Year 2 Monitoring Report

FINAL

Greenbrier Stream Mitigation Project

Yadkin County, North Carolina

Monitoring Year 2

Data Collection Period:	**Submission Date:**
July – October 2021	**December 2021**

NCDEQ Contract No. 7616
DMS ID No. 100086
USACE Action ID No. SAW-2018-01755
NCDWR ID: 20181272
Yadkin River Basin
HUC 03040101

Prepared For:

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Mr. Paul Wiesner
NCDEQ – Division of Mitigation Services
5 Ravencroft Dr., Suite 102
Asheville, NC 28801

December 8, 2021

RE: Response to Draft MY2 Monitoring Report Comments dated November 30, 2021
Greenbrier Stream Mitigation Site
Yadkin River Basin – CU# 03040101 - Yadkin County, North Carolina
NCDMS Project # 100086, Contract # 7616

Dear Mr. Wiesner,

Ecosystem Planning and Restoration (EPR) has reviewed the comments on the Draft MY2 Monitoring Report provided November 30, 2021. The comments have been addressed as described below and the Final Baseline Report and electronic deliverables have been revised in response to this review.

- ***Table 1. Project Mitigation Quantities and Credits****: The thermal regime for the project streams is "warm". Please update the table accordingly.*
    - **Thermal Regime in Table 1 has been updated. The Microsoft Excel version of Table 1 in the electronic support files has been updated as well.**

- ***Section 2.2.1 Vegetation Monitoring Data –*** *Please discuss the average tree heights in the vegetation plots assessed and (although early) note if the project vegetation appears to be on track to meet the year 5 interim height success criteria.*
    - **A discussion regarding plot height has been added to Section 2.2.1.**

- ***CCPV Maps:*** *The overview map is incorrectly labeled as MY0: 2020. The aerial orthoimagery is from 2018. Please update the maps if more recent aerial imagery is available. Please QA/QC the CCPV maps and update as necessary.*
    - **The date on the overview maps has been updated. The 2018 aerial orthoimagery shown in the CCPV is the latest aerial image available for the project area. EPR will update these images in future monitoring years as new imagery becomes available.**

- ***Table 4 (a-d) & Table 5*** *- 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.*
    - **The project assessment dates have been included in Tables 4 and 5.**

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- ***Appendix A. Monitoring Year 2 (2021) - Photo Point Logs:*** *Please provide dates for all project photo points. If exact dates cannot be provided, please include the month and year for each photo.*
    - **Dates have been included for all project photo points.**

- ***Report Text and Appendix B:*** *In the revised report (Appendix B), please provide a planting map and species list from the March 2021 supplemental planting effort reported in Section 2.2.1 Vegetation Monitoring Data. Please reference the planting map and species list in the report text.Please also report what percentage of the initial planted area was supplementally planted in MY2(2021). The supplemental planting area should also be included on the MY2 CCPV maps.*
    - **A planting species list has been included in Appendix B, and the planted areas are now shown on the CCPV. The map and species list are referenced in section 2.2.1 Vegetation Monitoring Data. The approximate percentage of the original planted area has also been included in this section.**

- ***Table 7. Vegetation Performance Standards Summary Table:*** *Please report the average vegetation plot height in the summary table.*
    - **Average height has been included in Table 7. The average height reported in the document was calculated from the stem height in the input file for the vegetation tool. The vegetation tool rounds these heights to whole numbers so that is why they are presented this way in the tables.**

<u>Electronic Support File Comments:</u>

The submitted input template for the DMS Veg tool cannot reproduce the tables included in the report. Several issues were identified:

- *The fixed plot data for years 0 and 1 are not consistent with previously submitted veg data. This is likely because not all dead stems were retained in the plot specific excel sheets.*
    - **Fixed plot data for years 0 and 1 have been updated in the input file and the plot data is now consistent from year to year. The draft submittal only included stems that were still living in MY2, but all stems will be included in this data moving forward.**

- *A formula was used to calculate stems per acre for fixed plot 4 in the Post Mitigation Plan Performance Standard section, the Current Year Stem Count was changed, and species count was changed.*
    - **The formula was used to calculate the total stems per acre for plot 4 because of a misunderstanding about what the Post Mitigation Plan Performance Standard row**

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was meant to show. This has been corrected for the final submittal and only the output that was produced by the DMS vegetation tool is included.

- *One stem in the random plot 5 tab does not have a height.*
    - **The stem in Random Plot 5 has been updated to include a height.**

- *Please do not edit the output of the tool – the logic used to calculate these output values is based on the current IRT requirements. To ensure that output data is consistent for the Vegetation Performance Standards Summary Table, be sure to maintain a record of each stem in the input across monitoring years. If the stem dies, do not include a height in the current monitoring year's height column but keep the record of the stem in the input. There is an example dataset for reference that can be downloaded from the application. DMS has also included an example using Greenbrier veg data for Fixed plot 1 and Random Plot Group 5.*
    - **The output of the vegetation tool has not been edited for the final submission. This practice will be used moving forward for future monitoring submittals.**

- *Please include a feature representing the supplemental planting areas and display this in the CCPV map/s.*
    - **The shapefile Greenbrier_2021_Planting_Zones has been added to the electronic submission CCPV folder. This shapefile has been included in the CCPV.**

If you have any questions regarding the MY1 Monitoring Report, please contact me at 919-623-5411 or via email at ajames@eprusa.net.

Sincerely,

Amy James, PWS

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1.0 PROJECT SUMMARY

Ecosystem Planning and Restoration, PLLC (EPR) implemented the Greenbrier Stream Mitigation Project (Project; Site) for the North Carolina Division of Mitigation Services (NCDMS) to provide 2,300 stream mitigation credits (SMCs) in the Yadkin River Basin, Hydrologic Unit Code (HUC) 03040101. The Project was instituted via NCDEQ-DMS RFP # 16-007406. The Project restored and enhanced 2,530 linear feet (LF) of one perennial (UT1) and three intermittent (UT1A, UT1A-1, and UT1B) unnamed tributaries (UT) to South Deep Creek within a 6.7-acre conservation easement. Mitigation assets are listed in Table 1.

The Site is located in DMS targeted local watershed 03040101130020. The Site was historically utilized for agricultural and cattle practices. As such, streams and existing wetlands in the project area were adversely impacted by direct cattle access, farming activities, and stream channelization. The Site is situated on once active pastureland in a WS-III watershed that is approximately 49% agricultural land, 42% forest, and 8% developed land, including open space and low intensity development. Prior to construction activities, project streams were incised, straightened, and suffered from significant damage from cattle. The adjacent wetlands were small, but similarly trampled, and heavily grazed. Pre-construction, or pre-existing, site conditions are provided in Table 8 of Appendix C. Photos and a more detailed description of Site conditions before restoration are available in the Mitigation Plan (Final version submitted December 2019).

1.1 Goals and Objectives

The Project goals were established based on an assessment of site conditions and restoration potential with careful consideration of the stressors identified in the Upper Yadkin Pee-Dee River Basin Restoration Priorities (RBRP) report (NCEEP, 2009) and Yadkin Pee-Dee Basinwide Water Quality Plan (NCDWQ, 2008). These goals and objectives are presented in Table 2.

Site construction, planting, and baseline vegetation data collection were completed in April 2020 and the as-built survey was completed in May 2020. A detailed timeline of the Project activity and reporting history is provided in Appendix E.

