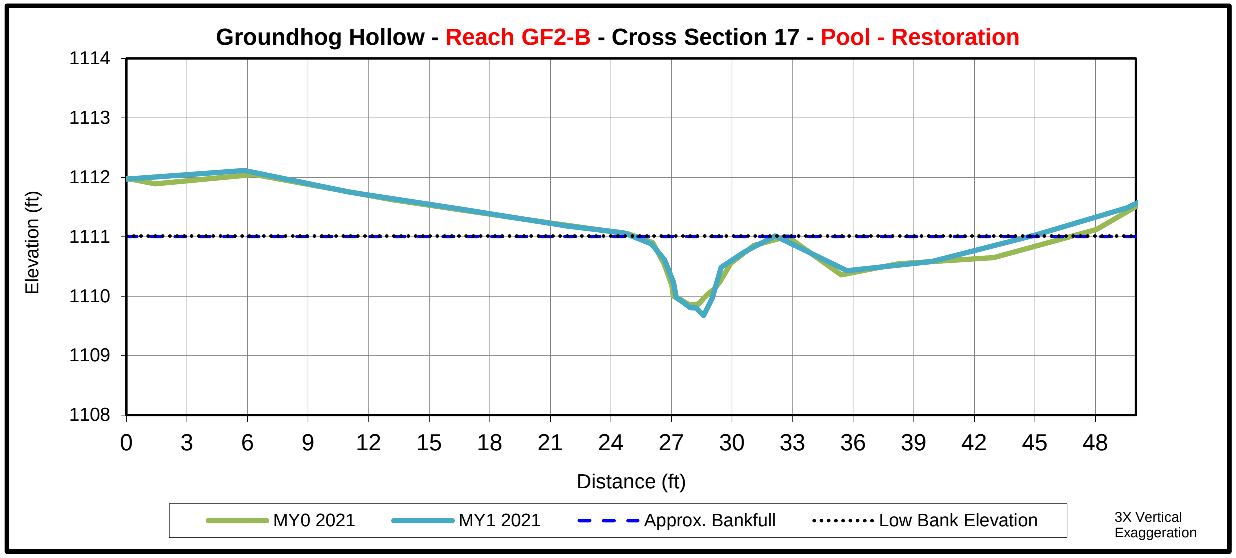


	Cross Section 16 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1118.63	1119.2					
Bankfull Width (ft)[1]	8.0	7.2					
Floodprone Width (ft)[1]	-	-					
Bankfull Max Depth (ft)[2]	2.3	2.4					
Low Bank Elevation (ft)	1118.63	1119.2					
Bankfull Cross Sectional Area (ft^2)[2]	8.3	8.8					
Bankfull Entrenchment Ratio[1]	-	-					
Bankfull Bank Height Ratio[1]	-	-					

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream



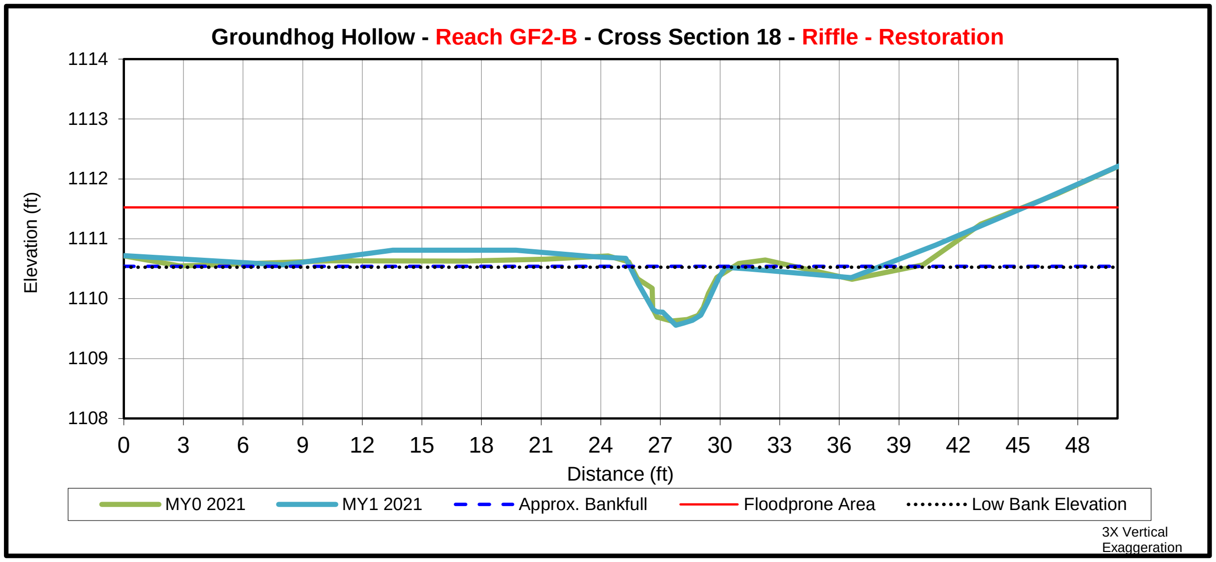
	Cross Section 17 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1111.00	1111.0					
Bankfull Width (ft)[1]	7.5	7.0					
Floodprone Width (ft)[1]	-	-					
Bankfull Max Depth (ft)[2]	1.1	1.3					
Low Bank Elevation (ft)	1111.00	1111.0					
Bankfull Cross Sectional Area (ft^2)[2]	3.7	3.7					
Bankfull Entrenchment Ratio[1]	-	-					
Bankfull Bank Height Ratio[1]	-	-					

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation

2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream



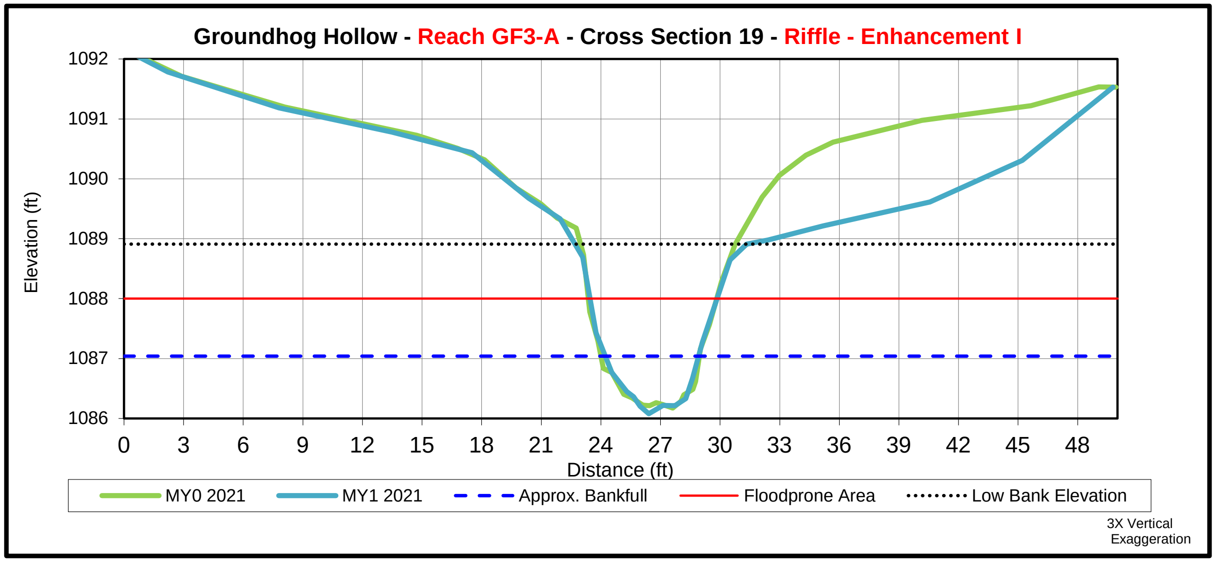
	Cross Section 18 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1110.59	1110.5					
Bankfull Width (ft)[1]	5.5	4.8					
Floodprone Width (ft)[1]	>45.4	>45.3					
Bankfull Max Depth (ft)[2]	1.0	1.0					
Low Bank Elevation (ft)	1110.59	1110.5					
Bankfull Cross Sectional Area (ft^2)[2]	3.0	3.0					
Bankfull Entrenchment Ratio[1]	8.3	>9.4					
Bankfull Bank Height Ratio[1]	1.0	1.0					

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation

2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

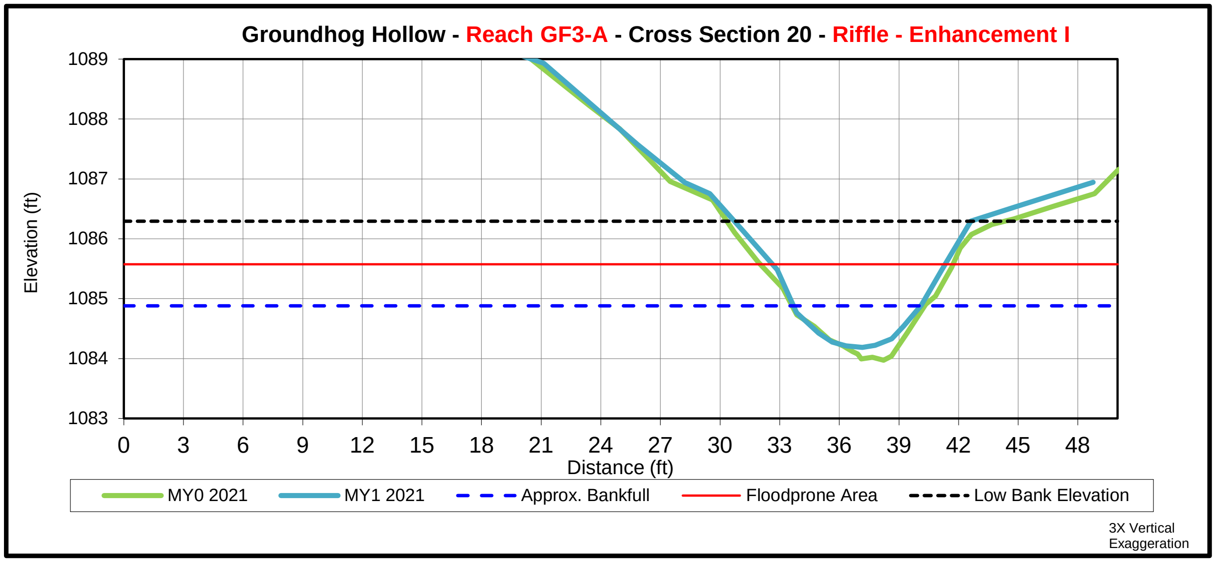


	Cross Section 19 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1087.00	1087.0					
Bankfull Width (ft)[1]	4.9	4.7					
Floodprone Width (ft)[1]	6.3	6.4					
Bankfull Max Depth (ft)[2]	0.8	1.0					
Low Bank Elevation (ft)	1089.20	1088.9					
Bankfull Cross Sectional Area (ft^2)[2]	3.0	3.0					
Bankfull Entrenchment Ratio[1]	1.3	1.4					
Bankfull Bank Height Ratio[1]	3.6	2.9					

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

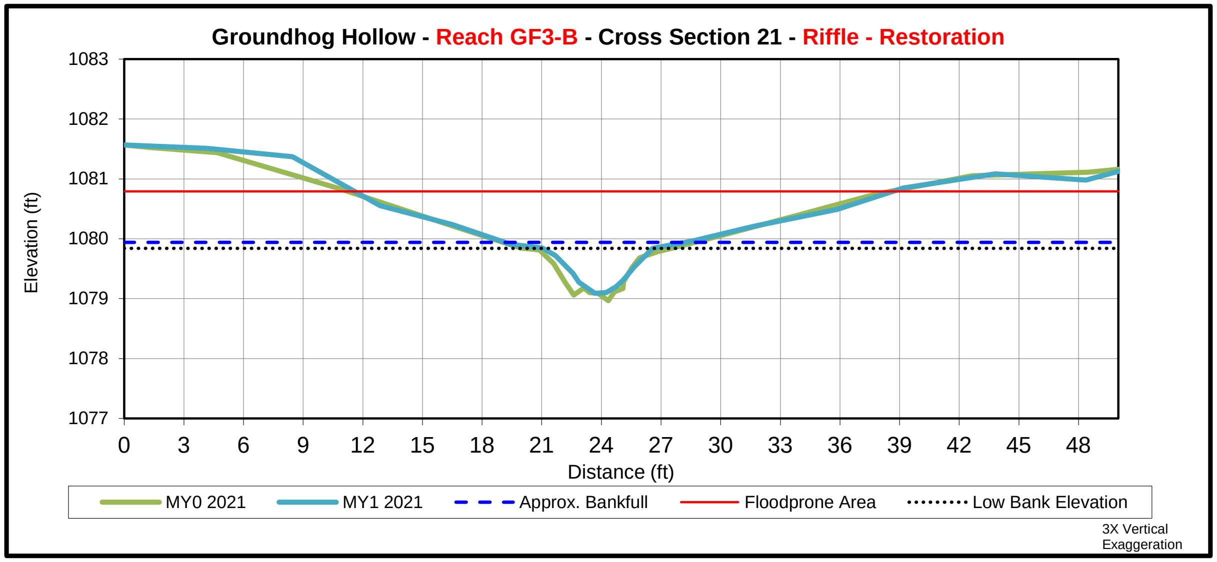


	Cross Section 20 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1084.80	1084.9					
Bankfull Width (ft)[1]	6.2	6.4					
Floodprone Width (ft)[1]	9.6	8.7					
Bankfull Max Depth (ft)[2]	0.8	0.7					
Low Bank Elevation (ft)	1086.20	1086.3					
Bankfull Cross Sectional Area (ft^2)[2]	3.0	3.0					
Bankfull Entrenchment Ratio[1]	1.5	1.4					
Bankfull Bank Height Ratio[1]	2.9	3.0					

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

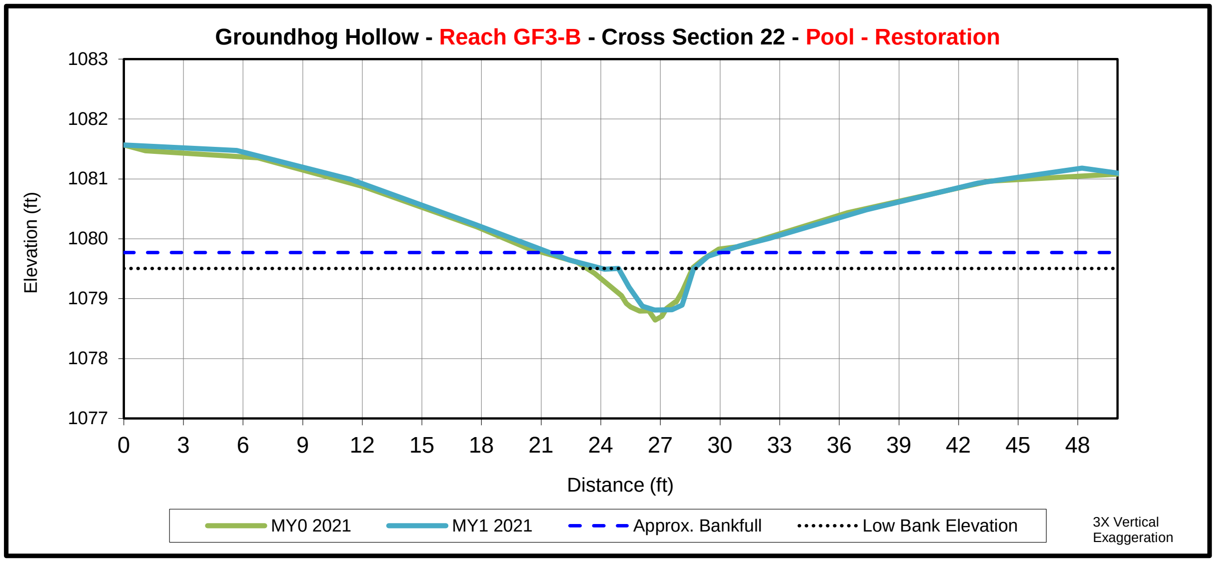


	Cross Section 21 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1079.84	1079.9					
Bankfull Width (ft)[1]	7.6	5.5					
Floodprone Width (ft)[1]	25.6	27.1					
Bankfull Max Depth (ft)[2]	0.9	0.8					
Low Bank Elevation (ft)	1079.84	1079.8					
Bankfull Cross Sectional Area (ft^2)[2]	2.9	2.3					
Bankfull Entrenchment Ratio[1]	3.4	4.9					
Bankfull Bank Height Ratio[1]	1.0	0.9					

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream



	Cross Section 22 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	1079.61	1079.8					
Bankfull Width (ft)[1]	6.2	5.1					
Floodprone Width (ft)[1]	-	-					
Bankfull Max Depth (ft)[2]	1.0	0.7					
Low Bank Elevation (ft)	1079.61	1079.5					
Bankfull Cross Sectional Area (ft^2)[2]	3.1	1.9					
Bankfull Entrenchment Ratio[1]	-	-					
Bankfull Bank Height Ratio[1]	-	-					

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Appendix E

Hydrology Data

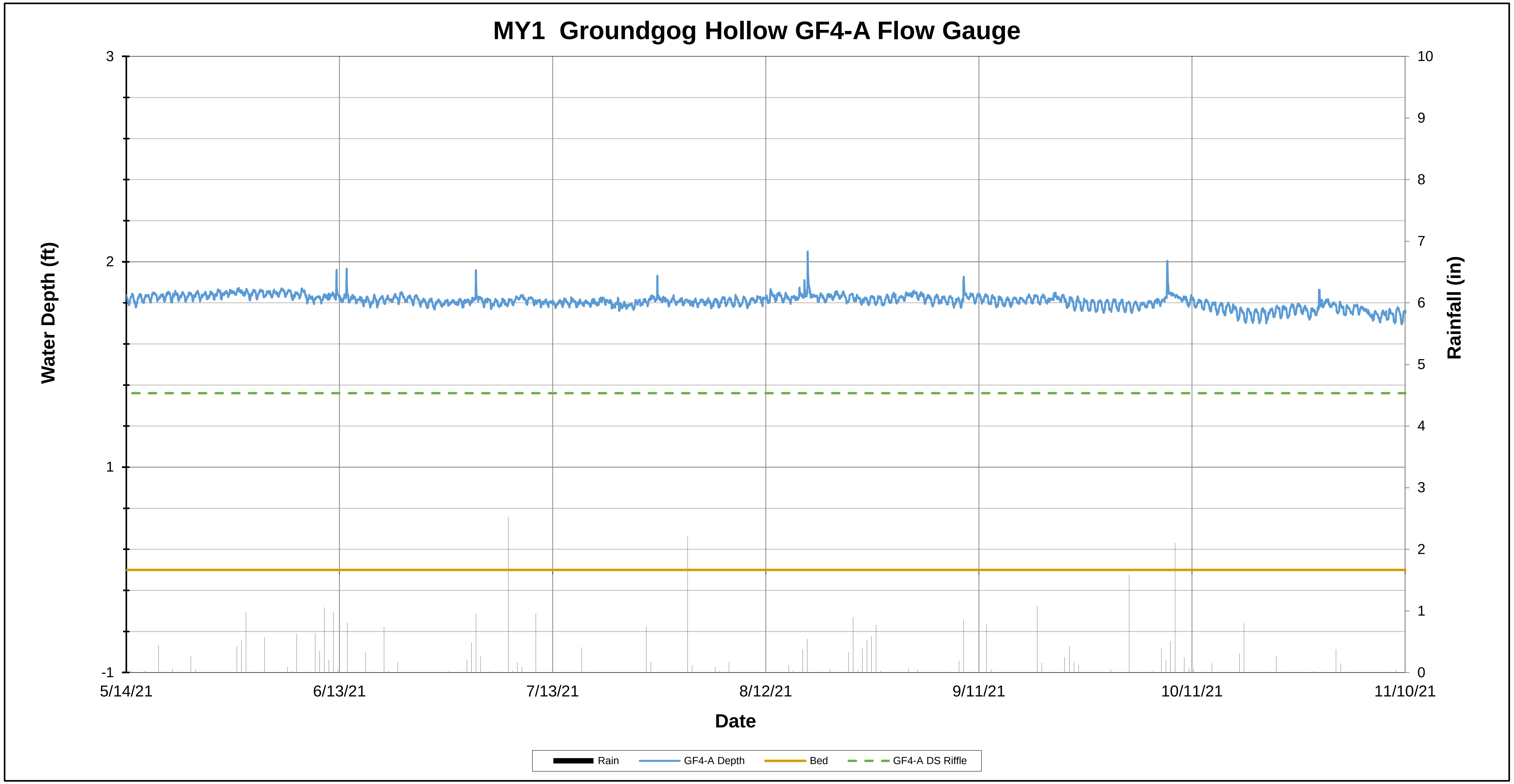
Table 12. Rainfall Summary MY1 2021

Month	Average	Normal Limits		Taylorsville Station Precipitation
		30 Percent	70 Percent	
January	4.36	2.96	4.81	4.23
February	3.57	2.51	4.55	5.94
March	4.26	3.19	4.85	5.91
April	4.73	2.85	5.62	1.36
May	4.56	2.60	5.54	3.73
June	5.07	3.58	6.11	3.76
July	4.33	3.28	5.68	4.12
August	5.42	3.51	6.18	5.74
September	4.47	3.02	5.51	1.65
October	3.77	2.50	4.29	3.59
November	3.75	2.13	4.52	0.32
December	4.27	3.24	5.17	---
Total	52.56	35.37	62.83	40.35
Above Normal Limits	Below Normal Limits			

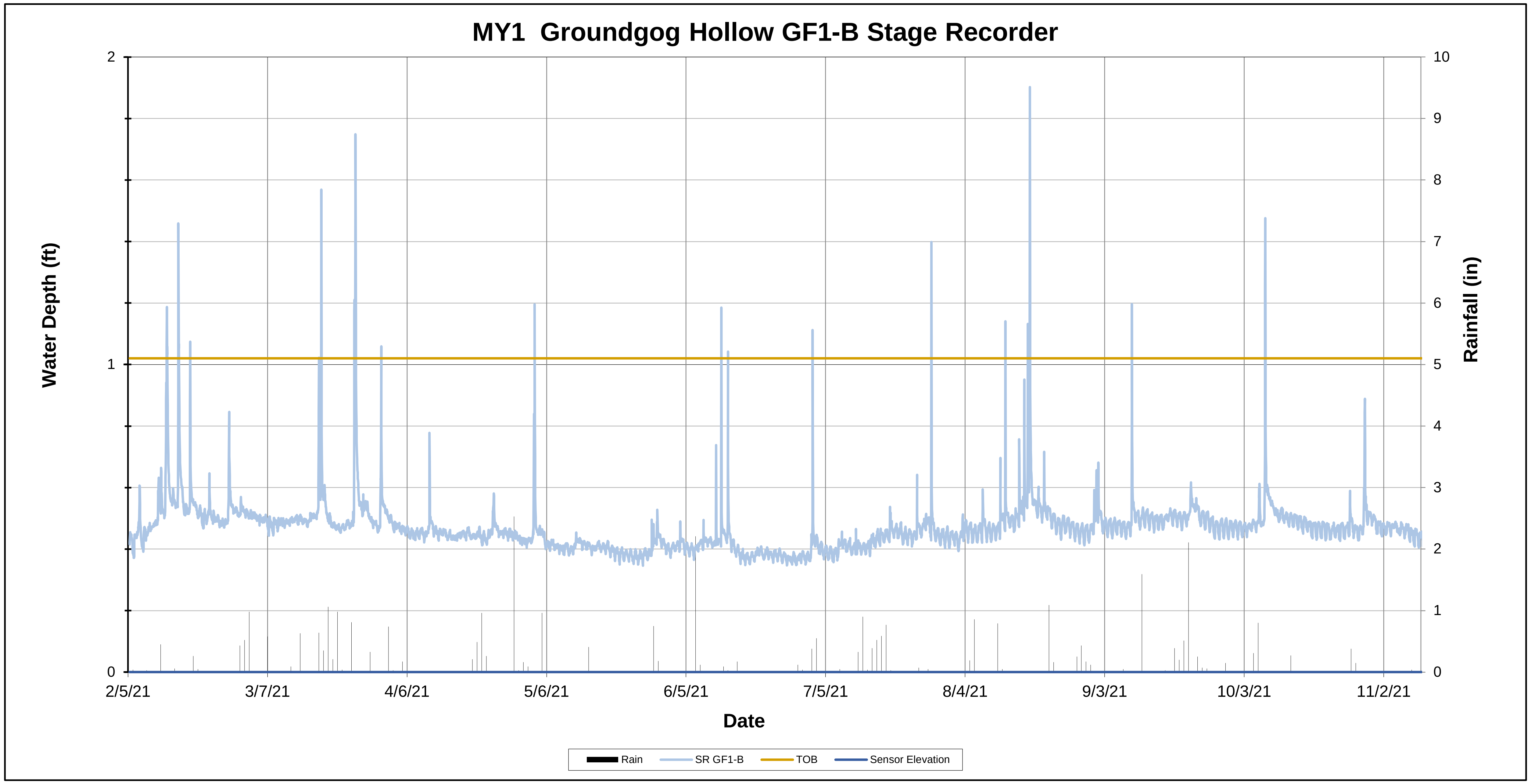
Note: Taylorsville CRONOS Station is approximately 3 miles southeast of the site

Table 13. Documentation of Geomorphically Significant Flow Events

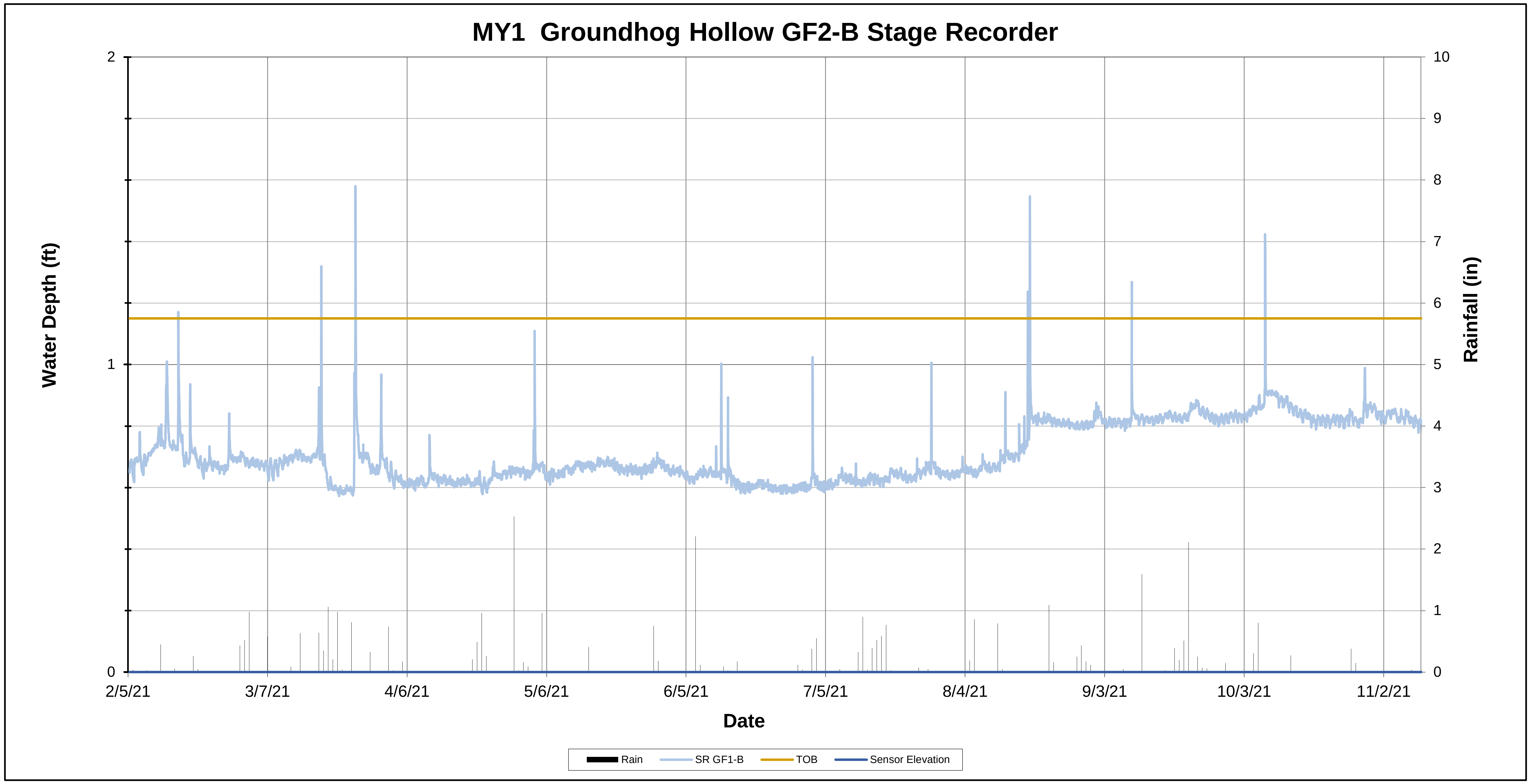
Year	Number of Bankfull Events	Maximum Bankfull Height (ft)	Date of Maximum Bankfull Event	
Stage Recorder GF1-B				
MY1 2021	15	1.90	8/17/2021	
Stage Recorder GF2-B				
MY1 2021	6	1.58	3/25/2021	
Stage Recorder GF3-B				
MY1 2021	8	1.68	8/17/2021	
Year	**Number of Flow Events**	**Maximum Consecutive Flow Days**	**Maximum Cummlative Flow Days**	**Maximum Consecutive Flow Date Range**
Flow Gauge GF4-A				
MY1 2021	1	184	184	5/10/2021-11/10/2021

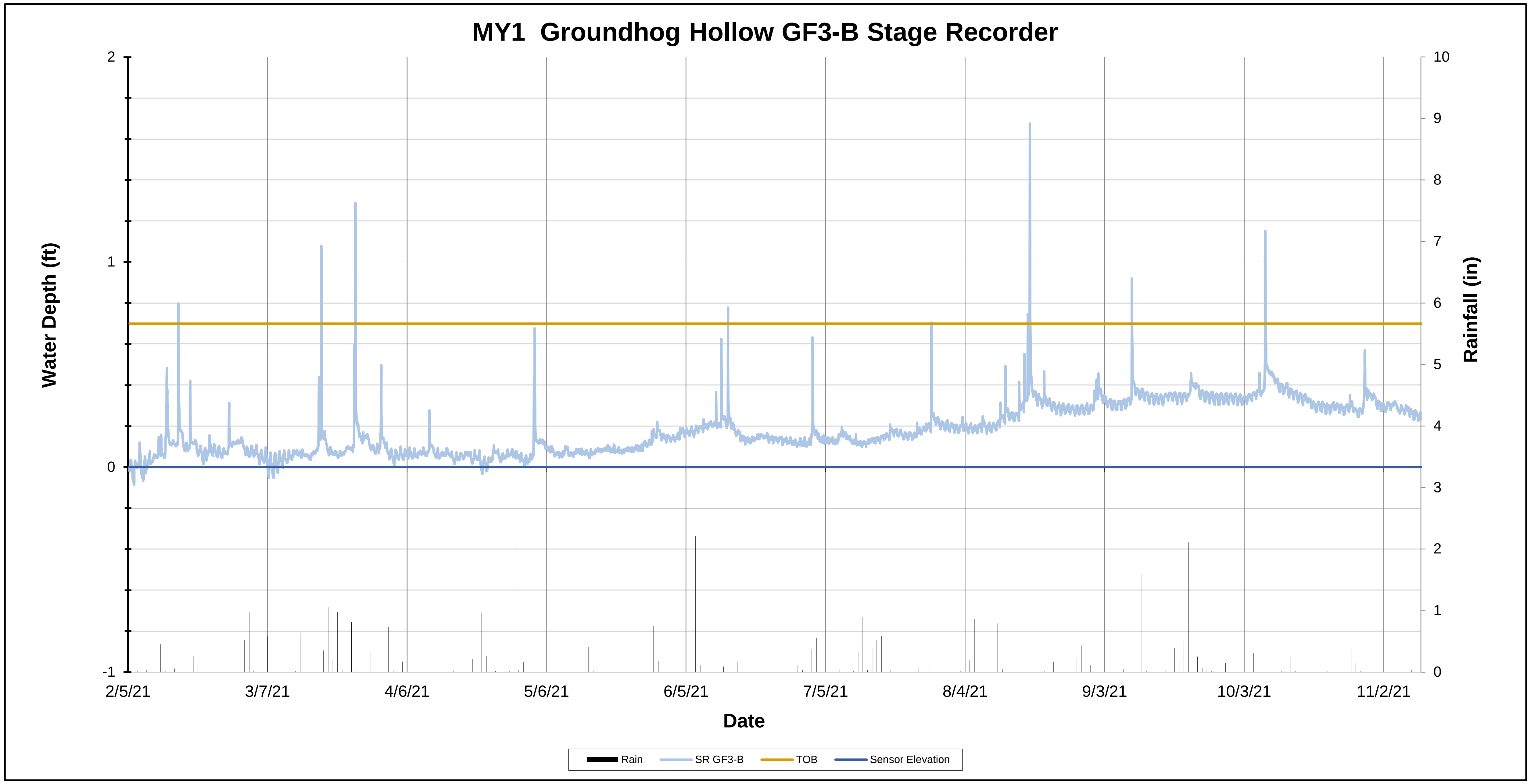


MY1 Groundgog Hollow GF4-A Flow Gauge
Water Depth (ft)
3
2
1
-1
Rainfall (in)
10
9
8
7
6
5
4
3
2
1
0
5/14/21
6/13/21
7/13/21
8/12/21
9/11/21
10/11/21
11/10/21
Date
Rain
GF4-A Depth
Bed
GF4-A DS Riffle



MY1 Groundgog Hollow GF1-B Stage Recorder
Water Depth (ft)
Rainfall (in)
Date
0
1
2
0
1
2
3
4
5
6
7
8
9
10
2/5/21
3/7/21
4/6/21
5/6/21
6/5/21
7/5/21
8/4/21
9/3/21
10/3/21
11/2/21
Rain
SR GF1-B
TOB
Sensor Elevation

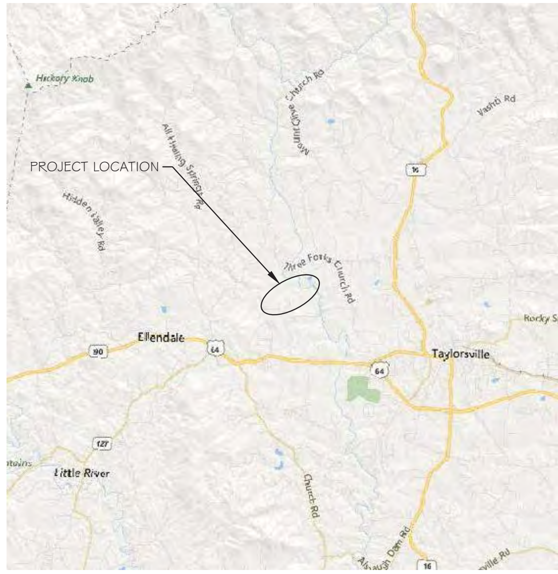

MY1 Groundhog Hollow GF2-B Stage Recorder
Water Depth (ft)
Rainfall (in)
Date
2/5/21
3/7/21
4/6/21
5/6/21
6/5/21
7/5/21
8/4/21
9/3/21
10/3/21
11/2/21
Rain
SR GF1-B
TOB
Sensor Elevation


MY1 Groundhog Hollow GF3-B Stage Recorder
Water Depth (ft)
Rainfall (in)
2
1
0
-1
10
9
8
7
6
5
4
3
2
1
0
2/5/21
3/7/21
4/6/21
5/6/21
6/5/21
7/5/21
8/4/21
9/3/21
10/3/21
11/2/21
Date
Rain
SR GF3-B
TOB
Sensor Elevation

Appendix F

2021 Repair Markups

and Design



VICINITY MAP
NTS

GROUNDHOG HOLLOW PROJECT

ALEXANDER COUNTY, NORTH CAROLINA

CATAWBA RIVER BASIN: HUC 03050101
JUNE 2020

RESOURCE ENVIRONMENTAL SOLUTIONS, LLC
3600 GLENWOOD AVE, SUITE 100
RALEIGH, NC 27612

Know what's below.
Call before you dig

NOTICE TO CONTRACTOR

PRIOR TO CONSTRUCTION, DIGGING, OR EXCAVATION THE CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UNDERGROUND UTILITIES (PUBLIC OR PRIVATE) THAT MAY EXIST AND CROSS THROUGH THE AREA(S) OF CONSTRUCTION, WHETHER INDICATED ON THE PLANS OR NOT. CALL "811" A MINIMUM OF 72 HOURS PRIOR TO DIGGING OR EXCAVATING. REPAIRS TO ANY UTILITY DAMAGED RESULTING FROM CONSTRUCTION ACTIVITIES SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.