1.2 Performance Criteria

Project success criteria were established in accordance with the *NCDMS Mitigation Plan Template* (ver. 06/2017), and *U.S. Army Corps of Engineers – Wilmington District Public Notice: Notification of Issuance of Guidance for Compensatory Stream and Wetland Mitigation Conducted for Wilmington District* (October 24, 2016). The monitoring plan for the site follows the guidance *NCDMS Annual Monitoring Report Format, Data, and Content Requirements* (October 2020). Table 2 details the United States Army Corps of Engineers (USACE) success criteria that evaluate whether project goals have been met throughout the monitoring period.

Table 1. Project Mitigation Quantities and Credits

Project Component (reach ID, etc.)	Original Mitigation Plan (ft)	As-built (ft)	Thermal Regime	Original Restoration Level	Original Mitigation Ratio (X:1)	Mitigation Credits	Notes/Comments
UT1 Reach 1	843.00	852.00	Warm	R	1.00000	843.00	Full Channel Restoration, Planted Buffer, Exclusion of Livestock, and Permanent Conservation Easement.
UT1 Reach 2	40.00	40.00	Warm	E2	2.50000	16.00	Bank stabilization, Bioengineering, Planted Buffer, Exclusion of Livestock, and Permanent Conservation Easement
UT1 Reach 3	1097.00	1141.00	Warm	R	1.00000	1097.00	Full Channel Restoration, Planted Buffer, Exclusion of Livestock, and Permanent Conservation Easement.
UT1A-1	153.70	145.00	Warm	E2	2.50000	61.48	Grade Control Structures, Bank Stabilization, Exclusion of Livestock, and Permanent Conservation Easement.
UT1A	148.50	153.00	Warm	R	1.00000	148.50	Full Channel Restoration, Planted Buffer, Exclusion of Livestock, and Permanent Conservation Easement.
UT1B	247.50	228.00	Warm	R	1.00000	247.50	
					Total Assets Summary:		**2,413.48**

Length and Area Summations by Mitigation Category

Restoration Level	Stream (linear feet)	Riparian Wetland (acres)		Non-riparian Wetland (acres)
		Riverine	Non-Riverine	
Restoration	2,336			
Enhancement				
Enhancement I				
Enhancement II	193.7			
Rehabilitation				
Preservation				
High Quality Pres				

Overall Assets Summary

Asset Category	Overall Credits
Stream	**2,413.48**

Table 2. Summary: Goals, Performance and Results

Goal	Objective/Treatment	Likely Functional Uplift	Performance Criteria	Measurement	Cumulative Monitoring Results
Reduce sediment inputs and stream turbidity;	▪ Stabilize eroding stream banks. ▪ Install fencing to exclude livestock from project streams. ▪ Increase distance between active farming operations and receiving waters by re-establishing a riparian buffer permanently protected through a conservation easement.	▪ The exclusion of livestock will remove a direct source of nutrients, coliform, and sediment from the system, as well as a major contributor to channel instability. ▪ Restored riparian buffers will provide woody debris and detritus for aquatic organisms, reduced water temperatures, and increased dissolved oxygen concentrations, as well as shade and diverse aquatic and terrestrial habitats that are appropriate for the ecoregion and setting.	▪ Recordation and protection of a conservation easement meeting NCDMS guidelines ▪ Visual inspection of fence installed to exclude cattle from the stream and riparian buffer, demonstrating no encroachment. ▪ Vegetation success criteria of 320 native stems/acre in Year 3, 260 stems/acre in Year 5 and 210 native stems/acre in Year 7. ▪ Trees must average 7 feet in height at year 5, and 10 feet in height at year 7. ▪ Visual inspection of BMP's to ensure proper function during monitoring period. ▪ Geomorphic cross sections indicate stable sections over the monitoring period. ▪ Bank height ratio (BHR) cannot exceed 1.2 for all measured cross sections on a given reach. ▪ Entrenchment ratio (ER) must be 2.2 or above for all measured riffle cross-sections for C/E stream types and 1.4 or above for B stream types.	<u>Permanent Vegetation Plots</u> 4 permanent vegetation plots, 0.02 acre in size, surveyed during As-built, Years 1, 2, 3, 5, and 7 between July 1st and leaf drop. Data collection includes species, height, planted vs. volunteer, and age.	In Monitoring Year 2, all permanent vegetation plots exceeded the performance standard as indicated for stem density in Year 3 with an average of 617 stems/acre.
Reduce nutrient inputs	▪ Install fencing to exclude livestock from project streams. ▪ Reduce the amount of land in active livestock pasture. ▪ Increase distance between active farming operations and receiving waters by re-establishing a riparian buffer permanently protected through a conservation easement. ▪ Restore riparian buffers to filter runoff.			<u>Annual Random Vegetation Plots</u> 2 randomly selected vegetation plots, 0.02 acre in size, surveyed during As-built, Years 1, 2, 3, 5, and 7 between July 1st and leaf drop. Data collection includes species and height.	The 2 randomly selected vegetation plots had an average stem density of 668 stems/acre and have met the interim success criteria of 320 native stems/acre in Year 3.
Reduce Fecal Coliform Inputs	▪ Install fencing to exclude livestock from project streams. ▪ Reduce the amount of land in active livestock pasture. ▪ Increase distance between active farming operations and receiving waters by re-establishing a riparian buffer permanently protected through a conservation easement.			<u>Cross Sections</u> Cross sections are surveyed during Years 1,2,3,5, and 7. 8 total cross sections, 6 on UT1 (3 riffle/3 pool), 1 on UT1A and 1 on UT1B.	The Year 2 monitoring cross-section survey indicates that the project streams are geomorphically stable and restored channel dimensions have not changed significantly during Monitoring Year 2. A few pools have filled somewhat and herbaceous vegetation has impacted a few of the cross sections, but overall the riffle cross sections indicate that all project streams are stable and functioning as intended.
Restore / Enhance Degraded Riparian Buffers	▪ Restore riparian buffer vegetation to filter runoff and provide organic matter and shade. ▪ Protect riparian buffers with a permanent conservation easement.				
Implement Agricultural BMPs in Agricultural Watersheds	▪ Install fencing to exclude livestock from project streams. ▪ Install alternative watering systems to keep livestock away from streams. ▪ Restore and protect riparian buffers. ▪ Install vegetated swales to slow and filter concentrated runoff before entering the streams.				