PROJECT DIRECTORY

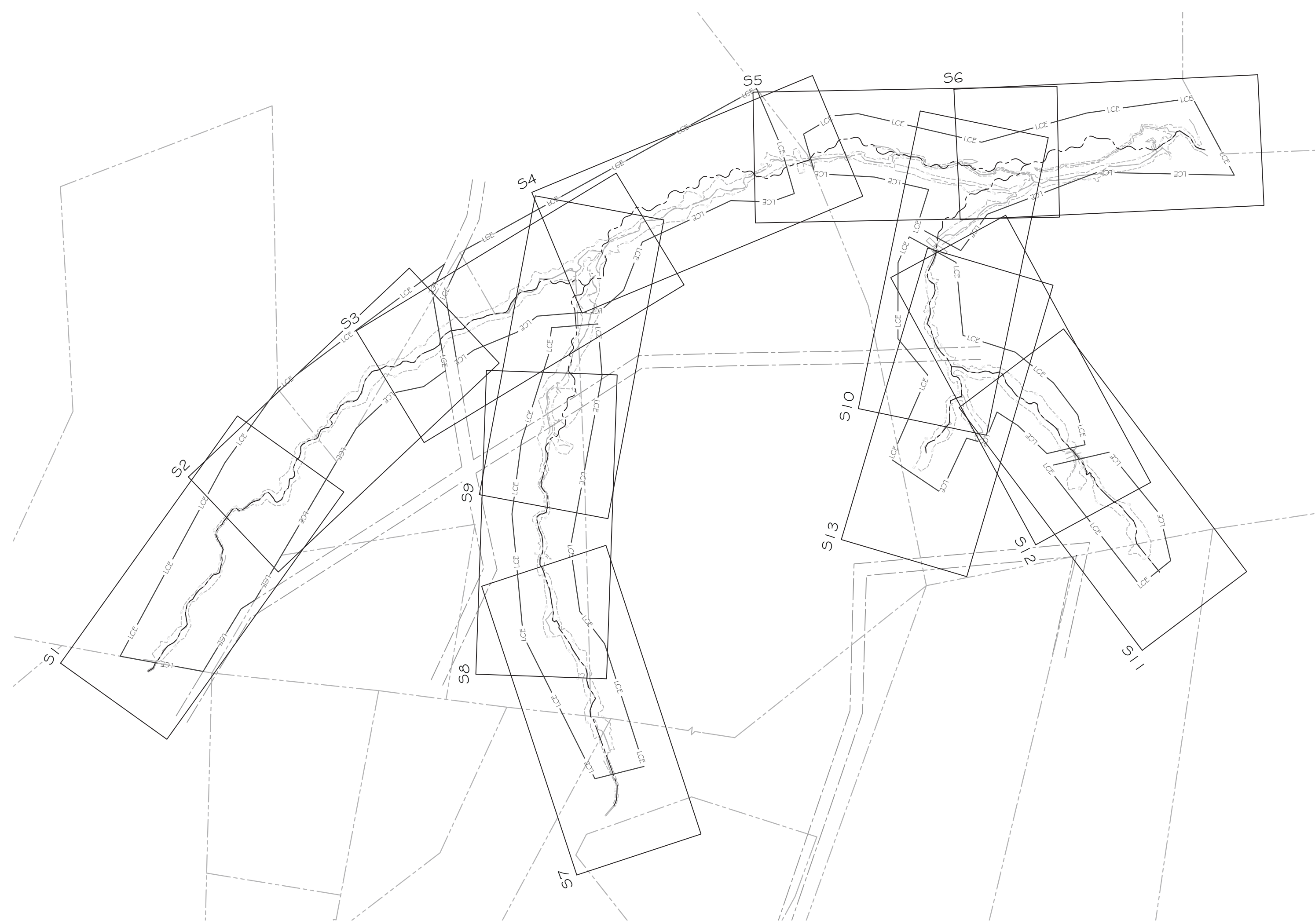
DESIGNED BY:
RESOURCE ENVIRONMENTAL SOLUTIONS, LLC
3600 GLENWOOD AVE, SUITE 100
RALEIGH, NC 27612

DESIGNED FOR:
PAUL WIESNER
NC DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF MITIGATION SERVICES
217 WEST JONES ST., SUITE 300A
RALEIGH, NC 27603

SURVEYED BY:
WSP USA INC.
128 TALBERT RD, SUITE A
MOORESVILLE, NC 28117

DMS PROJECT #: 100049
CONTRACT #: 7417
USACE ACTION ID #: SAW-2018-00450
RFP #: 16-007277

PROJECT TOPOGRAPHY AND EXISTING CONDITIONS PLANIMETRICS SURVEY WAS PROVIDED BY WSP USA INC. (NC FIRM LICENSE NUMBER F-0891, J. BRANDON HICKS, NC PLS L-5219), DATED MARCH 21, 2019



SITE MAP
NTS

Sheet List Table	
Sheet Number	Sheet Title
-	COVER
A1	OVERALL AERIAL VIEW
E1	NOTES
E2	EXISTING CONDITIONS
S1	REACH GF1
S2	REACH GF1
S3	REACH GF1
S4	REACH GF1
S5	REACH GF1
S6	REACH GF1
S7	REACH GF2
S8	REACH GF2
S9	REACH GF2
S10	REACH GF3
S11	REACH GF4
S12	REACH GF4
S13	REACH GF5
F1	FENCING PLAN
P1	PLANTING PLAN
EC1	EROSION CONTROL NOTES
EC2	EROSION CONTROL PLAN
EC3	EROSION CONTROL AERIAL
EC4	GROND STABILIZATION & MATERIALS
EC5	SELF-INSPECTION & REPORTING
D1	DETAILS
D2	DETAILS
D3	DETAILS
D4	DETAILS
D5	DETAILS

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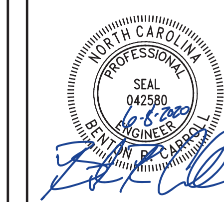
Main: 919.829.9909
www.res.us

Engineering Services Provided By:
Angler Environmental LLC
License: F-1428

SEAL



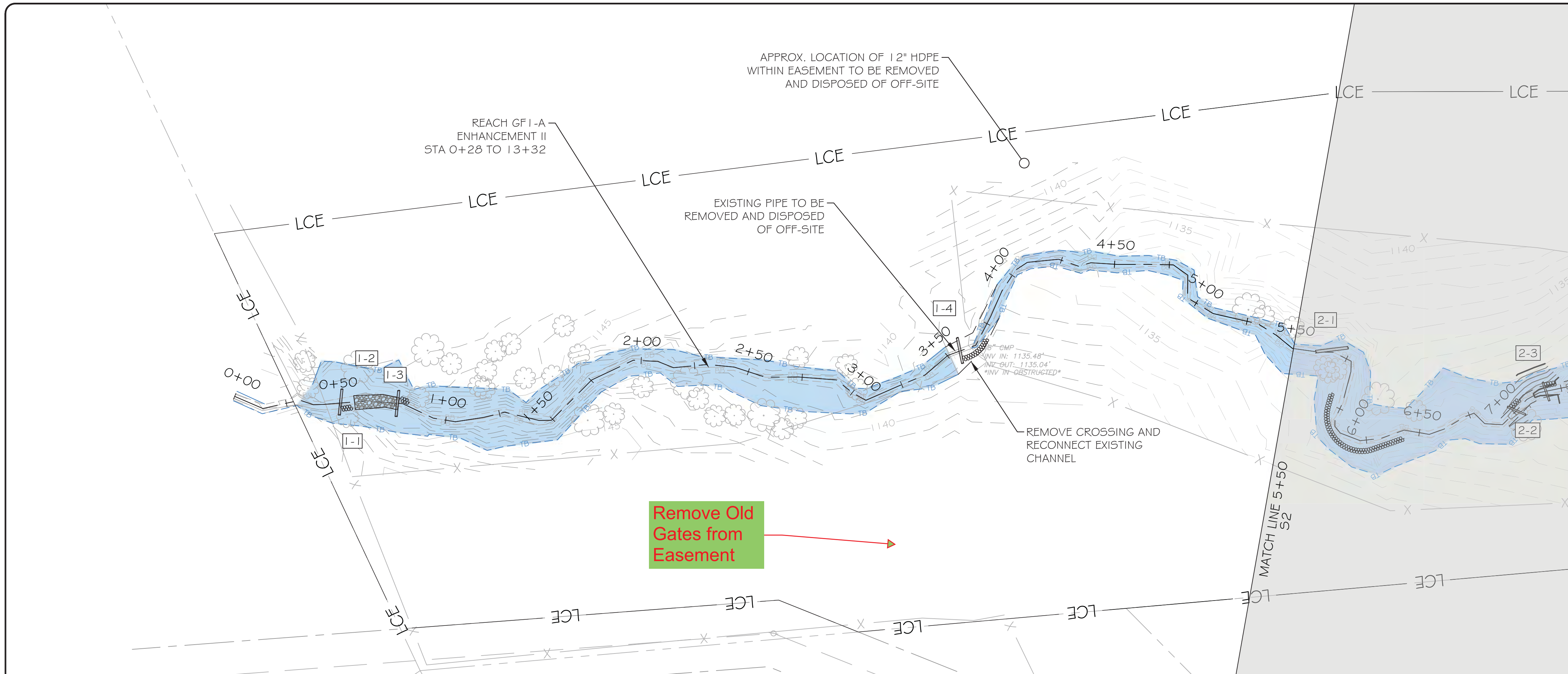
PLOT DATE:

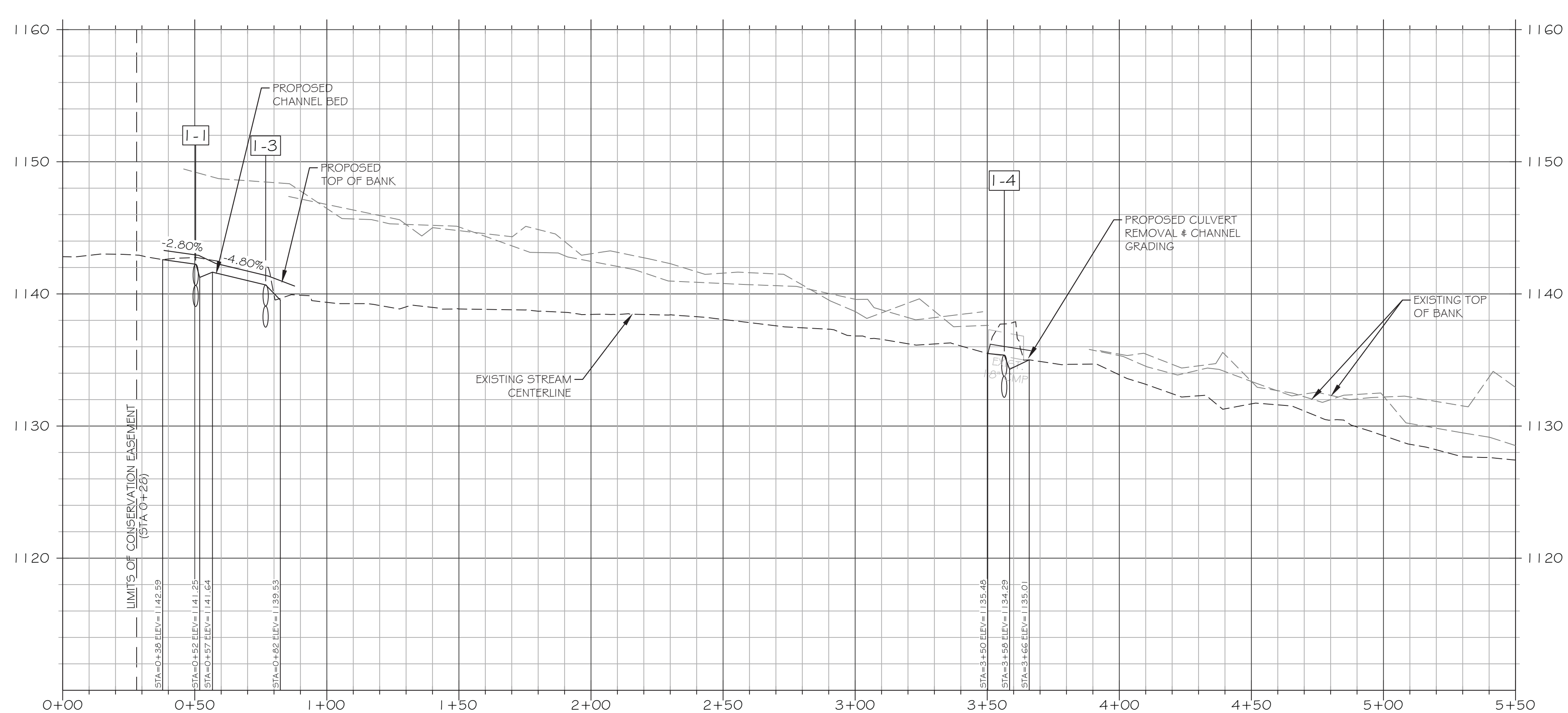
REVISIONS:

RELEASED FOR:
FINAL DESIGN - RELEASED FOR CONSTRUCTION

PROJECT NUMBER:	0438
PROJECT MANAGER:	BPB
DESIGNED:	BRC
DRAWN:	TRS
CHECKED:	AFM

SHEET NUMBER:
-





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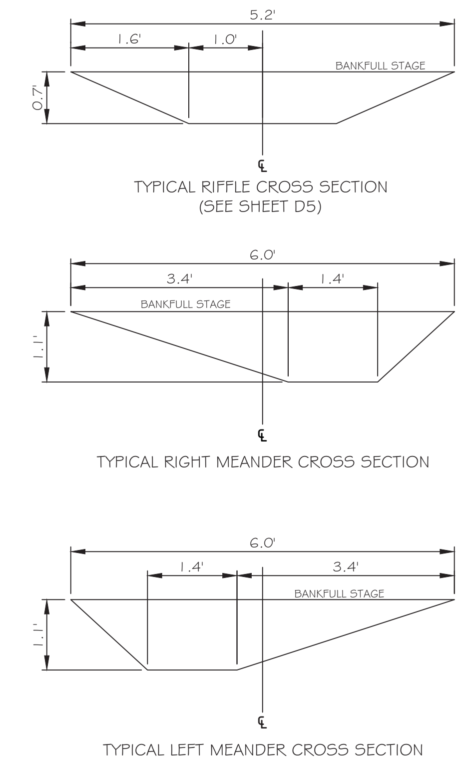

STRUCTURE TABLE

NO.	TYPE	STA.	ELEV.
1-1	LOG SILL	0+50'	1142.24'
1-2	RIFFLE GRADE CONTROL	0+77'	-
1-3	LOG SILL	0+77'	1140.68'
1-4	LOG SILL	3+56'	1135.37'

TOE PROTECTION TABLE

BANK	TYPE	FROM STA.	TO STA.
RT	BRUSH TOE	0+50'	0+56'
LT	BRUSH TOE	0+77'	0+82'
RT	BRUSH TOE	3+56'	3+69'

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SEAL
NORTH CAROLINA PROFESSIONAL SEAL 042580 ENGINEER BENTON R. CARROLL
6-8-2020

FULL SCALE: 1"=30
0 30 60
2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 6/8/2020

REVISIONS:

RELEASED FOR: FINAL DESIGN - RELEASED FOR CONSTRUCTION

PROJECT NAME: GROUNDHOG HOLLOW PROJECT ALEXANDER COUNTY, NORTH CAROLINA

DRAWING TITLE: REACH GF1

PROJECT NUMBER: 0438
PROJECT MANAGER: BPB
DESIGNED: BRC
DRAWN: TRS
CHECKED: AFM

SHEET NUMBER: S1

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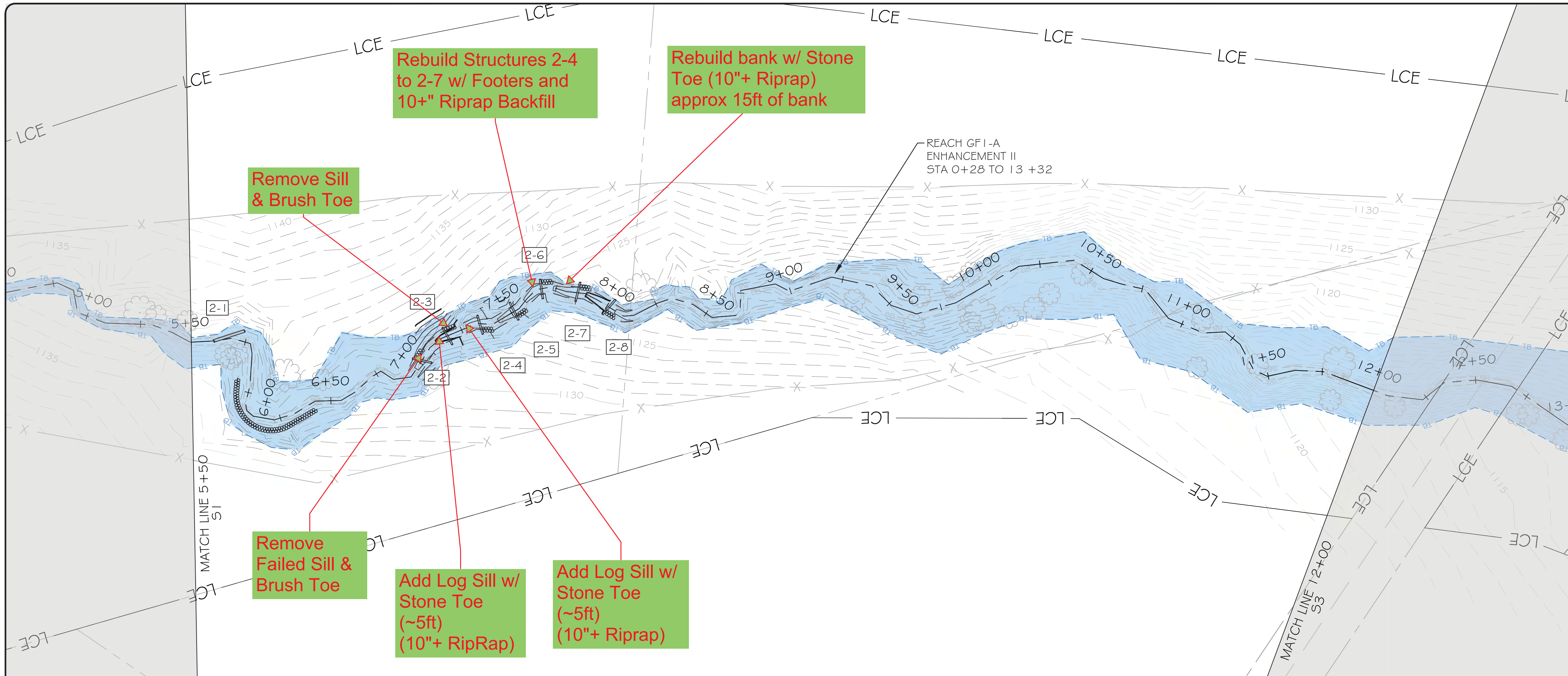

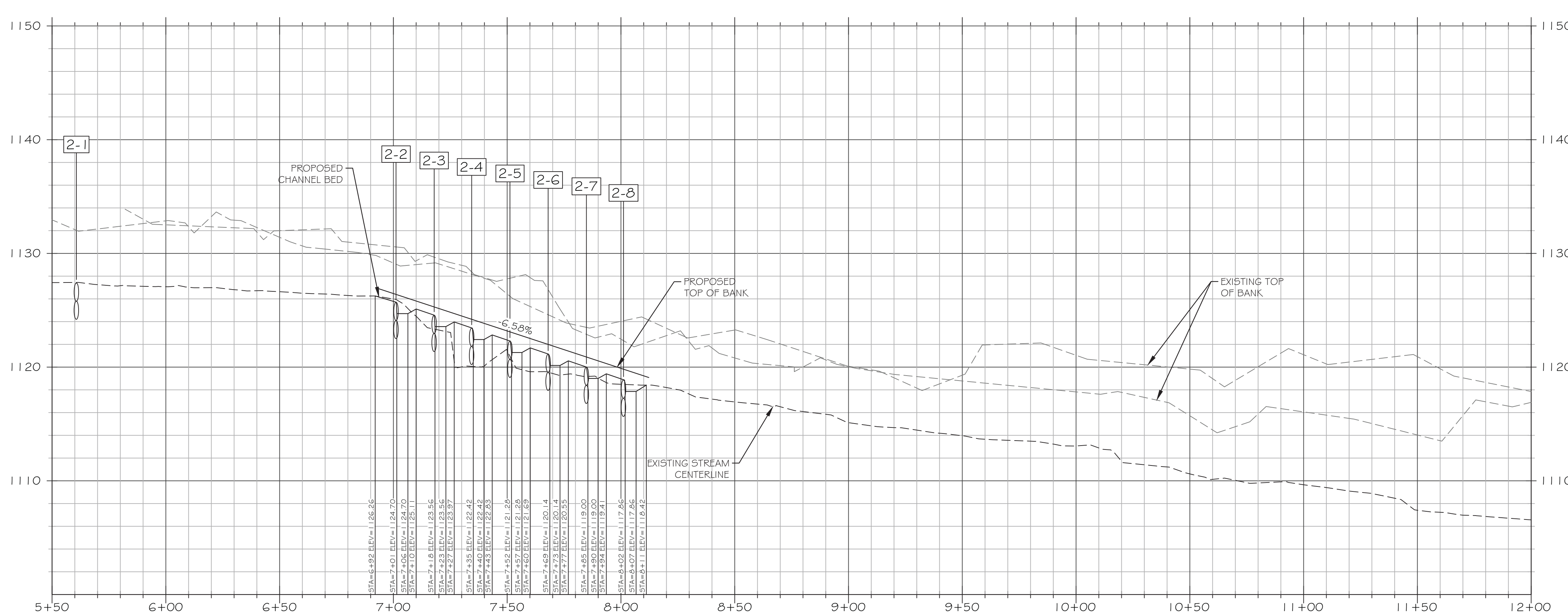

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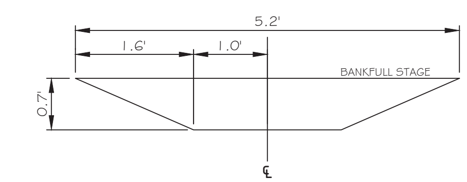
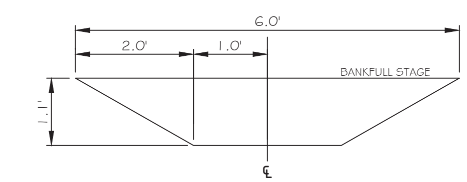


TYPICAL RIFFLE CROSS SECTION
(SEE SHEET D5)



TYPICAL POOL CROSS SECTION

STRUCTURE TABLE			
NO.	TYPE	STA.	ELEV.
2-1	LOG VANE	5+61'	1127.40'
2-2	LOG SILL	7+01'	1125.70'
2-3	LOG SILL	7+18'	1124.56'
2-4	LOG SILL	7+34'	1123.42'
2-5	LOG SILL	7+51'	1122.28'
2-6	LOG SILL	7+68'	1121.14'
2-7	LOG SILL	7+85'	1120.00'
2-8	LOG SILL	8+01'	1118.86'

TOE PROTECTION TABLE			
BANK	TYPE	FROM STA.	TO STA.
RT	BRUSH TOE	5+93'	6+41'
LT	BRUSH TOE	7+01'	7+06'
LT	BRUSH TOE	7+18'	7+23'
RT	BRUSH TOE	7+35'	7+40'
RT	BRUSH TOE	7+52'	7+56'
LT	BRUSH TOE	7+69'	7+73'
LT	BRUSH TOE	7+86'	7+90'
RT	BRUSH TOE	8+01'	8+06'

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NORTH CAROLINA PROFESSIONAL SEAL 042580 ENGINEER BENTON R. CARROLL 6-8-2020

FULL SCALE: 1"=30
0 30 60
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PROJECT NAME: GROUNDHOG HOLLOW PROJECT ALEXANDER COUNTY, NORTH CAROLINA

DRAWING TITLE: REACH GF1

PROJECT NUMBER:	0438
PROJECT MANAGER:	BPB
DESIGNED:	BRC
DRAWN:	TRS
CHECKED:	AFM

SHEET NUMBER: S2

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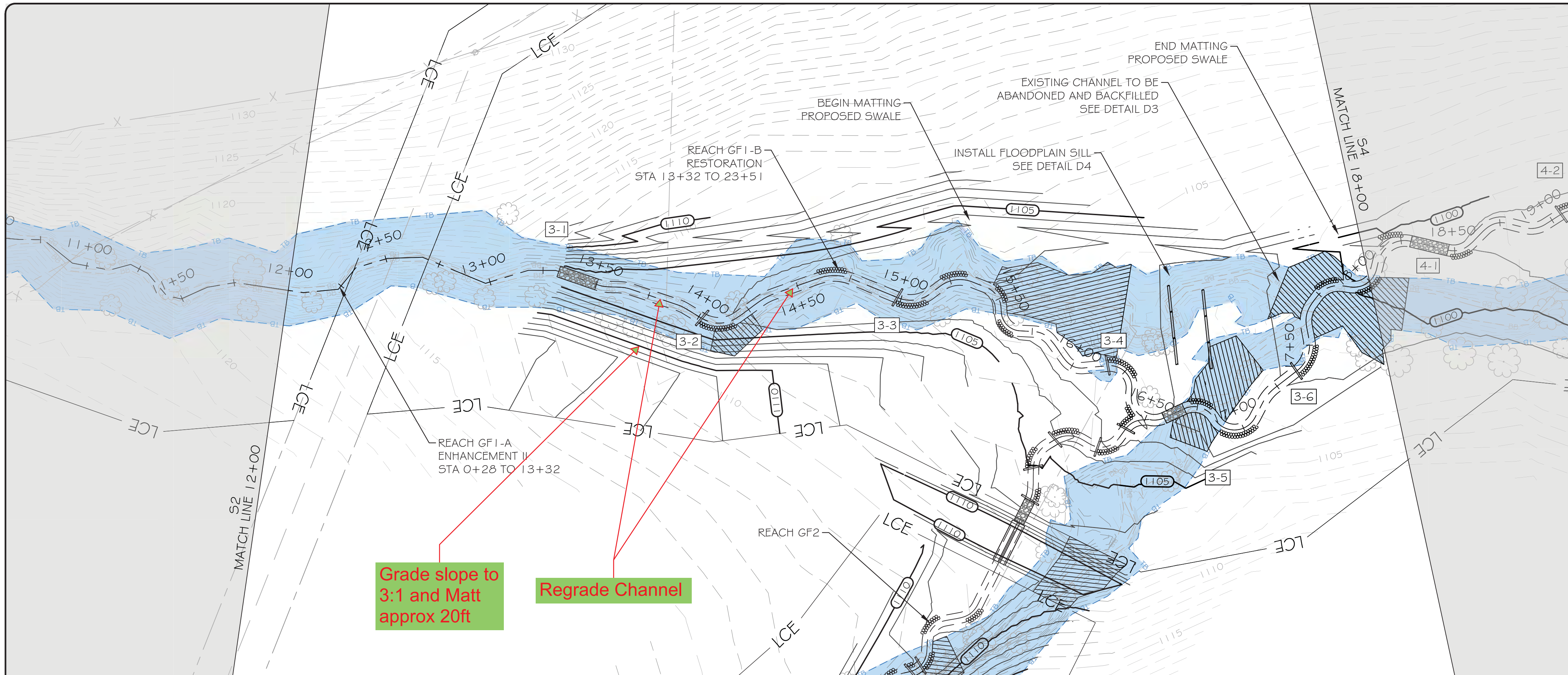
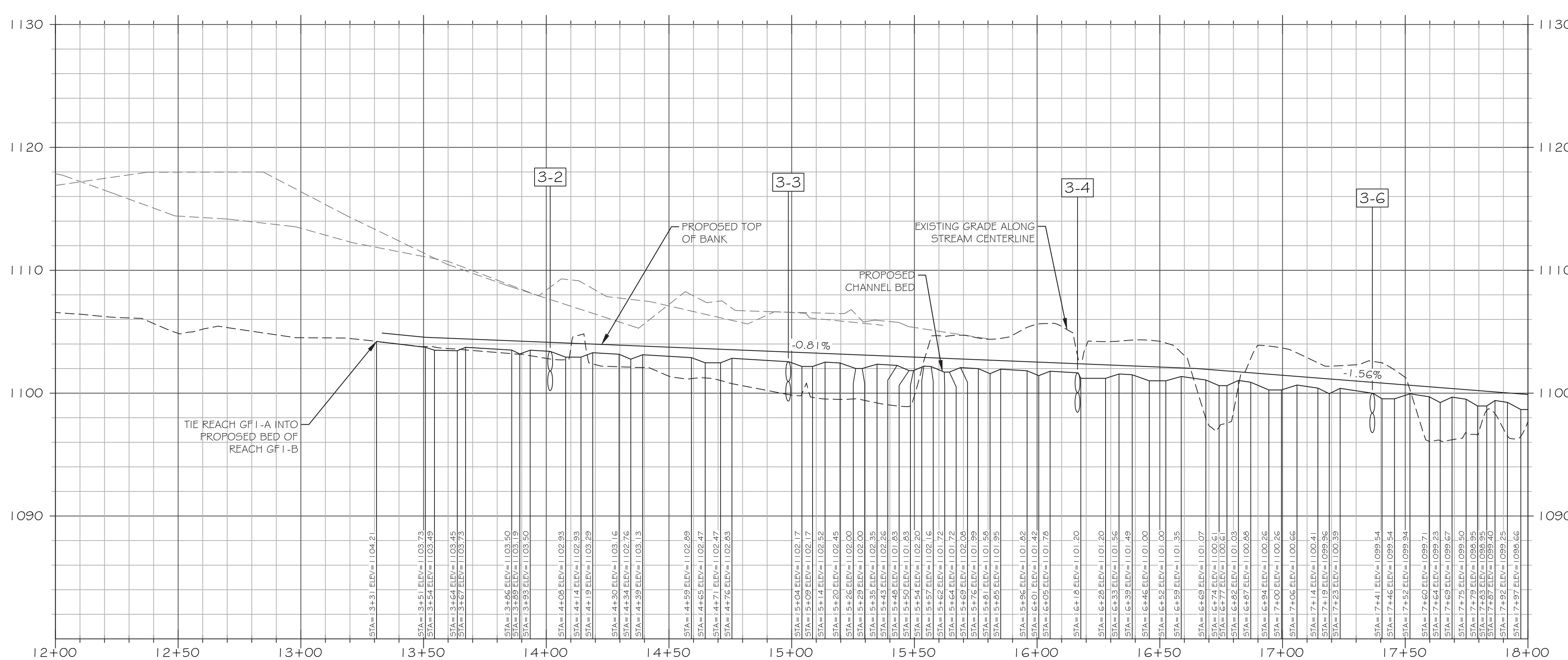
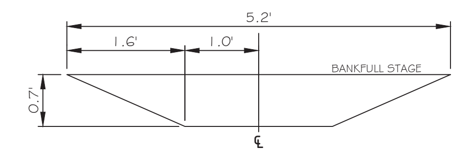


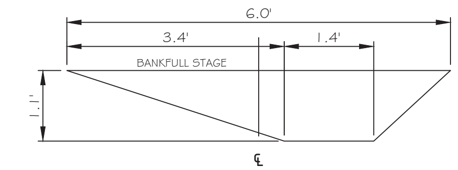


SCALE: HOR 1"=30'; VERT 1"=6'

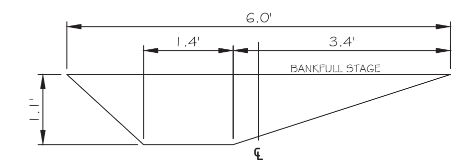
REACH GF1-B STA 13+32 TO STA 16+52



TYPICAL RIFFLE CROSS SECTION
(SEE SHEET D5)

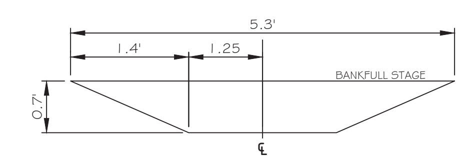


TYPICAL RIGHT MEANDER CROSS SECTION

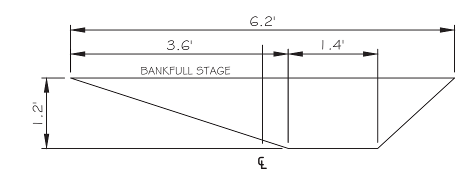


TYPICAL LEFT MEANDER CROSS SECTION

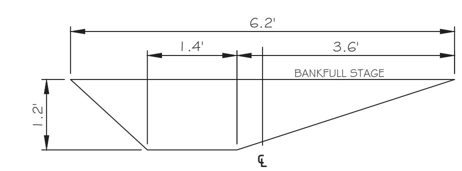
REACH GF1-B STA 16+52 TO STA 30+24



TYPICAL RIFFLE CROSS SECTION
(SEE SHEET D5)



TYPICAL RIGHT MEANDER CROSS SECTION



TYPICAL LEFT MEANDER CROSS SECTION

STRUCTURE TABLE

NO.	TYPE	STA.	ELEV.
3-1	RIFFLE GRADE CONTROL	13+51'	-
3-2	LOG SILL	14+02'	1103.40'
3-3	LOG SILL	14+99'	1102.55'
3-4	LOG SILL	16+16'	1101.64'
3-5	RIFFLE GRADE CONTROL	16+69'	-
3-6	LOG SILL	17+37'	1099.98'

TOE PROTECTION TABLE

BANK	TYPE	FROM STA.	TO STA.
RT	BRUSH TOE	14+02'	14+17'
LT	BRUSH TOE	14+60'	14+73'
RT	BRUSH TOE	14+99'	15+11'
LT	BRUSH TOE	15+45'	15+52'
RT	BRUSH TOE	15+59'	15+67'
LT	BRUSH TOE	16+17'	16+29'
RT	BRUSH TOE	16+41'	16+46'
LT	BRUSH TOE	16+71'	16+81'
RT	BRUSH TOE	16+90'	17+05'
RT	BRUSH TOE	17+37'	17+50'
LT	BRUSH TOE	17+75'	17+85'
RT	BRUSH TOE	17+93'	18+04'

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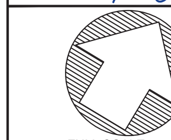

FULL SCALE: 1"=30
0 30 60
2" = FULL SCALE
1" = HALF SCALE

PLOT DATE:
6/8/2020

REVISIONS:

RELEASED FOR:
FINAL DESIGN - RELEASED FOR CONSTRUCTION

PROJECT NAME:
GROUNDHOG HOLLOW PROJECT
ALEXANDER COUNTY, NORTH CAROLINA

DRAWING TITLE:
REACH GF1

PROJECT NUMBER: 0438
PROJECT MANAGER: BPB
DESIGNED: BRC
DRAWN: TRS
CHECKED: AFM

SHEET NUMBER:
S3

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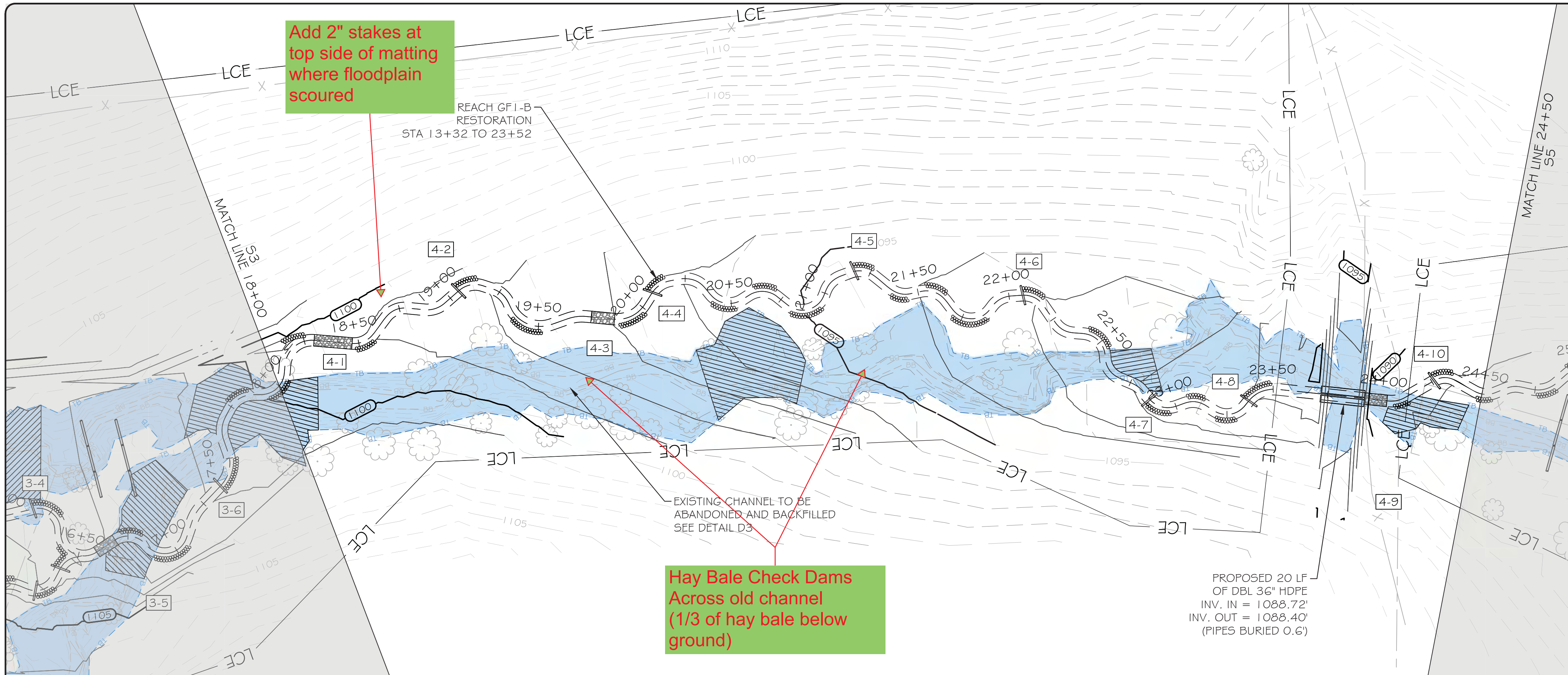
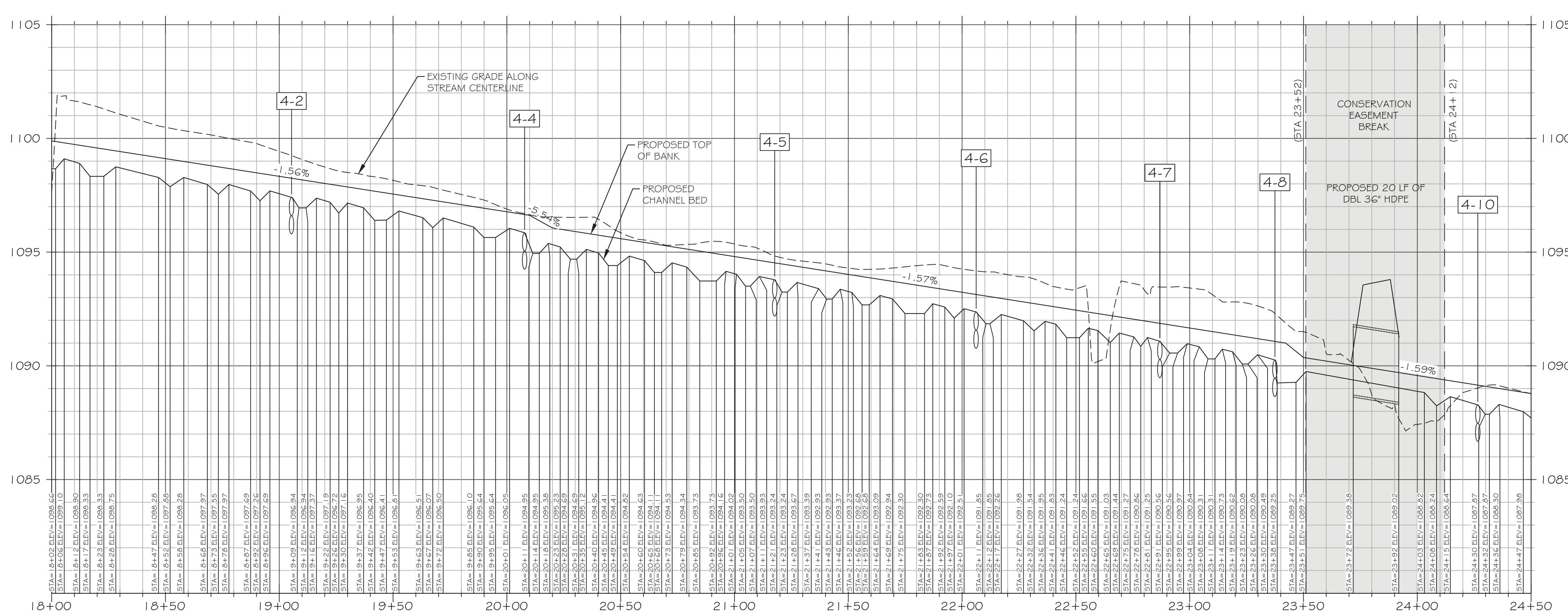
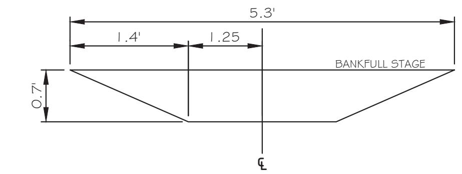


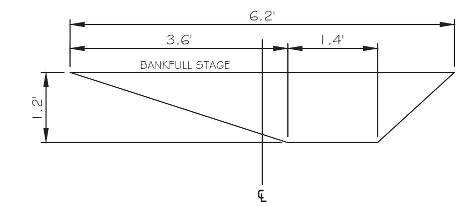


SCALE: HOR 1"=30'; VERT 1"=3'

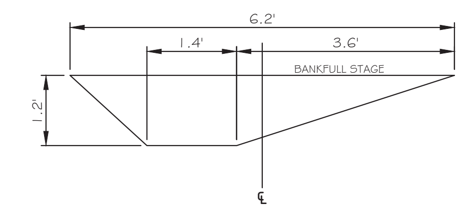
REACH GF1-B STA 16+52 TO STA 30+24



TYPICAL RIFFLE CROSS SECTION
(SEE SHEET D5)



TYPICAL RIGHT MEANDER CROSS SECTION



TYPICAL LEFT MEANDER CROSS SECTION

STRUCTURE TABLE

NO.	TYPE	STA.	ELEV.
4-1	RIFFLE GRADE CONTROL	18+47'	-
4-2	LOG SILL	19+05'	1097.40'
4-3	RIFFLE GRADE CONTROL	19+85'	-
4-4	LOG SILL	20+08'	1095.85'
4-5	LOG SILL	21+18'	1093.78'
4-6	LOG SILL	22+06'	1092.37'
4-7	LOG SILL	22+87'	1091.08'
4-8	LOG SILL	23+37'	1090.25'
4-9	RIFFLE GRADE CONTROL	24+02'	-
4-10	LOG SILL	24+27'	1088.28'