Table 2. Summary: Goals, Performance and Results

Goal	Objective/Treatment	Likely Functional Uplift	Performance Criteria	Measurement	Cumulative Monitoring Results
Protect High Resource Value Waters (including HQW, ORW, and WS classifications)	▪ Restore appropriate bed form diversity, headwater stream/wetland form, and in-stream structures to provide appropriate habitat. ▪ Restore minimum 50-foot riparian buffers along all project reaches. ▪ Protect riparian buffers with a permanent conservation easement.	▪ Functional uplift will occur by restoring project channels to their historic valley, raising the streambeds, and connecting them to adjacent wetlands at lower flows. ▪ The addition of in-stream structures help to ensure channel stability and will provide greater bedform diversity, enhancing aquatic habitat for native species.	▪ Documentation of hydrophytic vegetation within vegetation monitoring plots. ▪ Documentation of four bankfull events in different years throughout the monitoring period. ▪ Documentation of 30 days of consecutive stream flow in all reaches each monitoring year	<u>Stream Profile</u> Full longitudinal survey on all restored and enhanced stream channels. Data was collected during As-built survey only.	A full longitudinal survey of the project streams was conducted during As-built monitoring. No signs of instability or degradation were noted during MY2 monitoring. Additional longitudinal profile surveys will not be conducted unless stability issues are identified in future monitoring years.
				<u>Visual Assessment</u> Conducted yearly on all restored stream channels and in-stream structures.	Stream photo points and visual assessment indicate that all restored channels and in-stream structures are performing as intended. No stream problem areas were observed.
				<u>Additional Cross Sections</u> Only surveyed if instability is documented during monitoring	No instability was documented during MY2 monitoring, so no additional cross sections were surveyed.
				<u>Stream Hydrology Monitoring</u> 3 pressure transducers (1 on UT1, UT1A, and UT1B) and a rain gauge will record precipitation and streamflow data continuously through the monitoring period. Photos of high-water indicators will be taken yearly.	Flow gauge data from MY2 indicate that all three project streams met the established success criteria of 30 days or more of consecutive flow throughout the year. In addition, SG-1 recorded a single bankfull event during 2021.

Table 3. Project Attribute Table

Project Background Information				
Project Name		Greenbrier Stream Restoration Project		
County		Yadkin		
Project Area (acres)		6.7		
Project Coordinates (latitude and longitude)		latitude 36.1488 N, longitude 80.8289 W		
Planted Acreage (Acres of Woody Stems Planted)		6.3		
Project Watershed Summary Information				
Physiographic Province		Piedmont		
River Basin		Yadkin Pee-Dee		
USGS Hydrologic Unit 8-digit	03040101	USGS Hydrologic Unit 14-digit	3040101130020	
Project Drainage Area (Acres and Sq. Mi.)		85 acres/ 0.13 Sq.Mi. (Total)		
Project Stream Thermal Regime		Warm		
Project Drainage Area Percentage of Impervious Area		<1%		
CGIA Land Use Classification		Agriculture/Pasture 49%, Forest 42%, 8% Residential/Developed		

Reach Summary Information				
Parameters	**UT1**	**UT1A-1**	**UT1A**	**UT1B**
Length of reach (linear feet)	1958	154	115	195
Valley confinement (Confined, moderately confined, unconfined)	Moderately confined	Unconfined	Unconfined	Unconfined
Drainage area (Acres and Square Miles)	0.13 Sq.Mi., 85 Ac	0.01 Sq.Mi., 8 Ac	0.01 Sq.Mi., 8 Ac	0.02 Sq.Mi., 10 Ac
Perennial, Intermittent, Ephemeral	Perennial	Intermittent	Intermittent	Intermittent
NCDWR Water Quality Classification	WS-III	WS-III	WS-III	WS-III
Stream Classification (existing)	B4c/B4	B4	F4	G4
Stream Classification (proposed)	B4/C4	B4	B4	B4
Evolutionary trend (Simon)	IV	III	IV	III
FEMA classification	X	X	X	X

Regulatory Considerations			
Parameters	**Applicable?**	**Resolved?**	**Supporting Docs?**
Water of the United States - Section 404	Yes	Yes	USACE NWP 27 - ID# SAW-2018-01755
Water of the United States - Section 401	Yes	Yes	DWR 401 WQC No. 4134 -- ID # 20181272
Division of Land Quality (Erosion and Sediment Control)	Yes	Yes	General Permit NCG010000 - ID # YADKI-2020-010
Endangered Species Act	No	Yes	Categorical Exclusion Document; Appendix 6 in Mitigation Plan
Historic Preservation Act	No	Yes	
Coastal Zone Management Act (CZMA or CAMA)	No	N/A	N/A
FEMA Floodplain Compliance	No	N/A	N/A
Essential Fisheries Habitat	No	N/A	N/A

2.0 MONITORING DATA ASSESSMENT

Monitoring Year 2 (MY2) data was collected in July and October 2021. Current site conditions and monitoring data are described in the following sections to evaluate whether the project is meeting the success criteria established in the mitigation plan.

2.1 Stream Monitoring

Stream monitoring involves field data collection to assess the hydrologic and geomorphic functions of UT1, UT1A, and UT1B. Monitored parameters, methods, schedule/frequency, and extent are summarized in Table 2. These monitoring parameters follow USACE guidance but will also allow for monitoring of other parameters to document site performance related to the project goals listed in Table 2. The locations of the established monitoring cross sections and stream gauges are shown in Figure 2 Current Condition Plan View (CCPV).

2.1.1 Stream Profile

A full longitudinal profile was surveyed for the entire length of the restored streams in May 2020 to document as-built conditions. This survey was tied to a permanent benchmark and includes thalweg, right bank, and left bank features. Profile measurements were taken at the head and tail of each riffle, inverts of in-stream structures, and at the max depth of pools. The longitudinal profile will not be surveyed during annual monitoring unless vertical channel instability has been observed during monitoring and remedial actions or repairs are needed.

2.1.2 Stream Dimension

Eight (8) permanent cross sections were installed across the site; 6 on UT1 and 1 each on UT1A and UT1B. Five (5) cross sections were installed in riffles and three (3) were installed in pools. Each cross-section was marked using a length of rebar and steel t-posts on both streambanks. The location and elevation of each pin was recorded to facilitate data comparison from year to year. Cross-sections were surveyed using a Topcon RL-H5A Self Leveling Laser Level. Reported data includes measurements of bankfull elevation (based on the as-built bankfull area), bank height ratio (based on the as-built bankfull area), thalweg elevation, elevation of the low top of bank, maximum depth from the low top of bank, and low top of bank cross-sectional area (Appendix C). Stream dimension measurements were made using the NCDMS cross section tool (Version 5/11/2021). Reference photos were taken of both streambanks to provide a visual assessment of any changes that may have occurred since the previous monitoring year.

The Year 2 monitoring cross-section survey indicates that the project streams are stable and restored channel dimensions have not changed significantly during Monitoring Year 2. Cross sections were shot in October 2021 at the end of the growing season. At this time, portions of the stream channels still had vegetation growing in them, which affected the cross-section plots slightly. Every effort was made to survey the existing stream channel bottom and not the vegetation, but some of the cross-sections (XS3, XS5, XS7, and XS8) indicate that the channels appear to be temporarily aggraded. EPR does not believe this will be a long-term issue as the planted riparian trees and shrubs will begin to shade out the herbaceous vegetation growing in the channels. The riffle cross-sections, apart from XS8, showed only minor fluctuations compared to the as-built conditions and all restored streams meet the success criteria for restored stream channels as established in the mitigation plan and shown in Table 2. The cross-section plots, photos, and data summary (Table 9) are included in Appendix C.

2.1.3 Channel Stability

Channel stability is assessed on a yearly basis using photographs to visually document the condition of the restored project streams. Photographs are taken from the same location in the same direction each year. Sixteen (16) photo points were established during baseline monitoring and are shown in Appendix A. The locations of each permanent photo point are shown in the CCPV (Figure 2). Visual assessments of channel stability and in-stream structure condition were also made regularly throughout Monitoring Year 2.