TOE PROTECTION TABLE

BANK	TYPE	FROM STA.	TO STA.
LT	BRUSH TOE	18+18'	18+26'
RT	BRUSH TOE	18+48'	18+57'
LT	BRUSH TOE	19+05'	19+14'
RT	BRUSH TOE	19+38'	19+52'
RT	BRUSH TOE	19+88'	19+99'
LT	BRUSH TOE	20+08'	20+16'
RT	BRUSH TOE	20+42'	20+52'
LT	BRUSH TOE	20+62'	20+71'
RT	BRUSH TOE	20+81'	20+95'
LT	BRUSH TOE	21+18'	21+26'
RT	BRUSH TOE	21+38'	21+45'
LT	BRUSH TOE	21+53'	21+62'
RT	BRUSH TOE	21+71'	21+86'
LT	BRUSH TOE	22+06'	22+15'
LT	BRUSH TOE	22+43'	22+54'
RT	BRUSH TOE	22+87'	22+98'
LT	BRUSH TOE	23+05'	23+13'
RT	BRUSH TOE	23+21'	23+28'
LT	BRUSH TOE	23+37'	23+50'
RT	BRUSH TOE	24+05'	24+12'
LT	BRUSH TOE	24+26'	24+34'

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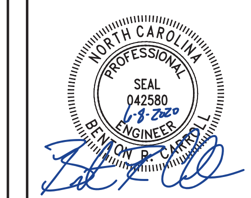

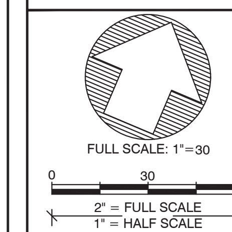

PLOT DATE: 6/8/2020

REVISIONS:

RELEASED FOR: FINAL DESIGN - RELEASED FOR CONSTRUCTION

PROJECT NAME: GROUNDHOG HOLLOW PROJECT
ALEXANDER COUNTY, NORTH CAROLINA

DRAWING TITLE: REACH GF1

PROJECT NUMBER:	0438
PROJECT MANAGER:	BPB
DESIGNED:	BRC
DRAWN:	TRS
CHECKED:	AFM

SHEET NUMBER: S4

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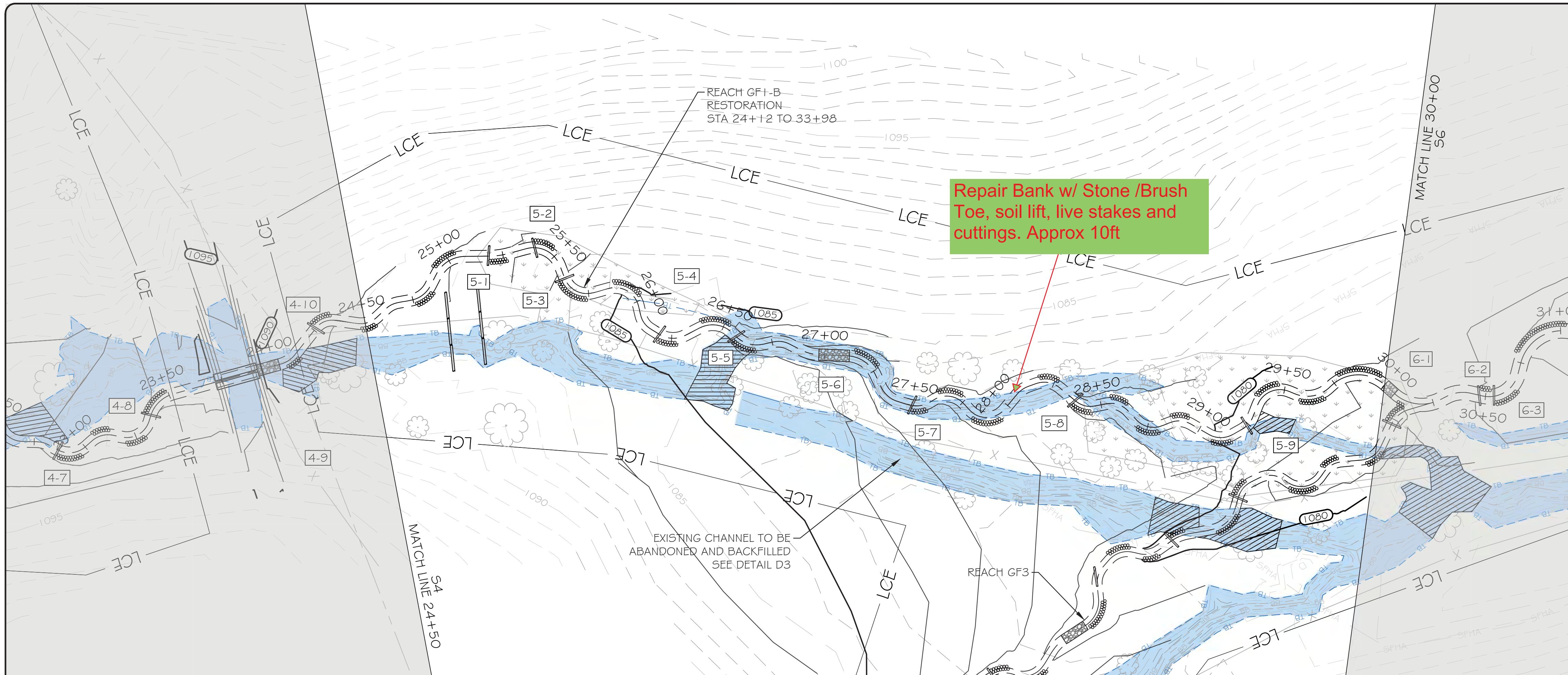
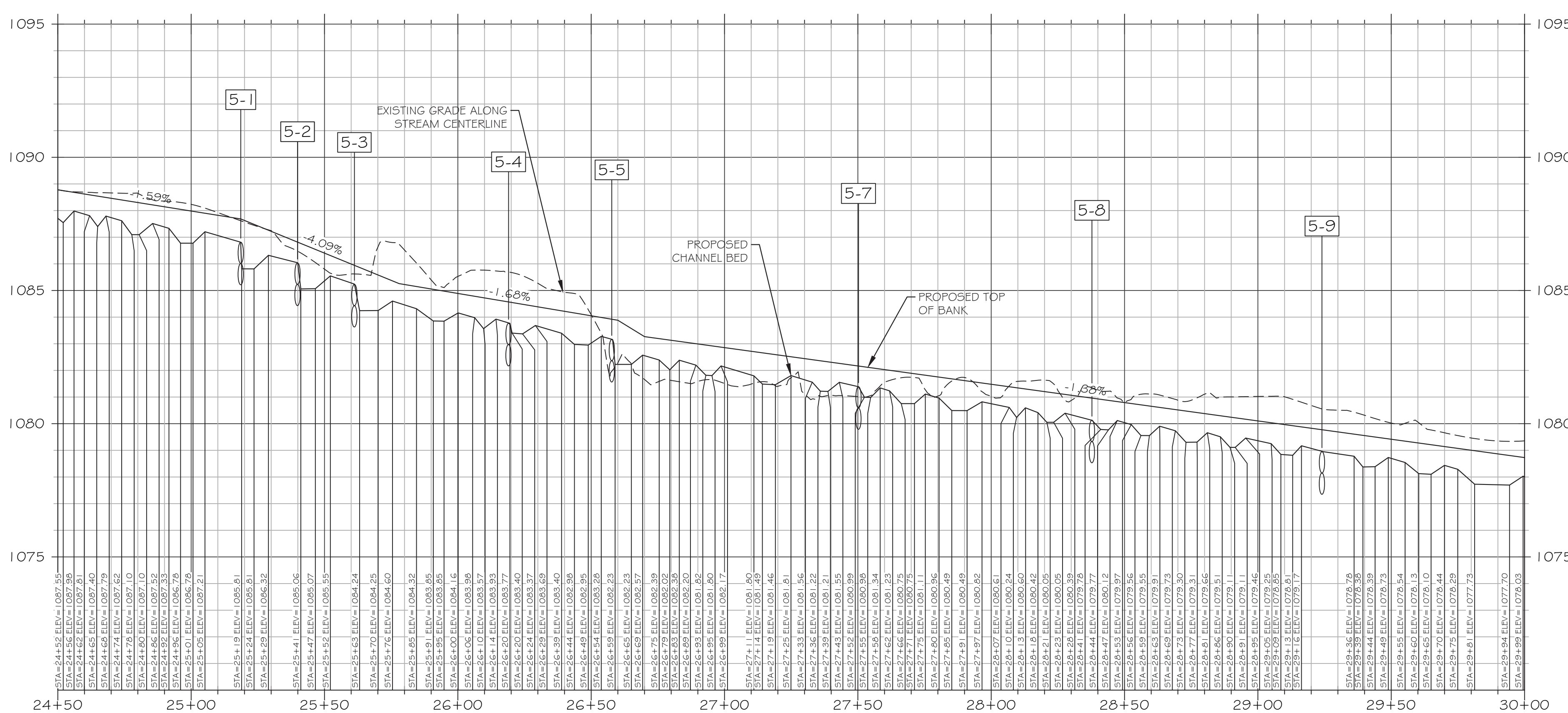
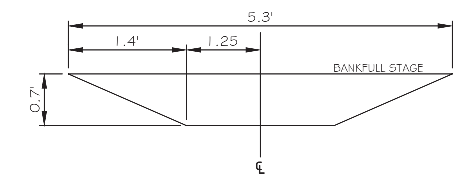


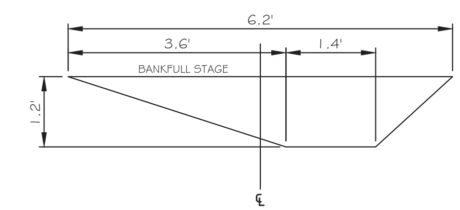


SCALE: HOR 1"=30'; VERT 1"=3'

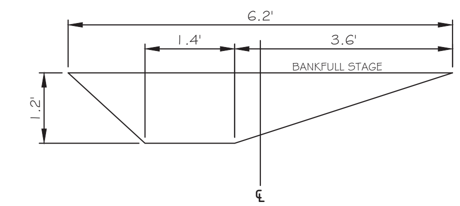
REACH GF1-B STA 16+52 TO STA 30+24



TYPICAL RIFFLE CROSS SECTION
(SEE SHEET D5)



TYPICAL RIGHT MEANDER CROSS SECTION



TYPICAL LEFT MEANDER CROSS SECTION

STRUCTURE TABLE

NO.	TYPE	STA.	ELEV.
5-1	LOG SILL	25+19'	1086.81'
5-2	LOG SILL	25+40'	1086.03'
5-3	LOG SILL	25+61'	1085.23'
5-4	LOG SILL	26+19'	1083.77'
5-5	LOG SILL	26+58'	1083.16'
5-6	RIFFLE GRADE CONTROL	27+11'	-
5-7	LOG SILL	27+50'	1081.39'
5-8	LOG SILL	28+38'	1080.13'
5-9	LOG SILL	29+24'	1078.95'

TOE PROTECTION TABLE

BANK	TYPE	FROM STA.	TO STA.
RT	BRUSH TOE	24+48'	24+55'
RT	BRUSH TOE	24+76'	24+84'
LT	BRUSH TOE	24+93'	25+04'
RT	BRUSH TOE	25+19'	25+27'
LT	BRUSH TOE	25+40'	25+48'
RT	BRUSH TOE	25+62'	25+75'
LT	BRUSH TOE	25+86'	25+98'
RT	BRUSH TOE	26+19'	26+27'
LT	BRUSH TOE	26+40'	26+52'
RT	BRUSH TOE	26+57'	26+68'
LT	BRUSH TOE	27+13'	27+25'
RT	BRUSH TOE	27+50'	27+57'
LT	BRUSH TOE	27+64'	27+73'
RT	BRUSH TOE	27+83'	27+95'
LT	BRUSH TOE	28+18'	28+27'
RT	BRUSH TOE	28+37'	28+46'
LT	BRUSH TOE	28+54'	28+61'
RT	BRUSH TOE	28+71'	28+80'
LT	BRUSH TOE	28+86'	28+94'
RT	BRUSH TOE	29+07'	29+15'
LT	BRUSH TOE	29+37'	29+48'
RT	BRUSH TOE	29+57'	29+69'
LT	BRUSH TOE	29+77'	29+98'

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SEAL

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 042580 BENTON P. CARROLL

FULL SCALE: 1"=30
0 30 60
2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 6/8/2020

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CHECKED:	AFM

SHEET NUMBER: S5

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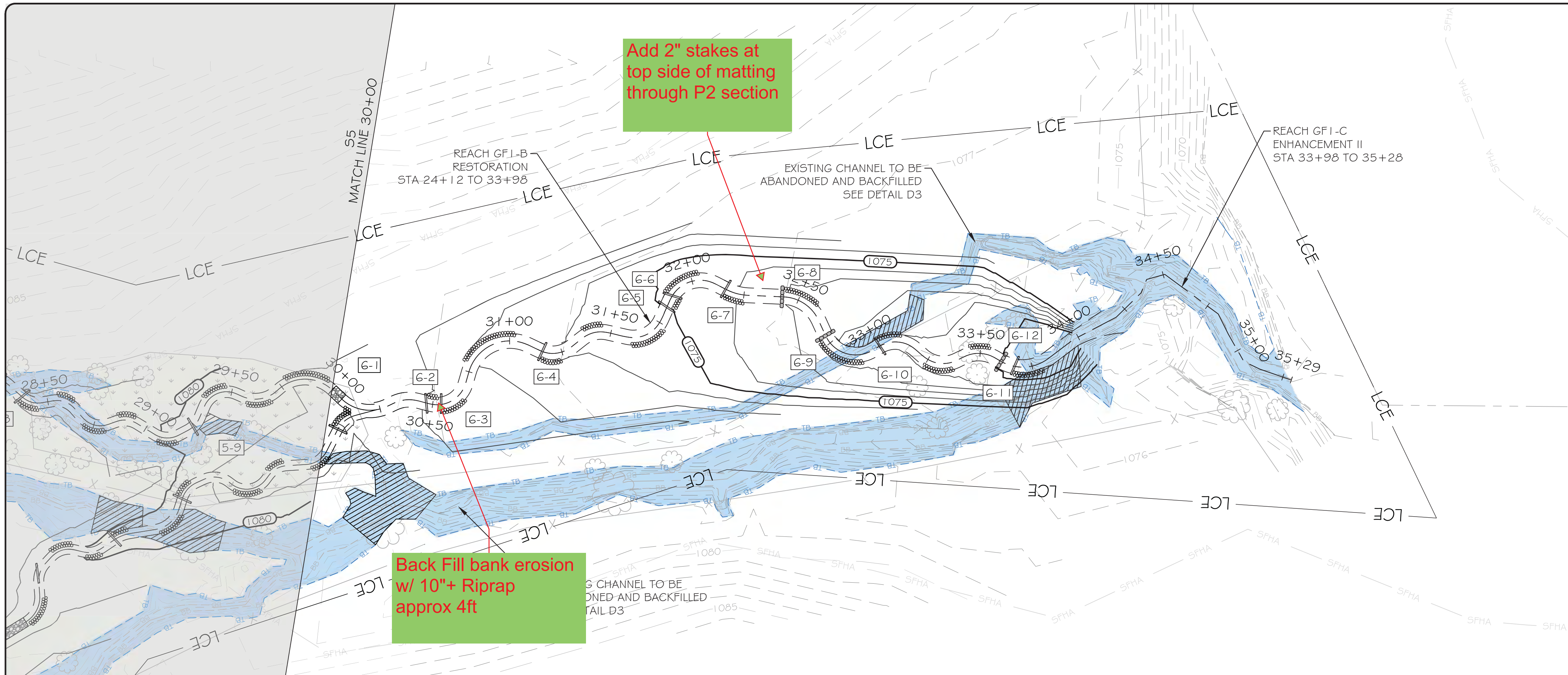
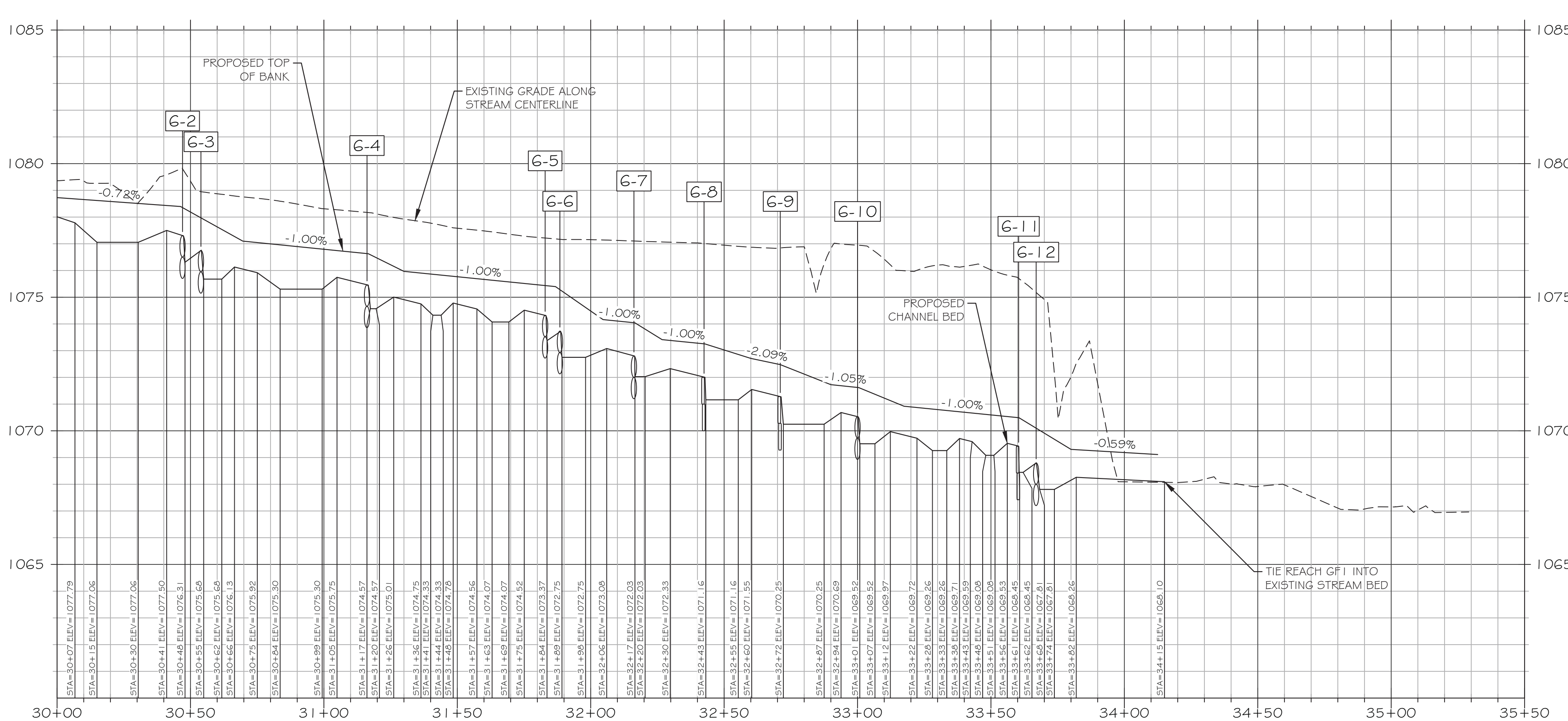
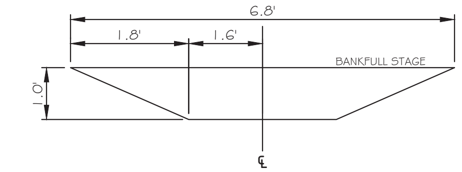


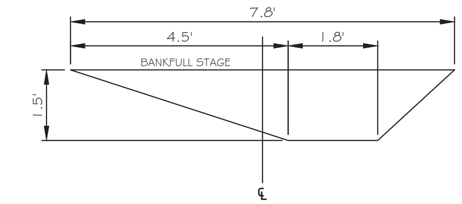


SCALE: HOR 1"=30'; VERT 1"=3'

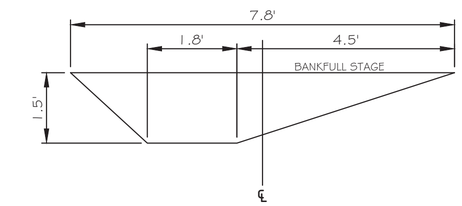
REACH GF1-B STA 30+24 TO STA 33+98



TYPICAL RIFFLE CROSS SECTION
(SEE SHEET D5)



TYPICAL RIGHT MEANDER CROSS SECTION



TYPICAL LEFT MEANDER CROSS SECTION

STRUCTURE TABLE

NO.	TYPE	STA.	ELEV.
6-1	RIFFLE GRADE CONTROL	30+06'	-
6-2	LOG SILL	30+47'	1077.30'
6-3	LOG SILL	30+54'	1076.75'
6-4	LOG SILL	31+16'	1075.46'
6-5	LOG SILL	31+83'	1074.32'
6-6	LOG SILL	31+88'	1073.73'
6-7	LOG SILL	32+16'	1072.80'
6-8	ROCK SILL	32+42'	1072.00'
6-9	ROCK SILL	32+71'	1071.28'
6-10	LOG SILL	33+00'	1070.53'
6-11	ROCK SILL	33+60'	1069.42'
6-12	LOG SILL	33+67'	1068.80'

TOE PROTECTION TABLE

BANK	TYPE	FROM STA.	TO STA.
RT	BRUSH TOE	30+09'	30+12'
LT	BRUSH TOE	30+46'	30+53'
RT	BRUSH TOE	30+54'	30+64'
LT	BRUSH TOE	30+78'	31+03'
RT	BRUSH TOE	31+16'	31+24'
LT	BRUSH TOE	31+38'	31+46'
RT	BRUSH TOE	31+60'	31+74'
RT	BRUSH TOE	31+83'	31+88'
RT	BRUSH TOE	31+89'	32+03'
RT	BRUSH TOE	32+17'	32+25'
LT	BRUSH TOE	32+43'	32+58'
RT	BRUSH TOE	32+72'	32+91'
LT	BRUSH TOE	33+00'	33+10'
RT	BRUSH TOE	33+24'	33+37'
LT	BRUSH TOE	33+45'	33+54'
RT	BRUSH TOE	33+67'	33+80'

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SEAL

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 042580 BENTON R. CARROLL 6-8-2020

FULL SCALE: 1"=30
0 30 60
2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 6/8/2020

REVISIONS:

RELEASED FOR: FINAL DESIGN - RELEASED FOR CONSTRUCTION

PROJECT NAME: GROUNDHOG HOLLOW PROJECT ALEXANDER COUNTY, NORTH CAROLINA

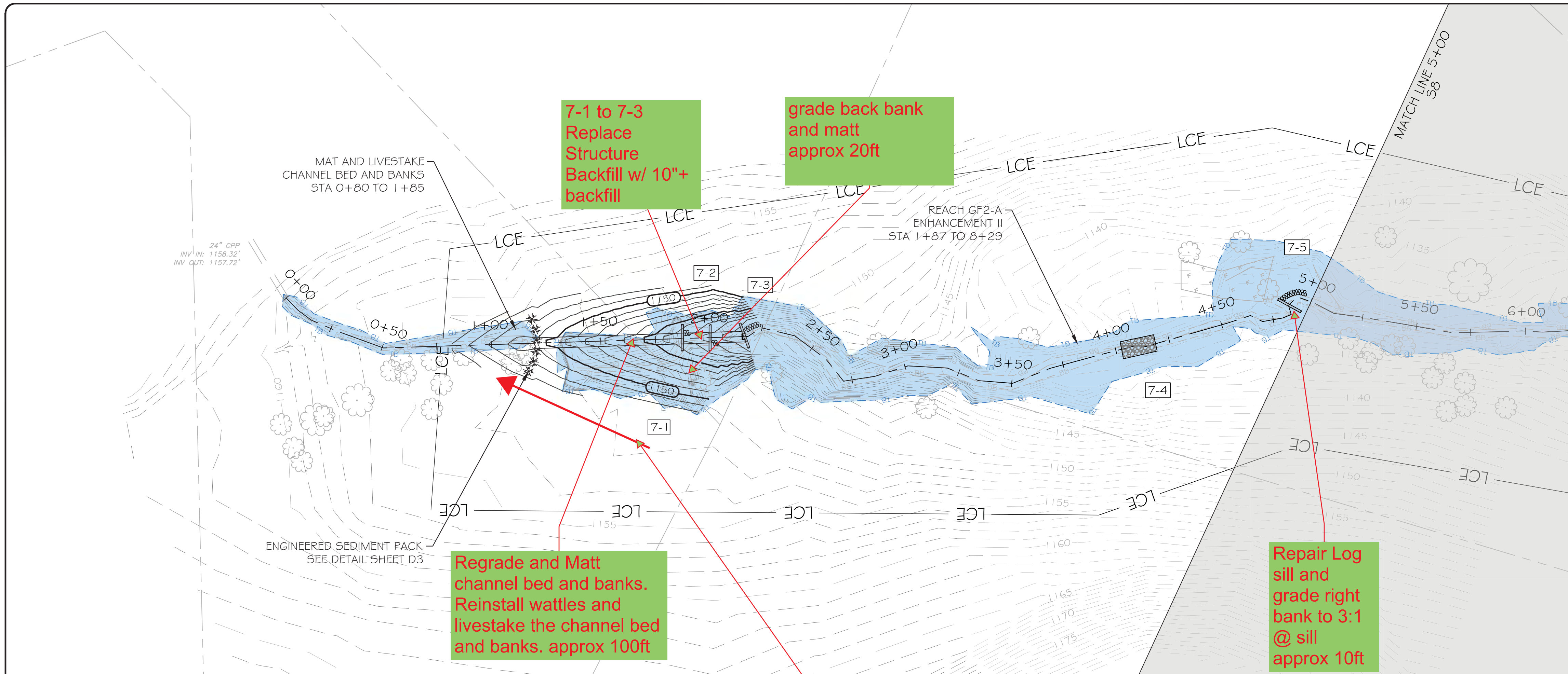
DRAWING TITLE: REACH GF1

PROJECT NUMBER:	0438
PROJECT MANAGER:	BPB
DESIGNED:	BRC
DRAWN:	TRS
CHECKED:	AFM

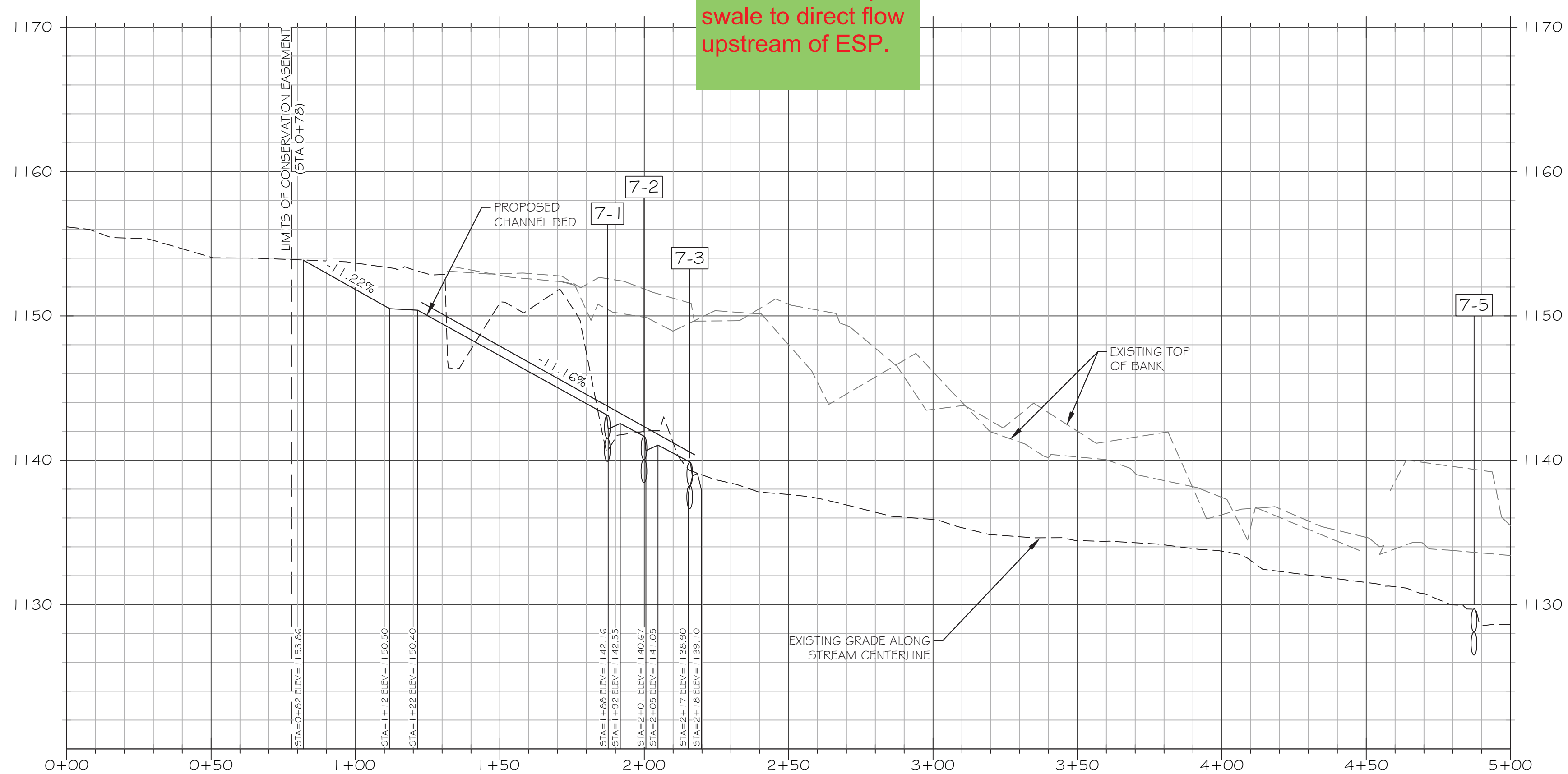
SHEET NUMBER:

S6

FILE NAME:R:\Resgis\dropbox\gis\projects\NC\Groundhog Hollow\CAD\DWG\0438_SHT_GF1.dwg SAVED BY: Bcarroll

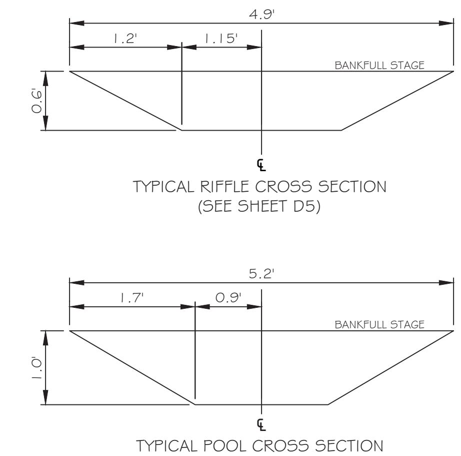


Grade 0.5ft deep swale to direct flow upstream of ESP.



SCALE: HOR 1"=30'; VERT 1"=6'

REACH GF2 STA 1+22 TO STA 2+18



STRUCTURE TABLE			
NO.	TYPE	STA.	ELEV.
7-1	LOG SILL	1+87'	1143.12'
7-2	LOG SILL	2+00'	1141.65'
7-3	LOG SILL	2+16'	1139.86'
7-4	RIFFLE GRADE CONTROL	4+19'	-
7-5	LOG SILL	4+87'	1129.70'

TOE PROTECTION TABLE			
BANK	TYPE	FROM STA.	TO STA.
LT	BRUSH TOE	1+88'	1+91'
RT	BRUSH TOE	2+00'	2+04'
LT	BRUSH TOE	2+16'	2+25'
LT	BRUSH TOE	4+88'	4+97'

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SEAL

NORTH CAROLINA PROFESSIONAL SEAL 042580 ENGINEER BENTON R. CARROLL 6.8.2020

FULL SCALE: 1"=30

0 30 60

2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 6/8/2020

REVISIONS:

RELEASED FOR: FINAL DESIGN - RELEASED FOR CONSTRUCTION

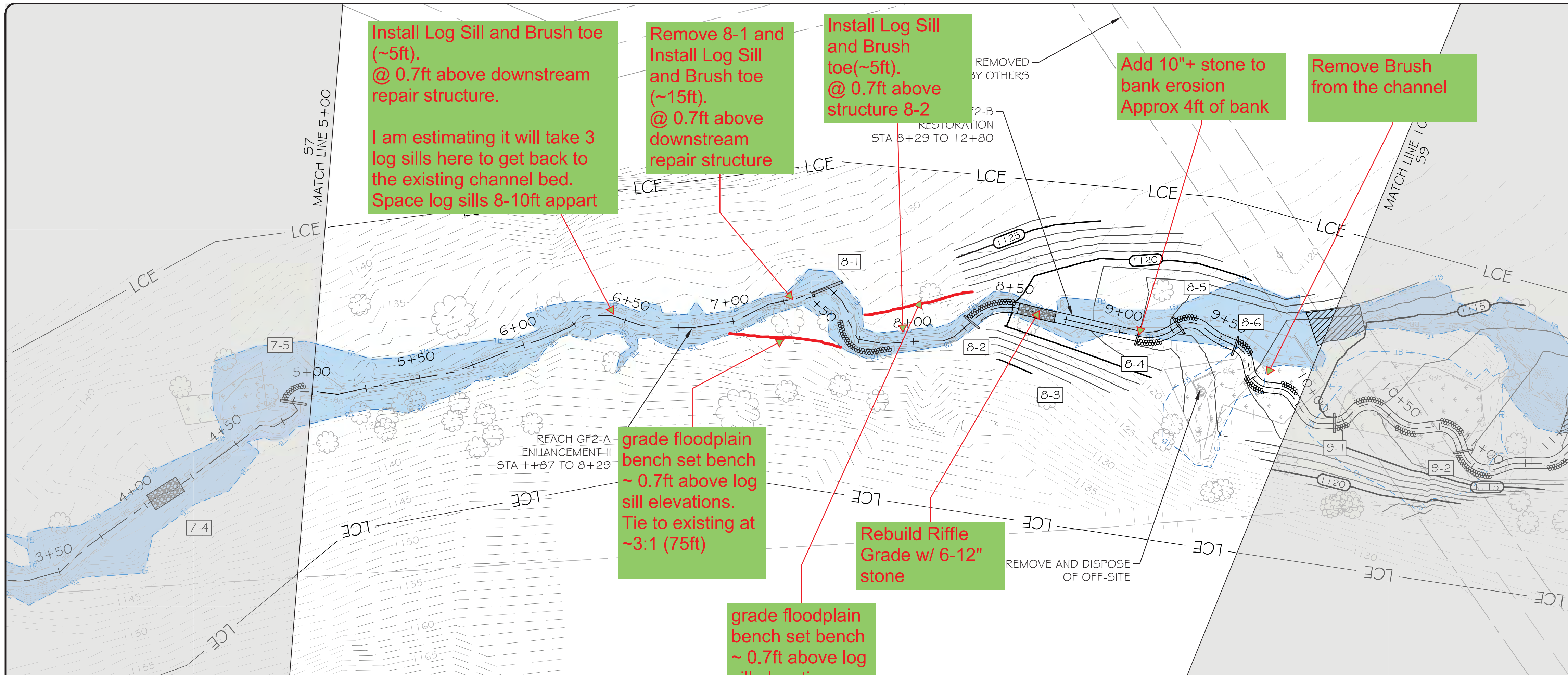
PROJECT NAME: GROUNDHOG HOLLOW PROJECT ALEXANDER COUNTY, NORTH CAROLINA

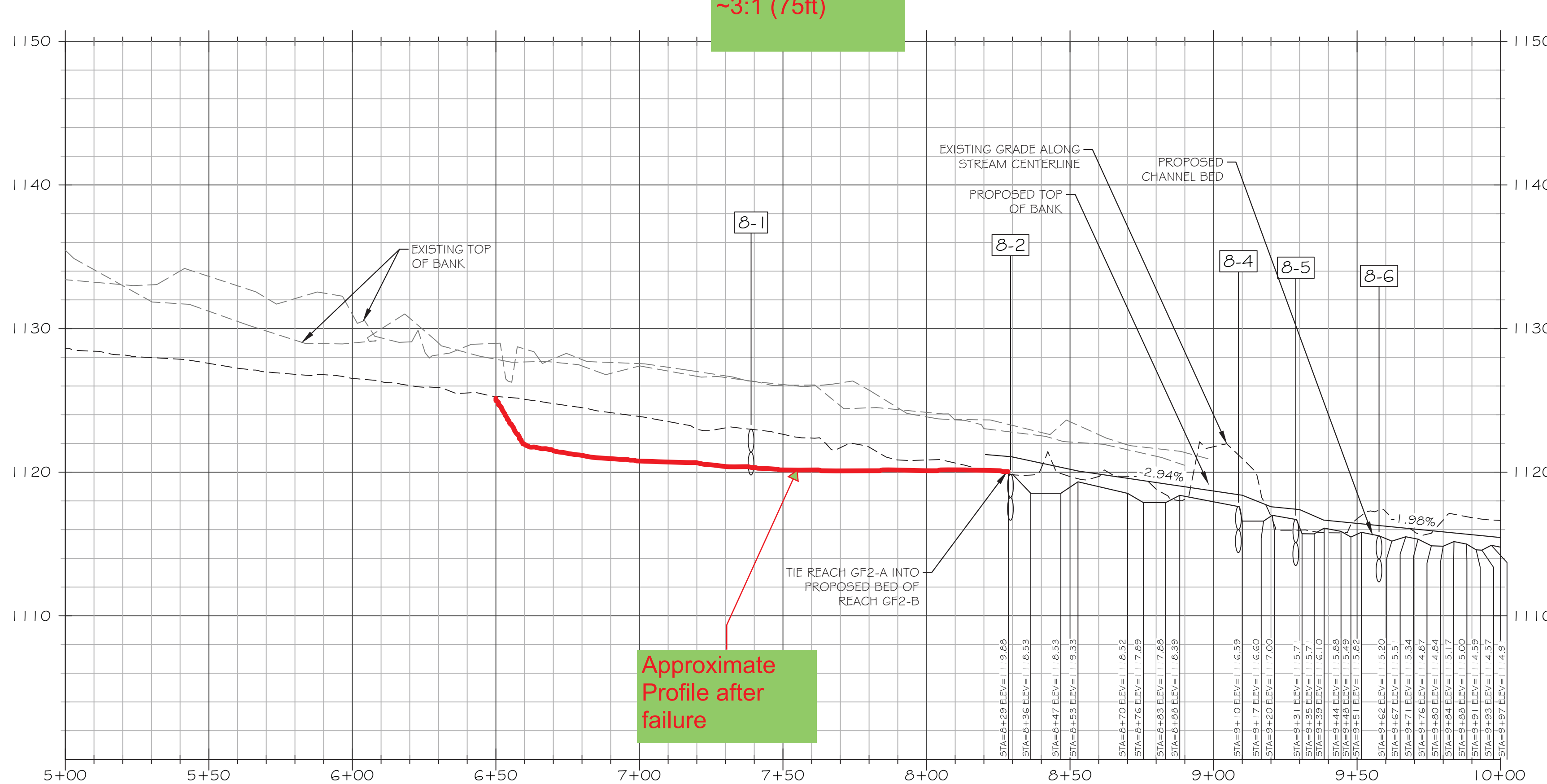
DRAWING TITLE: REACH GF2

PROJECT NUMBER: 0438
PROJECT MANAGER: BPB
DESIGNED: BRC
DRAWN: TRS
CHECKED: AFM

SHEET NUMBER: S7

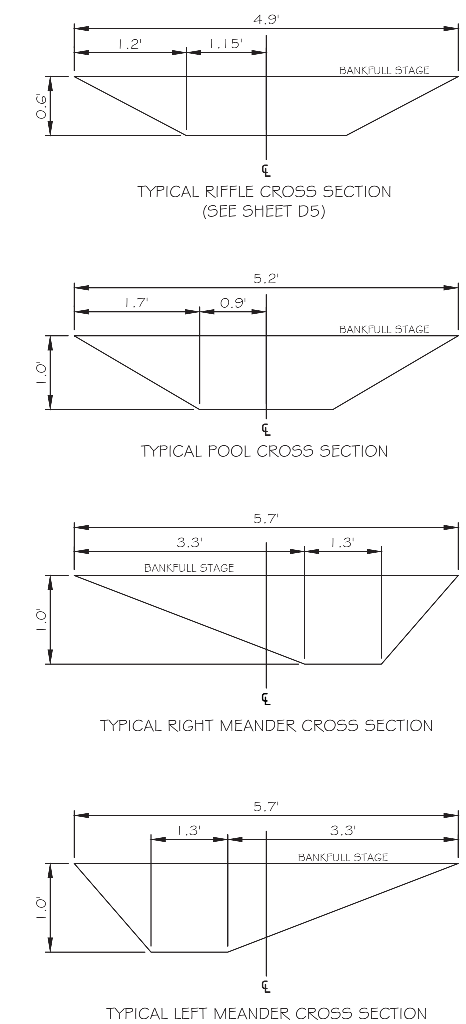
FILE NAME:R:\Resgis\dropbox\gis\projects\NC\Groundhog Hollow\CAD\DWG\0438_SHT_GF2.dwg SAVED BY: Bcarroll