Stream photo points and visual assessments indicate that all restored channels and in-stream structures are in good condition and performing as intended. No significant stream problem areas were observed. The minor floodplain rilling along UT1 Reach 1 that was noted in the MY1 report has mostly stabilized and these areas are covered with dense herbaceous vegetation. Some sections of the restored channels also contain this herbaceous vegetation as well; however, it does not appear to be causing any significant problems. EPR believes this is a temporary issue and the vegetation should wash through the channel during the dormant season and eventually be shaded out by streamside trees and shrubs.

2.1.4 Stream Hydrology

Three (3) pressure transducers were installed in UT1, UT1A, and UT1B to document stream flow and the occurrence of bankfull events within the monitoring period. The locations of these gauges are shown in the CCPV (Figure 2). All three gauges were installed in the downstream end of pools. The constructed bankfull elevation at each gauge was recorded, as well as the elevation of the downstream controlling grade. These elevations are compared with the gauge readings to determine whether the stream is flowing and if a bankfull event has occurred.

This Project utilizes a tipping bucket rain gauge installed at another EPR-completed stream restoration approximately 0.75 miles to the southeast (Meadowbrook, DMS project no. 100024) to accurately document rainfall at the Site. The rainfall data can be compared to the flow gauge data to verify that high flows at the Site are correlated with rainfall events. The monitoring gauges were downloaded regularly throughout Monitoring Year 2. Rainfall data is presented in Figure 3. Monthly Rainfall Summary Data and the precipitation and water level hydrographs are included in Appendix D. When the rain gauge was downloaded during MY2 monitoring in October 2021, it was determined that the batteries in the logger had expired around 9/2/2021. For this reason, no rainfall data was collected for September and October. The batteries were replaced in early November 2021.

Flow gauge data from MY2 indicate that all three project streams met the established success criteria of 30 days or more of consecutive flow throughout the year. According to the gauge for UT1 (SG-1), the stream had 294 days of consecutive flow and 1 bankfull event during Monitoring Year 2. SG-2, located in UT1A, documented consistent flow throughout the year, though bankfull events were difficult to accurately verify. The water level shown by SG-2 exceeds the bankfull elevation for the entirety of June through October, which is likely not accurate. EPR believes that vegetation growing in the channel combined with fine sediment accruing around the gauge artificially increased the pressure that was recorded. Because UT1A is such a small channel, any minor change in channel conditions could significantly influence the gauge readings. All stream gauges will be manually cleaned out prior to MY3 monitoring to prevent this from becoming an ongoing issue. SG-3, which is installed in UT1B, documented 186 days of consecutive flow. SG3 did not record any bankfull events.

2.2 Riparian Vegetation Monitoring

Riparian vegetation monitoring evaluates the growth and development of planted and volunteer vegetation across the site. Monitored parameters, methods, schedule/frequency, and extent are summarized in Table 2. These monitoring parameters follow USACE guidance but will also allow for monitoring of other parameters to document site performance related to the project goals listed in Table 2.

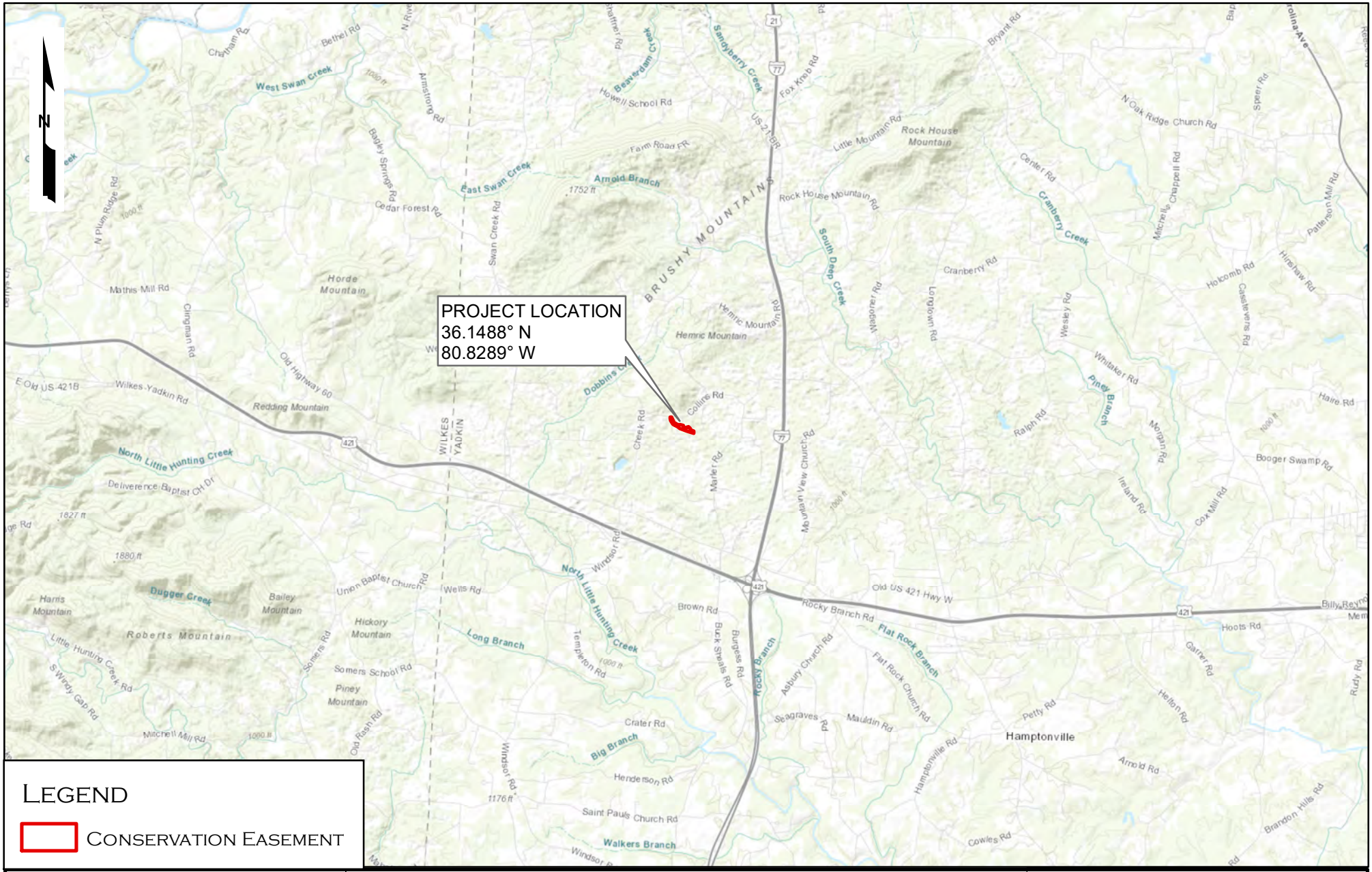
2.2.1 Vegetation Monitoring Data

Four (4) permanent vegetation monitoring plots were monitored across the site. The corners of the permanent vegetation plots were marked using steel t-posts and the location of each plot was surveyed during the as-built survey. The individual trees within each permanent plot were flagged and identified to facilitate repeat monitoring each year. In addition to the 4 permanent plots, 2 randomly placed vegetation plots are established each vegetation monitoring year and the location of these plots is recorded using GPS. All vegetation plots for MY2 are shown in the CCPV (Figure 2). Annual vegetation data was compiled and summarized using the DMS Vegetation Data Entry Tool (Version 8/23/2021).