SCALE: HOR 1"=30'; VERT 1"=6'

REACH GF2 STA 8+29 TO STA 13+93



STRUCTURE TABLE

NO.	TYPE	STA.	ELEV.
8-1	LOG VANE	7+39'	1123.00'
8-2	LOG SILL	8+29'	1119.85'
8-3	RIFFLE GRADE CONTROL	8+70'	-
8-4	LOG SILL	9+09'	1117.60'
8-5	LOG SILL	9+29'	1116.70'
8-6	LOG SILL	9+58'	1115.56'

TOE PROTECTION TABLE

BANK	TYPE	FROM STA.	TO STA.
RT	BRUSH TOE	7+65'	7+90'
LT	BRUSH TOE	8+29'	8+51'
RT	BRUSH TOE	9+09'	9+19'
LT	BRUSH TOE	9+29'	9+37'
LT	BRUSH TOE	9+58'	9+65'
RT	BRUSH TOE	9+73'	9+82'
LT	BRUSH TOE	9+89'	9+96'

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NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 042580 BENTON R. CARROLL 6-8-2020

FULL SCALE: 1"=30
0 30 60
2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 6/8/2020

REVISIONS:

RELEASED FOR: FINAL DESIGN - RELEASED FOR CONSTRUCTION

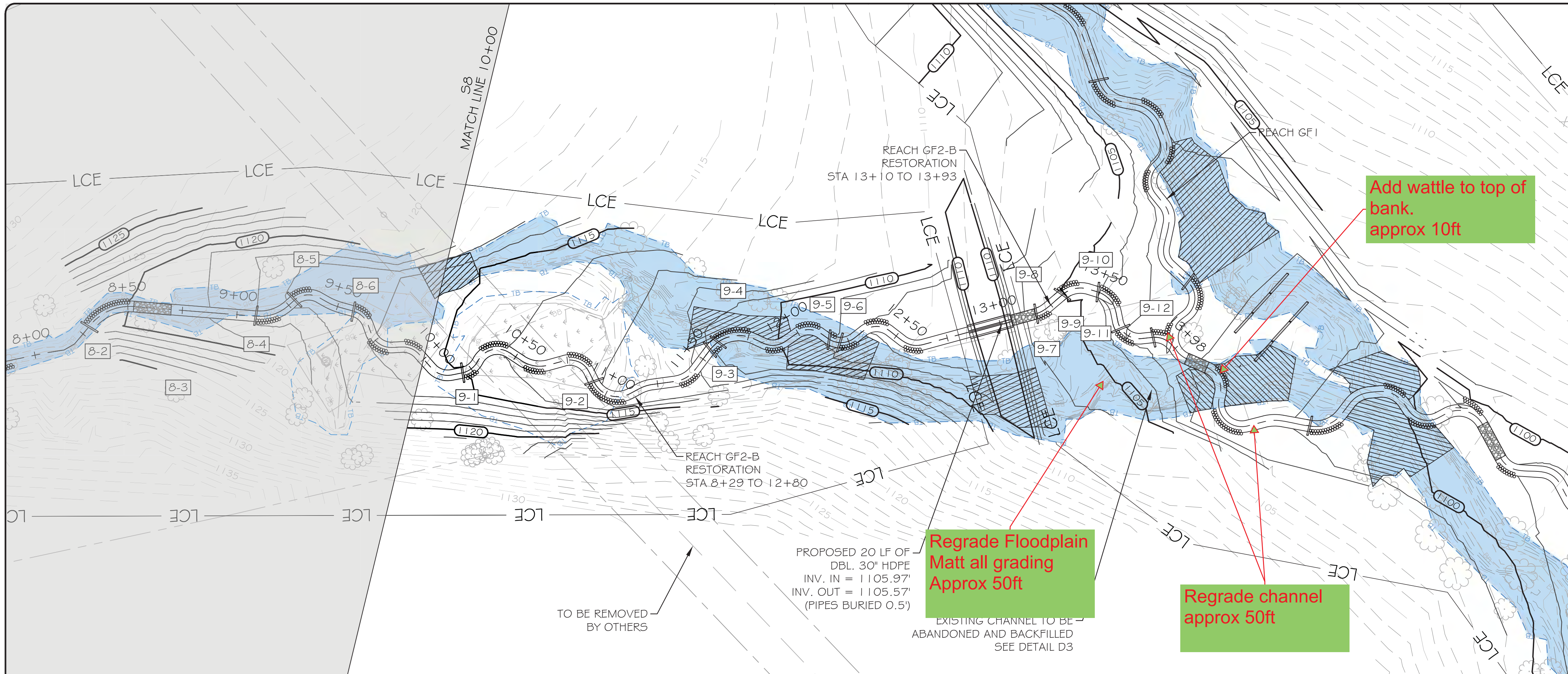
PROJECT NAME: GROUNDHOG HOLLOW PROJECT ALEXANDER COUNTY, NORTH CAROLINA

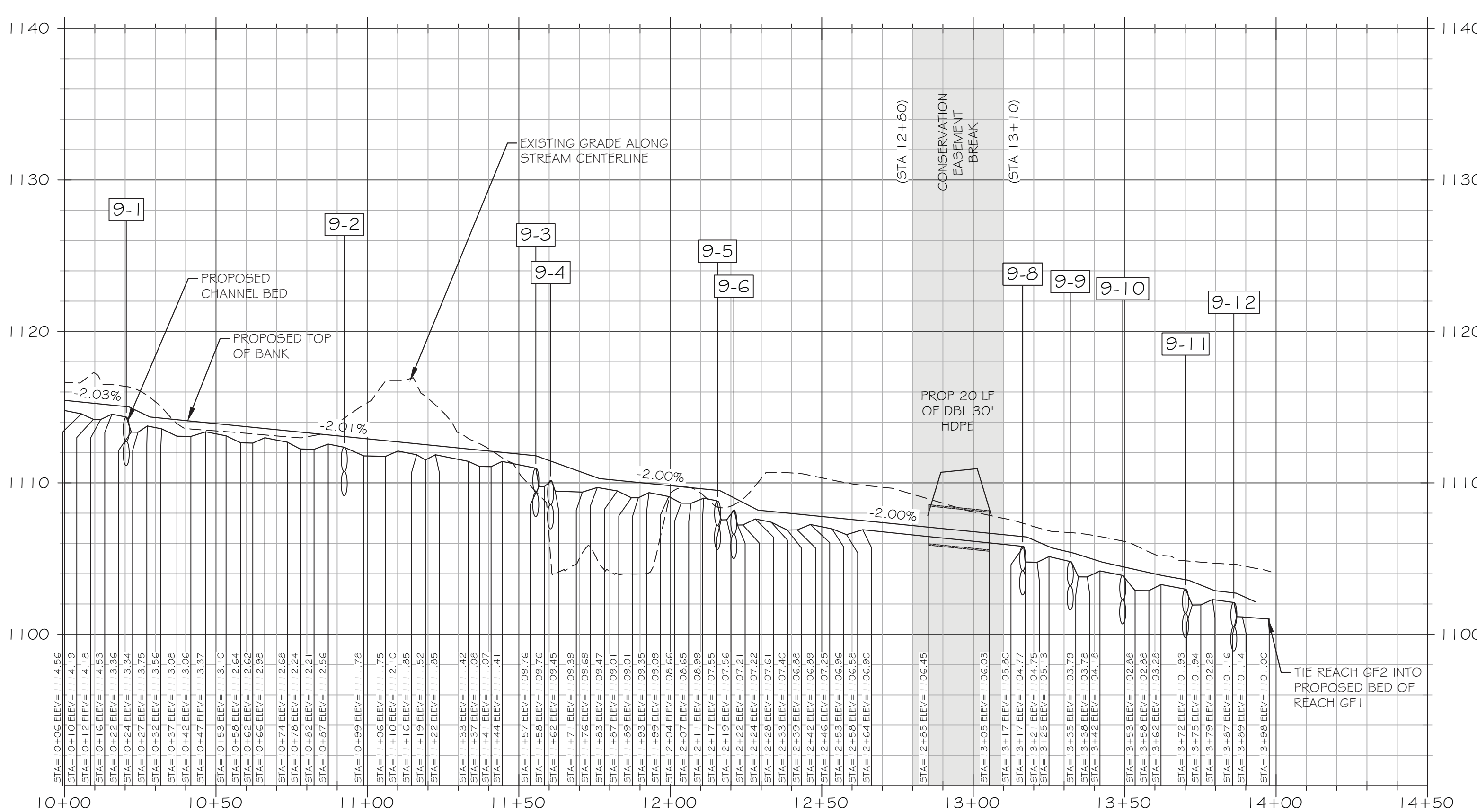
DRAWING TITLE: REACH GF2

PROJECT NUMBER: 0438
PROJECT MANAGER: BPB
DESIGNED: BRC
DRAWN: TRS
CHECKED: AFM

SHEET NUMBER: S8

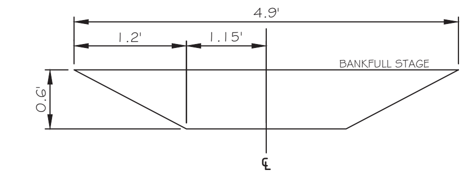
FILE NAME:R:\Resgis\dropbox\gis\projects\NC\Groundhog Hollow\CAD\DWG\0438_SHT_GF2.dwg SAVED BY: Bcarroll



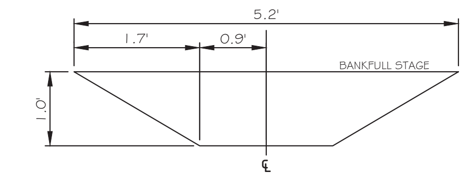


SCALE: HOR 1"=30'; VERT 1"=6'

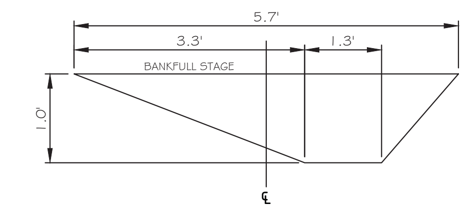
REACH GF2 STA 8+29 TO STA 13+93



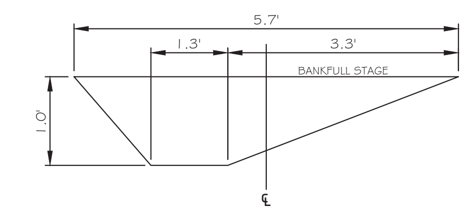
TYPICAL RIFFLE CROSS SECTION
(SEE SHEET D5)



TYPICAL POOL CROSS SECTION



TYPICAL RIGHT MEANDER CROSS SECTION



TYPICAL LEFT MEANDER CROSS SECTION

STRUCTURE TABLE

NO.	TYPE	STA.	ELEV.
9-1	LOG SILL	10+20'	1114.34'
9-2	LOG SILL	10+92'	1112.35'
9-3	LOG SILL	11+56'	1110.97'
9-4	LOG SILL	11+60'	1110.16'
9-5	LOG SILL	12+16'	1108.80'
9-6	LOG SILL	12+21'	1108.20'
9-7	RIFFLE GRADE CONTROL	13+16'	-
9-8	LOG SILL	13+16'	1105.80'
9-9	LOG SILL	13+32'	1104.80'
9-10	LOG SILL	13+49'	1103.88'
9-11	LOG SILL	13+70'	1102.98'
9-12	LOG SILL	13+86'	1102.09'

TOE PROTECTION TABLE

BANK	TYPE	FROM STA.	TO STA.
RT	BRUSH TOE	10+21'	10+26'
LT	BRUSH TOE	10+34'	10+45'
RT	BRUSH TOE	10+55'	10+64'
LT	BRUSH TOE	10+75'	10+85'
RT	BRUSH TOE	10+92'	11+09'
RT	BRUSH TOE	11+35'	11+43'
RT	BRUSH TOE	11+55'	11+60'
RT	BRUSH TOE	11+60'	11+75'
RT	BRUSH TOE	11+84'	11+91'
LT	BRUSH TOE	12+01'	12+10'
LT	BRUSH TOE	12+15'	12+19'
RT	BRUSH TOE	12+21'	12+28'
LT	BRUSH TOE	12+35'	12+45'
RT	BRUSH TOE	12+55'	12+63'
RT	BRUSH TOE	13+17'	13+22'
LT	BRUSH TOE	13+32'	13+40'
LT	BRUSH TOE	13+49'	13+60'
RT	BRUSH TOE	13+70'	13+78'
LT	BRUSH TOE	13+86'	13+92'

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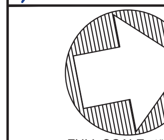


FULL SCALE: 1"=30
0 30 60
2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 6/8/2020

REVISIONS:

RELEASED FOR: FINAL DESIGN - RELEASED FOR CONSTRUCTION

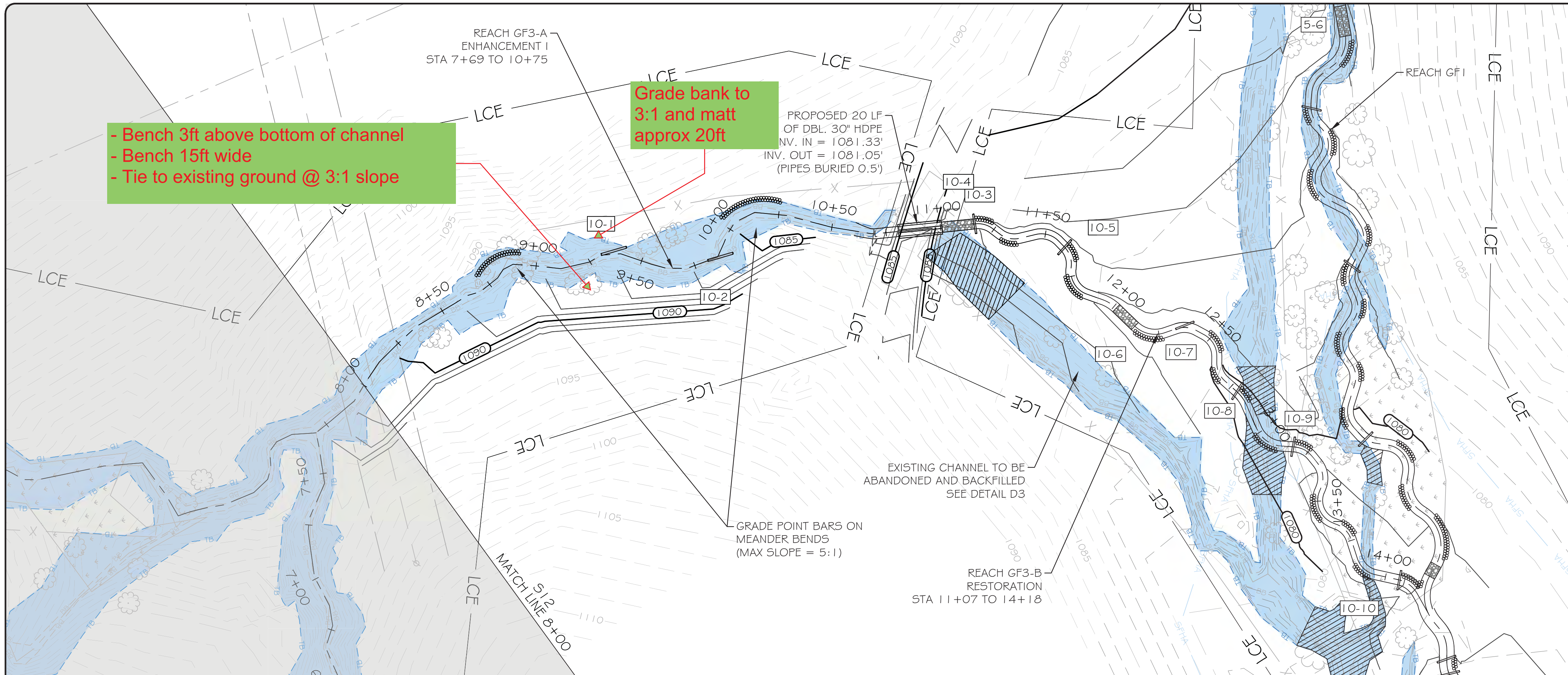
PROJECT NAME: GROUNDHOG HOLLOW PROJECT
ALEXANDER COUNTY, NORTH CAROLINA

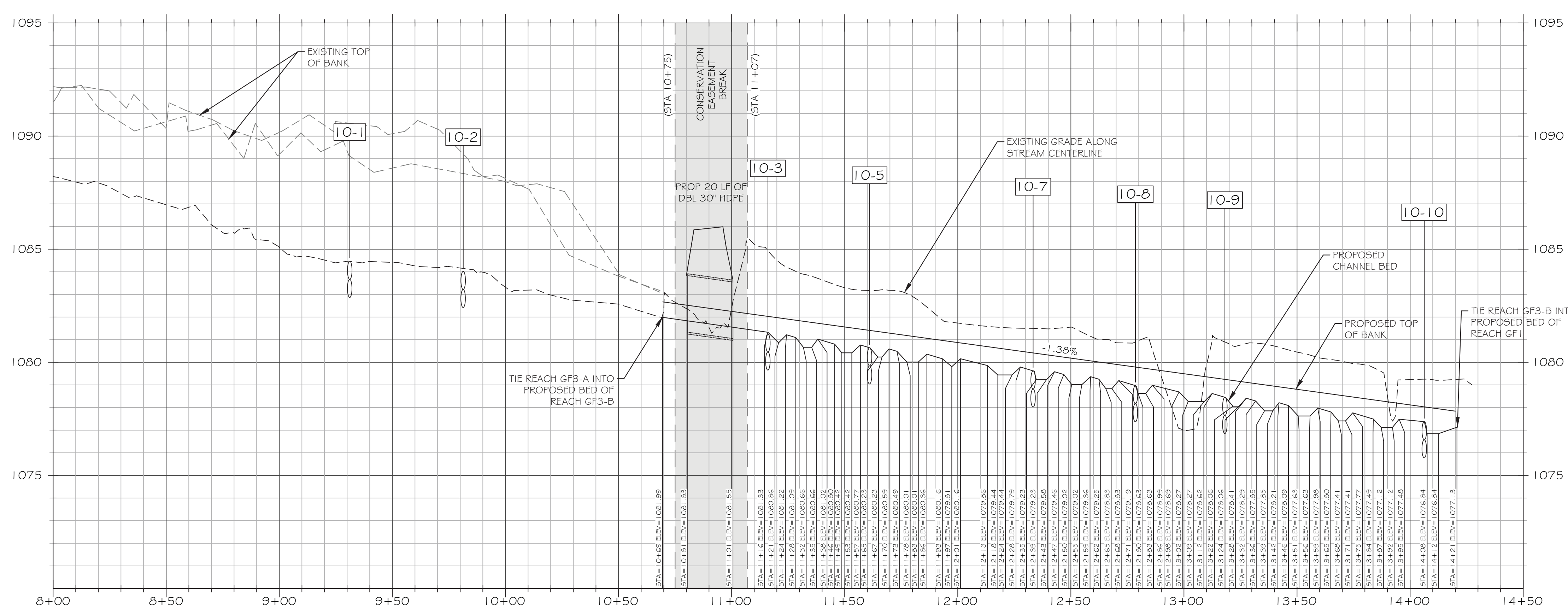
DRAWING TITLE: REACH GF2

PROJECT NUMBER:	0438
PROJECT MANAGER:	BPB
DESIGNED:	BRC
DRAWN:	TRS
CHECKED:	AFM

SHEET NUMBER:

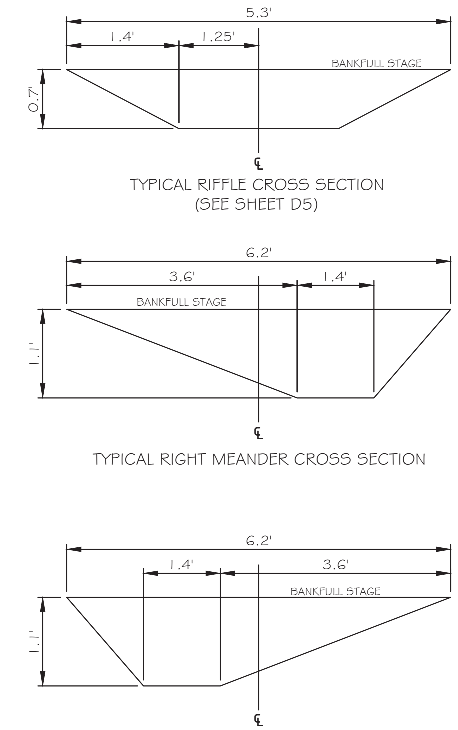
S9





SCALE: HOR 1"=30'; VERT 1"=3'

REACH GF3-B STA 11+20 TO STA 14+30



TYPICAL RIFFLE CROSS SECTION
(SEE SHEET D5)

TYPICAL RIGHT MEANDER CROSS SECTION

TYPICAL LEFT MEANDER CROSS SECTION

STRUCTURE TABLE			
NO.	TYPE	STA.	ELEV.
10-1	LOG VANE	9+31'	1084.47'
10-2	LOG VANE	9+81'	1084.02'
10-3	LOG SILL	11+16'	1081.25'
10-4	RIFFLE GRADE CONTROL	11+16'	-
10-5	LOG SILL	11+61'	1080.64'
10-6	RIFFLE GRADE CONTROL	12+13'	-
10-7	LOG VANE	12+33'	1079.62'
10-8	LOG SILL	12+79'	1078.97'
10-9	LOG SILL	13+18'	1078.45'
10-10	LOG SILL	14+06'	1077.38'

TOE PROTECTION TABLE			
BANK	TYPE	FROM STA.	TO STA.
LT	BRUSH TOE	8+72'	8+93'
LT	BRUSH TOE	10+02'	10+26'
LT	BRUSH TOE	11+16'	11+23'
RT	BRUSH TOE	11+30'	11+37'
LT	BRUSH TOE	11+61'	11+69'
RT	BRUSH TOE	11+74'	11+85'
RT	BRUSH TOE	12+14'	12+27'
LT	BRUSH TOE	12+48'	12+57'
RT	BRUSH TOE	12+64'	12+71'
LT	BRUSH TOE	12+79'	12+86'
RT	BRUSH TOE	13+00'	13+11'
LT	BRUSH TOE	13+19'	13+26'
RT	BRUSH TOE	13+47'	13+59'
LT	BRUSH TOE	13+66'	13+74'
RT	BRUSH TOE	13+85'	13+94'
LT	BRUSH TOE	14+07'	14+15'

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FULL SCALE: 1"=30
0 30 60
2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 6/8/2020

REVISIONS:

RELEASED FOR: FINAL DESIGN - RELEASED FOR CONSTRUCTION

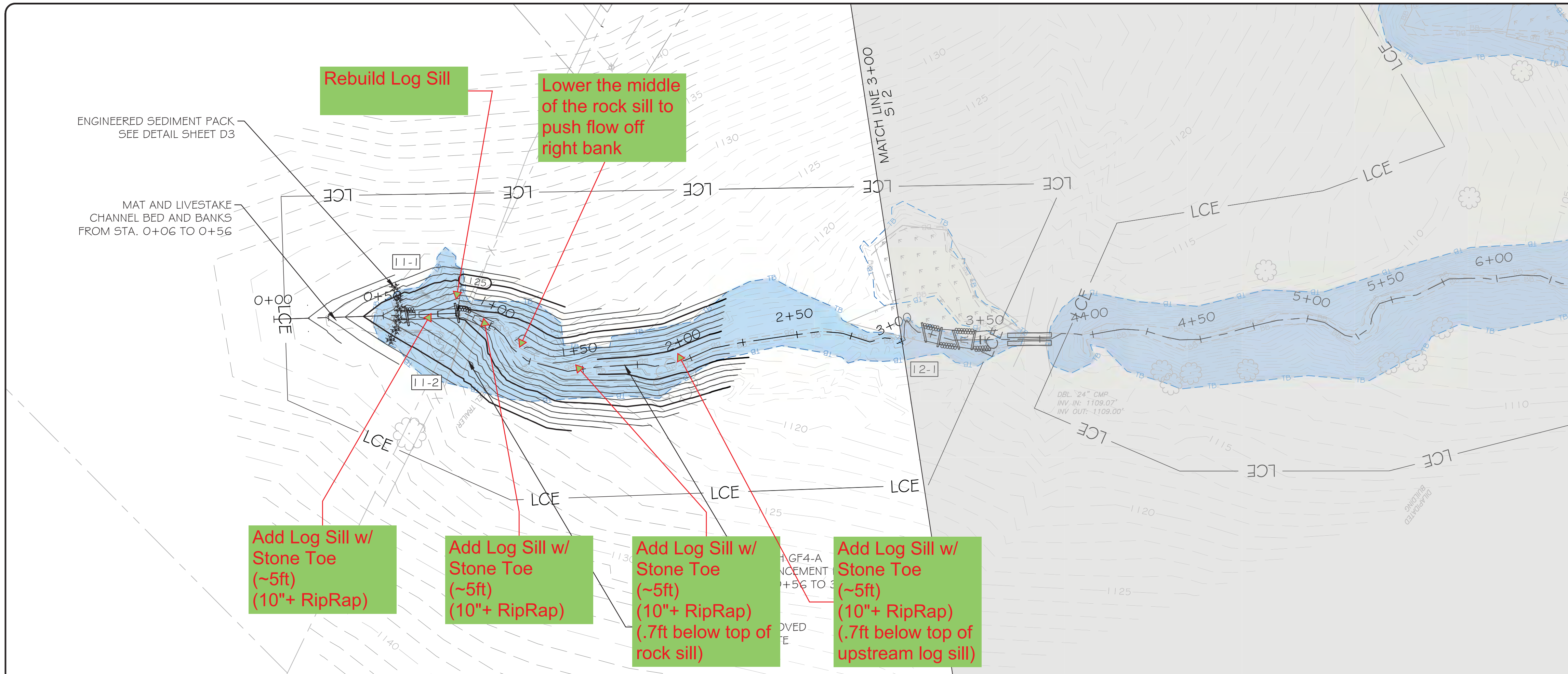
PROJECT NAME: GROUNDHOG HOLLOW PROJECT ALEXANDER COUNTY, NORTH CAROLINA

DRAWING TITLE: REACH GF3

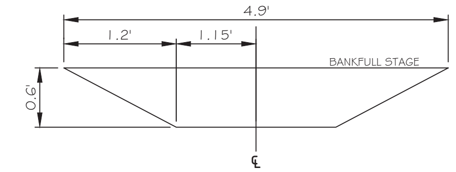
PROJECT NUMBER:	0438
PROJECT MANAGER:	BPB
DESIGNED:	BRC
DRAWN:	TRS
CHECKED:	AFM

SHEET NUMBER: S10

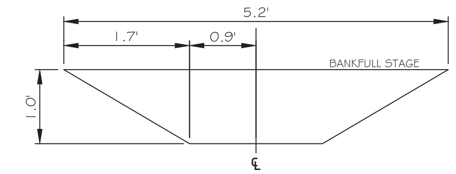
FILE NAME:R:\Resgis\dropboxgis\projects\NC\Groundhog Hollow\CAD\DWG\0438_SHT_GF3.dwg SAVED BY: Bcarroll



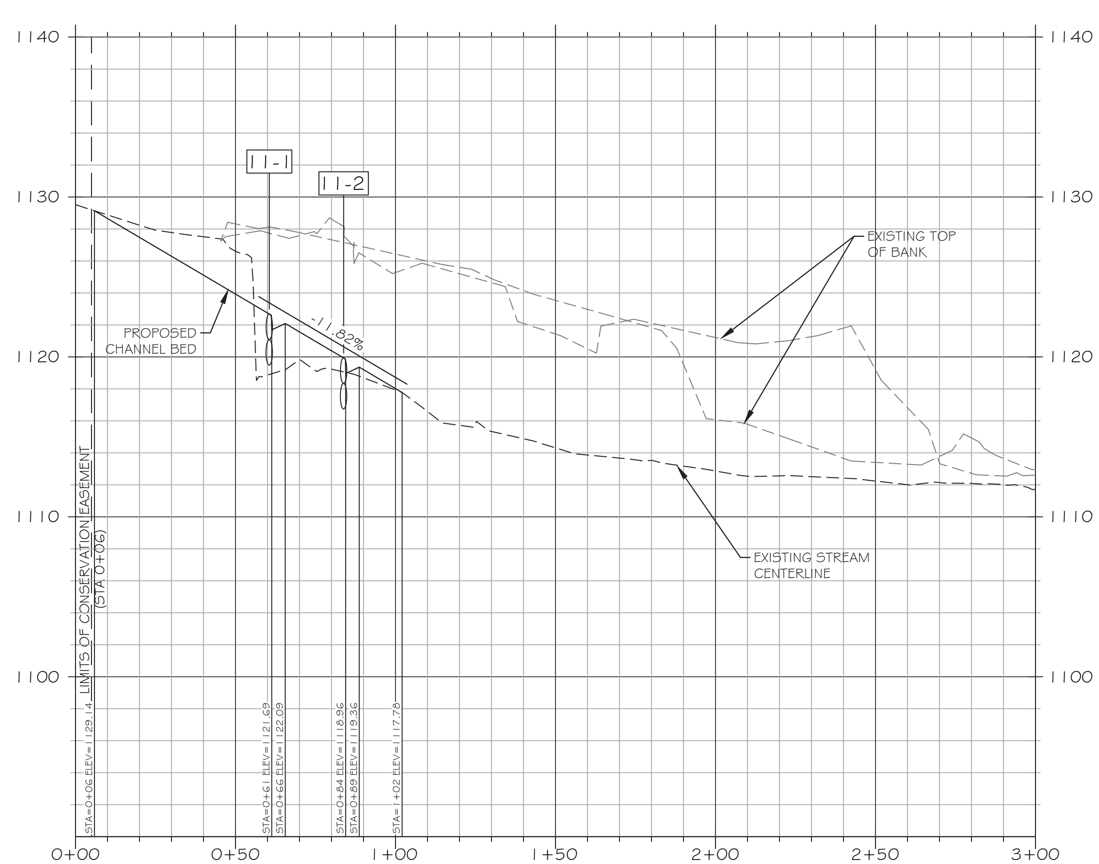
REACH GF4 STA 0+57 TO STA 1+04



TYPICAL RIFFLE CROSS SECTION
(SEE SHEET D5)



TYPICAL POOL CROSS SECTION



SCALE: HOR 1"=30'; VERT 1"=6'

STRUCTURE TABLE			
NO.	TYPE	STA.	ELEV.
11-1	LOG SILL	0+61'	1122.68'
11-2	LOG SILL	0+84'	1119.95'

TOE PROTECTION TABLE			
BANK	TYPE	FROM STA.	TO STA.
LT	BRUSH TOE	0+61'	0+65'
LT	BRUSH TOE	0+84'	0+89'

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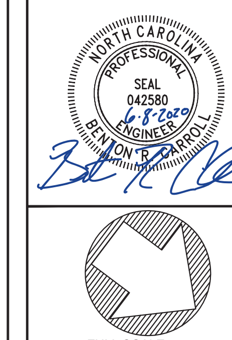
SEAL



FULL SCALE: 1"=30
0 30 60
2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 6/8/2020

REVISIONS:

RELEASED FOR: FINAL DESIGN - RELEASED FOR CONSTRUCTION

PROJECT NAME: GROUNDHOG HOLLOW PROJECT
ALEXANDER COUNTY, NORTH CAROLINA

DRAWING TITLE: REACH GF4

PROJECT NUMBER: 0438
PROJECT MANAGER: BPB
DESIGNED: BRC
DRAWN: TRS
CHECKED: AFM

SHEET NUMBER: S11

From: Ryan Medric
To: Kim Browning; Haywood, Casey M CIV (USA); Tugwell, Todd J CIV USARMY CESAW (US); Davis, Erin B; Bowers, Todd; Youngman, Holland J; Merritt, Katie; Wilson, Travis W.; Munzer, Olivia
Cc: Bradley Breslow; Allen, Melonie; Stanfill, Jim; Harmon, Beth; Wiesner, Paul; Jones, M Scott (Scott) CIV USARMY CESAW (USA); Crumbley, Tyler A CIV USARMY CESAW (USA); Matthews, Monte K CIV USARMY CESAW (USA)
Subject: [External] RE: Notice of Initial Credit Release /Groundhog Hollow / SAW-2018-00450 / Alexander Co.
Date: Wednesday, August 4, 2021 4:01:57 PM

All,

Please find our comment responses below:

DWR Comments, Erin Davis:

1. Regarding the May 2021 repairs, please callout the repair locations on the MY1 report CCPV.
   Repair callouts will be added to the MY1 CCPV.
2. If additional planting becomes an action item during the monitoring period, DWR requests that at least one or two additional species be used to promote more diversity. Two of the fixed veg plots are starting out with only three species present.
   If supplemental planting is needed, RES will replant with additional species to increase diversity.
3. Please confirm there were no changes to the approved seed mixes.
   There were no changes to the approved seed mixes.
4. Several of the pool cross section photos appear to show significant fine sediment present. Since January, have you observed this material flushing through the project reaches? Do you expect the MY1 cross section data to deviate substantially from MY0?
   There was a large sediment pulse as a result of the 10-inch October rain event that also damaged portions of the stream. RES believes that as the banks and floodplain stabilize with vegetation the sediment will flush out.
5. The Flow Gauge GF4-A photo shows a rock sill structure upstream. What is the drop depth from this structure? Were there any concerns with how it was installed?
   There were concerns with the installation of this structure. RES has since reduced the drop over the rock sill to 0.7ft. This was accomplished by installing additional log sills downstream of the gauge.

USACE Comments, Casey Haywood:

1. Appreciate veg plot 8 and random veg plot 2 being established in existing wetlands. Recommend including wetland indicator status for planted stems in Table 7 in future reports.
   Noted. RES will add wetland indicator status in Table 7 from now on.
2. Table 9. Veg plots 1, 2, 3, 6, & R1 are all meeting success, however the plots are dominated by a single species and account for more than half of the planted stems. Okay with the addition of sugarberry to the planting plan species list, but would encourage the addition of one or two species if a supplemental planting is needed in the future.

If supplemental planting is needed, RES will replant with additional species to increase diversity.

Thanks!

Ryan Medric
Ecologist

RES | res.us
D: 919.741.6268 | M: 703.424.6313

From: Browning, Kimberly D CIV USARMY CESAW (USA) <Kimberly.D.Browning@usace.army.mil>
Sent: Wednesday, July 28, 2021 2:05 PM
To: Haywood, Casey M CIV (USA) <Casey.M.Haywood@usace.army.mil>; Tugwell, Todd J CIV USARMY CESAW (USA) <Todd.J.Tugwell@usace.army.mil>; Davis, Erin B <erin.davis@ncdenr.gov>; 'Bowers, Todd (bowers.todd@epa.gov)' <bowers.todd@epa.gov>; Youngman, Holland J <holland_youngman@fws.gov>; Merritt, Katie <katie.merritt@ncdenr.gov>; Wilson, Travis W. <travis.wilson@ncwildlife.org>; Munzer, Olivia <olivia.munzer@ncwildlife.org>
Cc: Bradley Breslow <bbreslow@res.us>; Ryan Medric <rmedric@res.us>; Allen, Melonie <melonie.allen@ncdenr.gov>; Stanfill, Jim <jim.stanfill@ncdenr.gov>; Harmon, Beth <beth.harmon@ncdenr.gov>; Wiesner, Paul <paul.wiesner@ncdenr.gov>; Jones, M Scott (Scott) CIV USARMY CESAW (USA) <Scott.Jones@usace.army.mil>; Crumbley, Tyler A CIV USARMY CESAW (USA) <Tyler.A.Crumbley2@usace.army.mil>; Matthews, Monte K CIV USARMY CESAW (USA) <Monte.K.Matthews@usace.army.mil>
Subject: [EXTERNAL] Notice of Initial Credit Release /Groundhog Hollow / SAW-2018-00450 / Alexander Co.

Good afternoon all,

The 15-Day As-Built/Record Drawing review for the Groundhog Hollow Mitigation Site (SAW-2018-00450) ended July 16, 2020. Per Section 332.8(o)(9) of the 2008 Mitigation Rule, this review followed the streamlined review process. All comments received from the NCIRT are incorporated within this email. There were no objections to issuing the initial 30% credit release. Please find attached the current signed ledger. A site visit is not requested at this time.

DWR Comments, Erin Davis:
1. Regarding the May 2021 repairs, please callout the repair locations on the MY1 report CCPV.
2. If additional planting becomes an action item during the monitoring period, DWR requests that at least one or two additional species be used to promote more diversity. Two of the fixed veg plots are starting out with only three species present.
3. Please confirm there were no changes to the approved seed mixes.
4. Several of the pool cross section photos appear to show significant fine sediment present. Since January, have you observed this material flushing through the project reaches? Do you expect the MY1 cross section data to deviate substantially from MY0?
5. The Flow Gauge GF4-A photo shows a rock sill structure upstream. What is the drop depth from this structure? Were there any concerns with how it was installed?

USACE Comments, Casey Haywood:
1. Appreciate veg plot 8 and random veg plot 2 being established in existing wetlands. Recommend including wetland indicator status for planted stems in Table 7 in future reports.
2. Table 9. Veg plots 1, 2, 3, 6, & R1 are all meeting success, however the plots are dominated by a single species and account for more than half of the planted stems. Okay with the addition of sugarberry to the planting plan species list, but would encourage the addition of one or two species if a supplemental planting is needed in the future.

Please reach out if you have any questions.
Thanks
Kim

Kim Browning
Mitigation Project Manager, Regulatory Division I U.S. Army Corps of Engineers

Project Information:
Groundhog Hollow Site (DMS#100049)
USACE ID: 2018-00450
DWR#: 2018-0666
RFP: 16-007277– Issued 06/21/2017
Institution Date: 2/7/2018 – Full Delivery
Catawba River Basin
Cataloging Unit 03050101
Alexander County, North Carolina

Proposed Mitigation Plan Assets:
4,093.950 SMUs (warm)

As-Built MY0 Project Credits:
4,093.950 SMUs (warm)

Mitigation Plan Lengths/ Acreages:
6,129 LF

As-Built-MY0 Lengths/ Acreages:
6,134 LF