The Greenbrier conservation easement area was supplementally planted in March 2021 in response to areas of low growth and stem count in Monitoring Year 1. Vegetation across the majority of the site was performing well in MY1 so these areas were only supplementally planted using a low stem density. Two areas (the left terrace along UT1 Reach 1 and the floodplain along lower UT1 Reach 3) were replanted using a higher number of stems because the trees in these areas had been smothered by dense herbaceous vegetation in MY1. A total of 1.28 acres were replanted (500 stems per acre) and 3.19 acres were supplementally planted (200 stems per acre). A total of 71% of the original planted area was replanted in 2021, but most of this was done using a low stem density. The supplementally planted areas are shown in the CCPV (Figure 2). A planted species list is provided in Appendix B and matches the species in the approved mitigation plan that were originally planted after construction.

Year 2 vegetation monitoring occurred in July 2021 before leaf drop. Stem counts for the vegetation plots (fixed and random) ranged from 10 trees per plot (405 trees per acre) in VP-4 F (Fixed) to 20 trees per plot (810 trees per acre) in VP-6 R (Random). The average stem density from all 6 vegetation plots (fixed and random) was 15 trees per plot (625 trees per acre). Therefore, the vegetation plot data indicates that planted trees on the Site are meeting the interim success criteria of 320 stems/acre in Monitoring Year 3. Average planted stem height for Monitoring Year 2 was 1.7 feet, which reflects the fact that many of these trees were planted in early 2021 during the supplemental planting effort. Success criteria for stem height does not take effect until MY5, but stem height will be continually monitored for MY3 and MY5 to determine whether the site appears to be on track to meet the performance criteria in MY5.

A small patch of Chinese privet (<0.1 acres) was observed on the right bank of UT1 Reach 2. This will be sprayed and removed in early MY3. No other invasive species were found on the mitigation site.



LEGEND

Conservation Easement

0 1 2 Miles

GREENBRIER STREAM RESTORATION

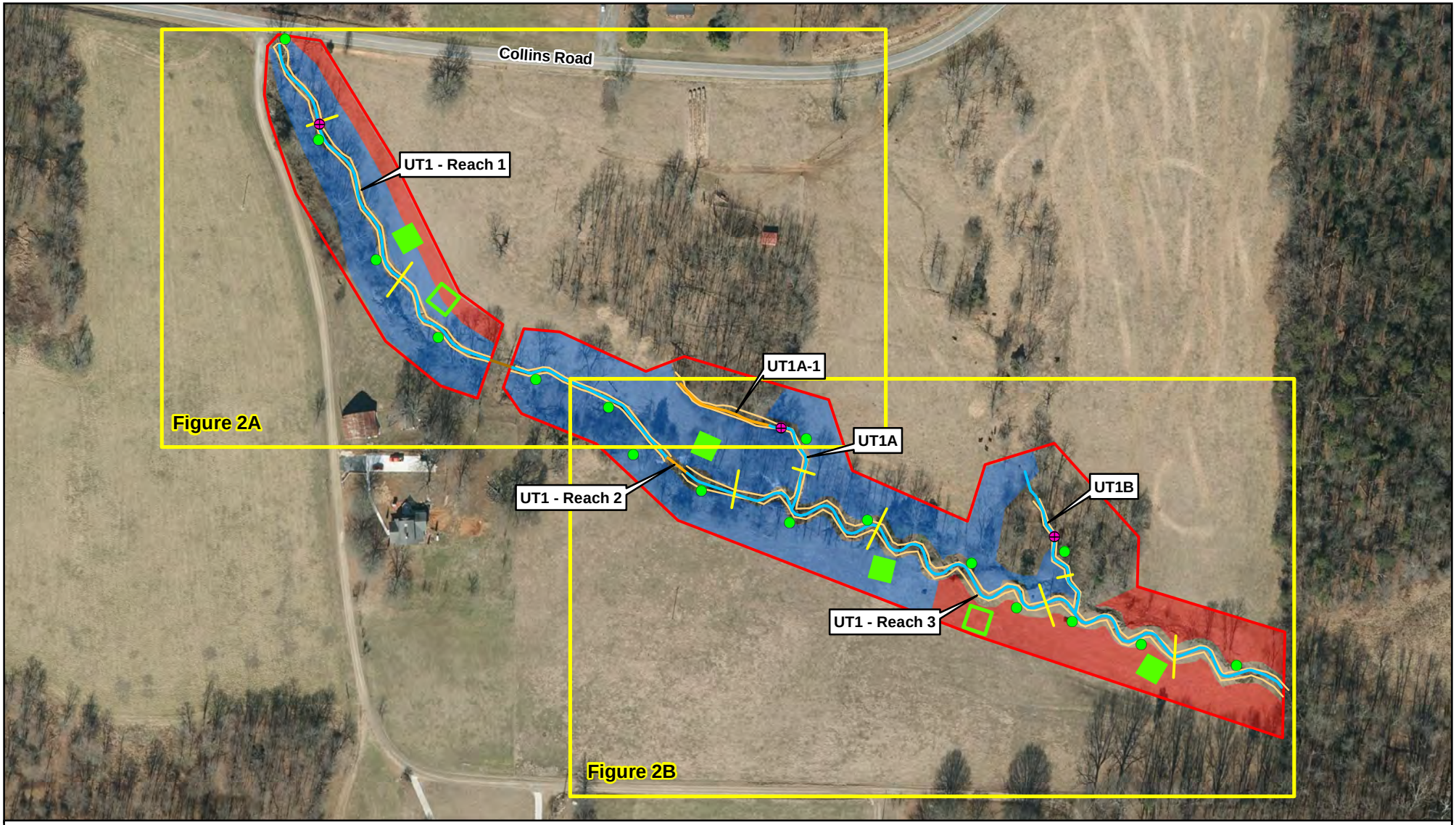
VICINITY MAP

PREPARED FOR:
NCDEQ
DIVISION OF
MITIGATION SERVICES

FIGURE 1

YADKIN COUNTY, NC

PREPARED BY:
ECOSYSTEM
PLANNING &
RESTORATION



Streams - Restoration
Streams - Enhancement
No Credit
Conservation Easement
Top of Bank
Photo Points
Stream Gauges
Cross Sections
Fixed Veg Plot - Successful
Random Veg Plot - Successful
2021 Replanting
2021 Supplemental Planting

NC OneMap Orthoimagery (2018)

0 100 200 Feet

1 inch = 200 feet

N

GREENBRIER STREAM RESTORATION SITE

CURRENT CONDITION PLAN VIEW: OVERVIEW MAP

MY2: 2021

DMS PROJECT ID# 100086

DEC 2021

FIGURE 2

YADKIN COUNTY, NC

NC Mitigation Services

ECOSYSTEM PLANNING & RESTORATION

Streams - Restoration
Streams - Enhancement
No Credit
Conservation Easement
Structures
Top of Bank
Photo Points
Stream Gauges
Cross Sections
Fixed Veg Plot - Successful
Random Veg Plot - Successful
2021 Replanting
2021 Supplemental Planting

NC OneMap Orthoimagery (2018)

0 100 Feet
1 inch = 100 feet

N

GREENBRIER STREAM RESTORATION SITE

Current Condition Plan View: Asset Map

MY2: 2021

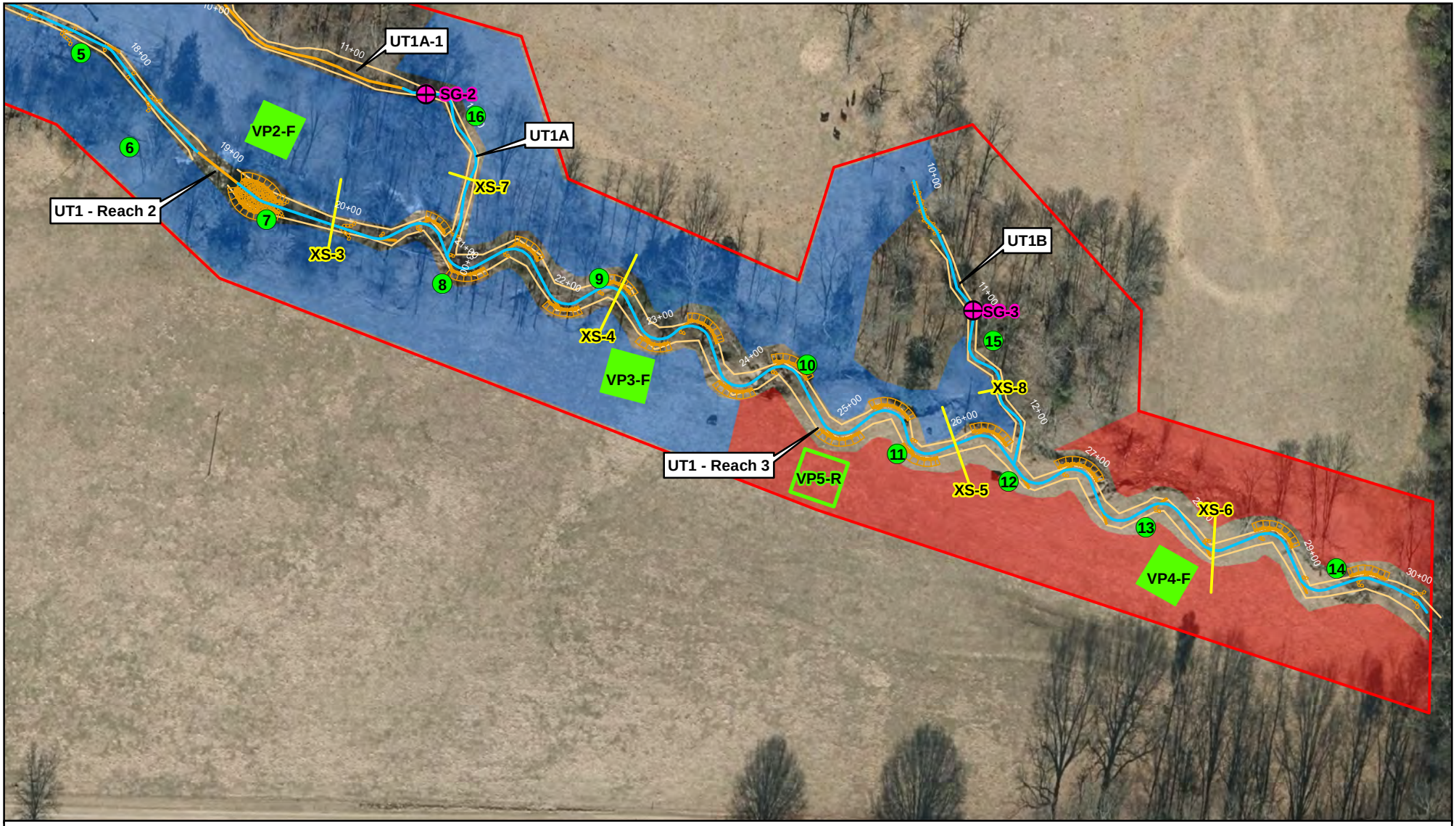
DMS Project ID# 100086
DEC 2021

FIGURE 2A

Yadkin County, NC

Mitigation Services
Environmental Quality

Ecosystem Planning & Restoration



Streams - Restoration
Streams - Enhancement
No Credit
Conservation Easement
Structures
Top of Bank
Photo Points
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0 100 Feet
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GREENBRIER STREAM RESTORATION SITE

Current Condition Plan View: Asset Map

MY2: 2021

DMS Project
ID# 100086
DEC 2021

FIGURE 2B

Yadkin County, NC

Mitigation Services
Environmental Quality

Ecosystem Planning & Restoration

3.0 REFERENCES

North Carolina Department of Environmental Quality, Division of Mitigation Services (DMS). DMS Vegetation Data Entry Tool, October 2020. https://ncdms.shinyapps.io/Veg_Table_Tool/

North Carolina Department of Environmental Quality, Division of Mitigation Services (DMS). DMS Cross Section Tool V.1.0 2020. https://ncdms.shinyapps.io/XS_APP/

North Carolina Department of Environmental Quality, Division of Mitigation Services (DMS). Annual Monitoring Report Format, Data, and Content Requirements, October 2020.

North Carolina Ecosystem Enhancement Program. 2009. Upper Yadkin Pee-Dee River Basin Restoration Priorities.

North Carolina Division of Water Quality. 2008. Yadkin Pee-Dee Basinwide Water Quality Plan.

U.S. Army Corps of Engineers. October 2016. Wilmington District Public Notice: Notification of Issuance of Guidance for Compensatory Stream and Wetland Mitigation Conducted for Wilmington District.

Appendix A

Visual Assessment Data

Table 4. Visual Stream Morphology Stability Assessment Table

Table 5. Vegetation Condition Assessment Table

Vegetation Photo Log

Photo Log

Table 4a. Visual Stream Morphology Stability Assessment Table
Greenbrier Stream Mitigation Project (DMS No.100086)

Reach ID	**UT1 Reach 1**
Assessed Stream Length (ft)	**843**
Assessed Bank Length (ft)	**1686**
Assessment Date	**10/21/2021**

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.	24	24		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)	24	24		100%

Table 4b. Visual Stream Morphology Stability Assessment Table
Greenbrier Stream Mitigation Project (DMS No.100086)

Reach ID	**UT1 Reach 3**
Assessed Stream Length (ft)	**1097**
Assessed Bank Length (ft)	**2194**
Assessment Date	**10/21/2021**

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)	24	24		100%

Table 4c. Visual Stream Morphology Stability Assessment Table
Greenbrier Stream Mitigation Project (DMS No.100086)

Reach ID	**UT1A**
Assessed Stream Length (ft)	**148.5**
Assessed Bank Length (ft)	**297**
Assessment Date	**10/21/2021**

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)	6	6		100%

Table 4d. Visual Stream Morphology Stability Assessment Table
Greenbrier Stream Mitigation Project (DMS No.100086)

Reach ID	**UT1B**
Assessed Stream Length (ft)	**247.5**
Assessed Bank Length (ft)	**495**
Assessment Date	**10/21/2021**

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)	6	6		100%

Table 5. Vegetation Condition Assessment Table
Greenbrier Stream Mitigation Project (DMS No.100086)

Planted Acreage **6.34**
Assessment Date **7/22/2021**

Vegetation Category	Definitions	Mapping Threshold	Combined Acreage	% of Planted Acreage
Bare Areas	Very limited cover of both woody and herbaceous material.	0.1 acres	0.00	0.0%
Low Stem Density Areas	Woody stem densities clearly below target levels based on current MY stem count criteria.	0.1 acres	0.00	0.0%
		Total	0.00	0.0%
Areas of Poor Growth Rates	Planted areas where average height is not meeting current MY Performance Standard.	0.25 acres	0.00	0.0%
		Cumulative Total	0.00	0.0%

Easement Acreage **6.7**

Vegetation Category	Definitions	Mapping Threshold	Combined Acreage	% of Easement Acreage
Invasive Areas of Concern	Invasives may occur outside of planted areas and within the easement and will therefore be calculated against the total easement acreage. Include species with the potential to directly outcompete native, young, woody stems in the short-term or community structure for existing communities. Species included in summation above should be identified in report summary.	0.1 acres	0.00	0.0%
Easement Encroachment Areas	Encroachment may be point, line, or polygon. Encroachment to be mapped consists of any violation of restrictions specified in the conservation easement. Common encroachments are mowing, cattle access, vehicular access. Encroachment has no threshold value as will need to be addressed regardless of impact area.	None	No Encroachments Noted	

Greenbrier Stream Mitigation Project
Monitoring Year 2 (7/22/2021) - Vegetation Photo Log

Veg Plot 1 – NE Corner (07/22/2021)

Veg Plot 2 – NW Corner (07/22/2021)

Veg Plot 3 – NW Corner (07/22/2021)

Veg Plot 4 – NW Corner (07/22/2021)

Veg Plot 5 R – W Corner (07/22/2021)

Veg Plot 6 R – N Corner (07/22/2021)

Greenbrier Stream Mitigation Project
Monitoring Year 2 (10/21/2021) - Photo Log

Photo Point 1 – UT1 Reach 1, Sta. 10+00
Facing Downstream (10/21/2021)

Photo Point 2 – UT1 Reach 1, Sta. 11+50
Facing Upstream (10/21/2021)

Photo Point 3 – UT1 Reach 1, Sta. 13+55
Facing Downstream (10/21/2021)

Photo Point 4 – UT1 Reach 1, Sta. 15+00
Facing Downstream (10/21/2021)

Photo Point 5 – UT1 Reach 1, Sta. 17+60
Facing Upstream (10/21/2021)

Photo Point 6 – UT1 Reach 1, Sta. 18+50
Facing Downstream (10/21/2021)

Greenbrier Stream Mitigation Project
Monitoring Year 2 (10/21/2021) - Photo Log

Photo Point 7 – UT1 Reach 3, Sta. 19+60
Facing Upstream (10/21/2021)

Photo Point 8 – UT1 Reach 3, Sta. 21+00
Looking Upstream at UT1A From UT1 (10/21/2021)

Photo Point 9 – UT1 Reach 3, Sta. 22+40
Facing Downstream (10/21/2021)

Photo Point 10 – UT1 Reach 3, Sta. 24+30
Facing Upstream (10/21/2021)

Photo Point 11 – UT1 Reach 3, Sta. 25+55
Facing Downstream (10/21/2021)

Photo Point 12 – UT1 Reach 3, Sta. 26+45
Looking Upstream at UT1B From UT1 (10/21/2021)

Greenbrier Stream Mitigation Project
Monitoring Year 2 (10/21/2021) - Photo Log

Photo Point 13 – UT1 Reach 3, Sta. 27+55
Facing Upstream (10/21/2021)

Photo Point 14 – UT1 Reach 3, Sta. 29+45
Facing Downstream (10/21/2021)

Photo Point 15A – UT1B, Sta. 11+90
Facing Downstream (10/21/2021)

Photo Point 15B – UT1B, Sta. 11+90
Facing Upstream (10/21/2021)

Photo Point 16A – UT1A, Sta. 12+00
Facing Downstream (10/21/2021)

Photo Point 16B – UT1A, Sta. 12+00
Facing Upstream Towards UT1A-1 (10/21/2021)

Greenbrier Stream Mitigation Project
Monitoring Year 2 (2/10/2021) - Photo Log

Photo Point 17 – UT1 Reach 1, Sta. 16+50
Facing Upstream (2/10/2021)

Site Overview
Facing Northeast (10/21/2021)

Site Overview
Facing Southwest (10/212021)

Appendix B

Vegetation Plot Data

Table 6. Vegetation Plot Data

Table 7. Vegetation Performance Standards Summary Table

2021 Supplemental Planting Species List

Table 6. Vegetation Plot Data
Greenbrier Stream Mitigation Project (NCDMS Project No. 100086)

Planted Acreage	6.34
Date of Initial Plant	2020-04-01
Date(s) of Supplemental Plant(s)	2021-03-15
Date(s) Mowing	#N/A
Date of Current Survey	2021-07-23
Plot size (ACRES)	0.0247

	Scientific Name	Common Name	Tree/Shrub	Indicator Status	Veg Plot 1 F		Veg Plot 2 F		Veg Plot 3 F		Veg Plot 4 F		Veg Plot 5 R	Veg Plot 6 R
					Planted	Total	Planted	Total	Planted	Total	Planted	Total	Total	Total
Species Included in Approved Mitigation Plan	Betula nigra	river birch	Tree	FACW	5	5			5	5	1	1	2	5
	Cercis canadensis	eastern redbud	Tree	UPL			1	1			2	2		
	Cornus amomum	silky dogwood	Shrub	FACW	1	1								1
	Diospyros virginiana	common persimmon	Tree	FAC	2	2	7	7	1	1				1
	Liriodendron tulipifera	tuliptree	Tree	FACU			1	1	3	3	1	1		
	other				1	1					1	1		
	Platanus occidentalis	American sycamore	Tree	FACW	4	4	3	3	2	2	2	2	3	10
	Quercus nigra	water oak	Tree	FAC			1	1	1	1	2	2	1	1
	Quercus phellos	willow oak	Tree	FACW	1	1			2	2	1	1	1	1
	Salix nigra	black willow	Tree	OBL									1	
	Ulmus americana	American elm	Tree	FAC	5	5			5	5			5	1
Sum	Performance Standard				19	19	13	13	19	19	10	10	13	20
Post Mitigation Plan Species	*Hamamelis virginiana*	*American witchhazel*	*Tree*	*FACU*								*1*		
Sum	Proposed Standard				19	19	13	13	19	19	10	10	13	20
Mitigation Plan Performance Standard	*Current Year Stem Count*					*19*		*13*		*19*		*10*	*13*	*20*
	Stems/Acre					769		526		769		405	526	810
	Species Count					7		5		7		7	6	7
	Dominant Species Composition (%)					26		54		26		18	38	50
	Average Plot Height					2		3		1		2	2	2
	% Invasives					0		0		0		0	0	0
Post Mitigation Plan Performance Standard	Current Year Stem Count					19		13		19		10	13	20
	Stems/Acre					769		526		769		405	526	810
	Species Count					7		5		7		7	6	7
	Dominant Species Composition (%)					26		54		26		18	38	50
	Average Plot Height					2		3		1		2	2	2
	% Invasives					0		0		0		0	0	0

1). Bolded species are proposed for the current monitoring year, italicized species are not approved, and a regular font indicates that the species has been approved.
2). The "Species Included in Approved Mitigation Plan" section contains only those species that were included in the original approved mitigation plan. The "Post Mitigation Plan Species" section includes species that are being proposed through a mitigation plan addendum for the current monitoring year (bolded) , species that have been approved in prior monitoring years through a mitigation plan addendum (regular font), and species that are not approved (italicized).
3). The "Mitigation Plan Performance Standard" section is derived only from stems included in the original mitigation plan, whereas the "Post Mitigation Plan Performance Standard" includes data from mitigation plan approved, post mitigation plan approved, and proposed stems.

Table 7. Vegetation Performance Standards Summary Table
Greenbrier Stream Mitigation Project (NCDMS Project No. 100086)

Vegetation Performance Standards Summary Table												
	Veg Plot 1 F				Veg Plot 2 F				Veg Plot 3 F			
	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives
Monitoring Year 7												
Monitoring Year 5												
Monitoring Year 3												
Monitoring Year 2	769	2	7	0	526	3	5	0	769	1	7	0
Monitoring Year 1	445	2	8	0	364	2	4	0	688	1	7	0
Monitoring Year 0	729	2	9	0	607	1	5	0	769	1	7	0
	Veg Plot 4 F				Veg Plot 5 R				Veg Plot 6 R			
	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives
Monitoring Year 7												
Monitoring Year 5												
Monitoring Year 3												
Monitoring Year 2	405	2	7	0	526	2	6	0	810	2	7	0
Monitoring Year 1	162	2	3	0	283	2	5	0	972	3	2	0
Monitoring Year 0	688	1	4	0								

Greenbrier 2021 Supplemental Planting Species List

Trees and Shrubs			
The following table lists bare-root vegetation selection for the 2021 replanting effort. -Trees were planted in replanting areas at a total density of 500 stems per acre. Total replanting area was approximately 1.28 acres. -Trees were planted in supplemental planting areas at a total density of 200 stems per acre. Total replanting area was approximately 3.19 acres.			
Common Name	**Scientific Name**	**Percent Planted by Species**	**Wetness Tolerance**
Trees (75%) Planted 9' X 9' Spacing – 538 Trees/ Acre			
River Birch	*Betula nigra*	20%	FACW
Sycamore	*Platanus occidentalis*	20%	FACW
Water Oak	*Quercus nigra*	10%	FAC
American Elm	*Ulmus americana*	10%	FACW
Persimmon	*Diospryos virginiana*	10%	FAC
Willow Oak	*Quercus phellos*	10%	FAC
Tulip Poplar	*Liriodendron tulipifera*	20%	FAC
	Tree Total	100%	
Shrubs (25%) Planted 16' X 16' Spacing - 164 Shrubs/ Acre			
Tag Alder	*Alnus serrulata*	20%	FACW
Spicebush	*Lindera benzoin*	25%	FACW
Redbud	*Cercis canadensis*	20%	FACU
Elderberry	*Sambucus canadensis*	15%	FAC
Silky Dogwood	*Cornus amomum*	20%	FACW
	Shrub Total	100%	

Appendix C

Stream Geomorphology Data

Cross-Sections With Annual Overlays

Table 8. Baseline Stream Data Summary

Table 9. Cross-Section Morphology Data Table

Cross Section Plot - MY2 - November 2021

XS1 - UT1 Reach 1

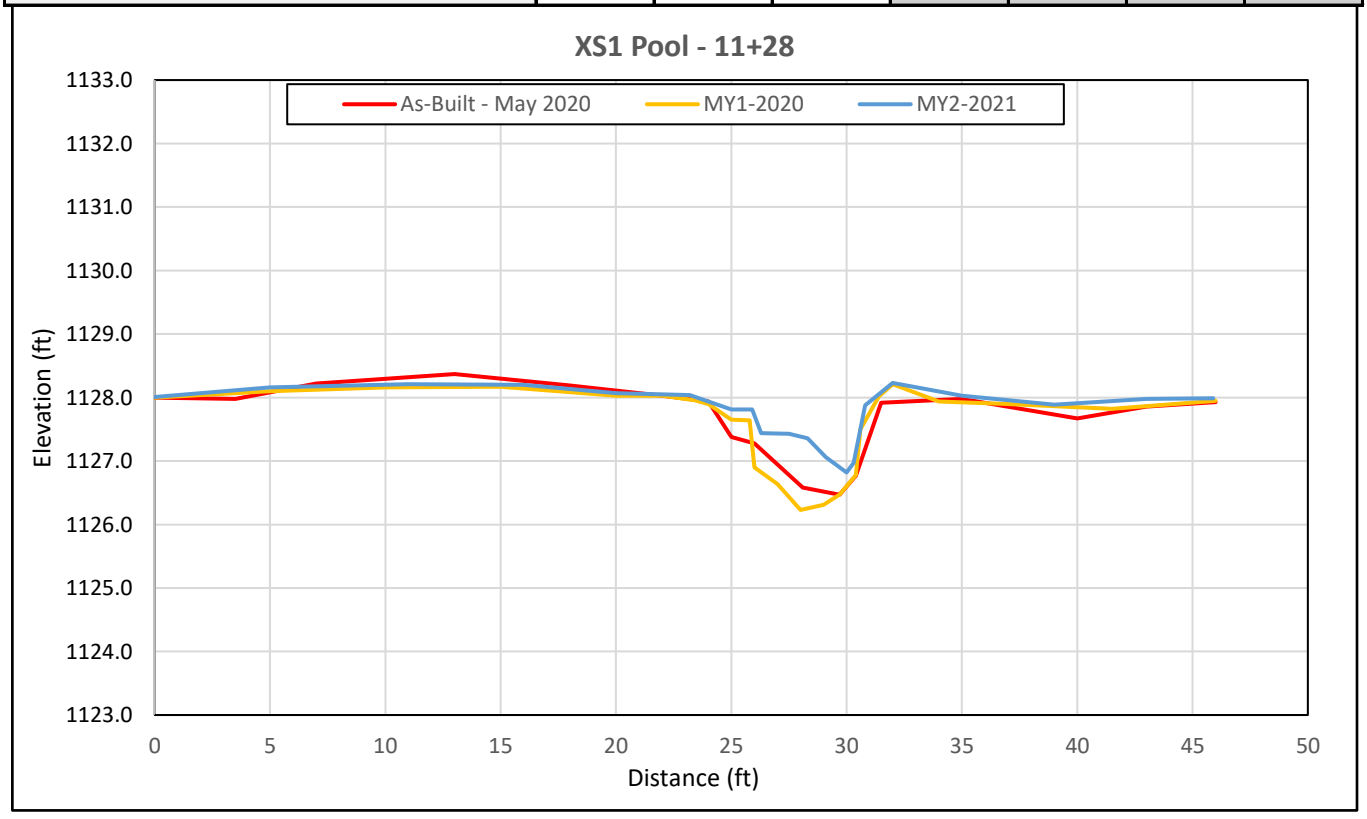
Rosgen Stream Type - B4

Station 11+28 - Pool

XS1 looking upstream

XS1 looking downstream

	MY0	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Elevation - Based on AB Bankfull Area	1127.92	1127.87	1128.35				
Bank Height Ratio - Based on AB-Bankfull Area	1.00	1.09	0.8				
Thalweg Elevation	1126.47	1126.23	1126.82				
LTOB Elevation	1127.92	1128.02	1128.04				
LTOB Max Depth	1.45	1.79	1.22				
LTOB Cross Sectional Area	6.70	7.87	4.17				
Entrenchment Ratio	-	-	-				



Cross Section Plot - MY2 - November 2021

XS2 - UT1 Reach 1

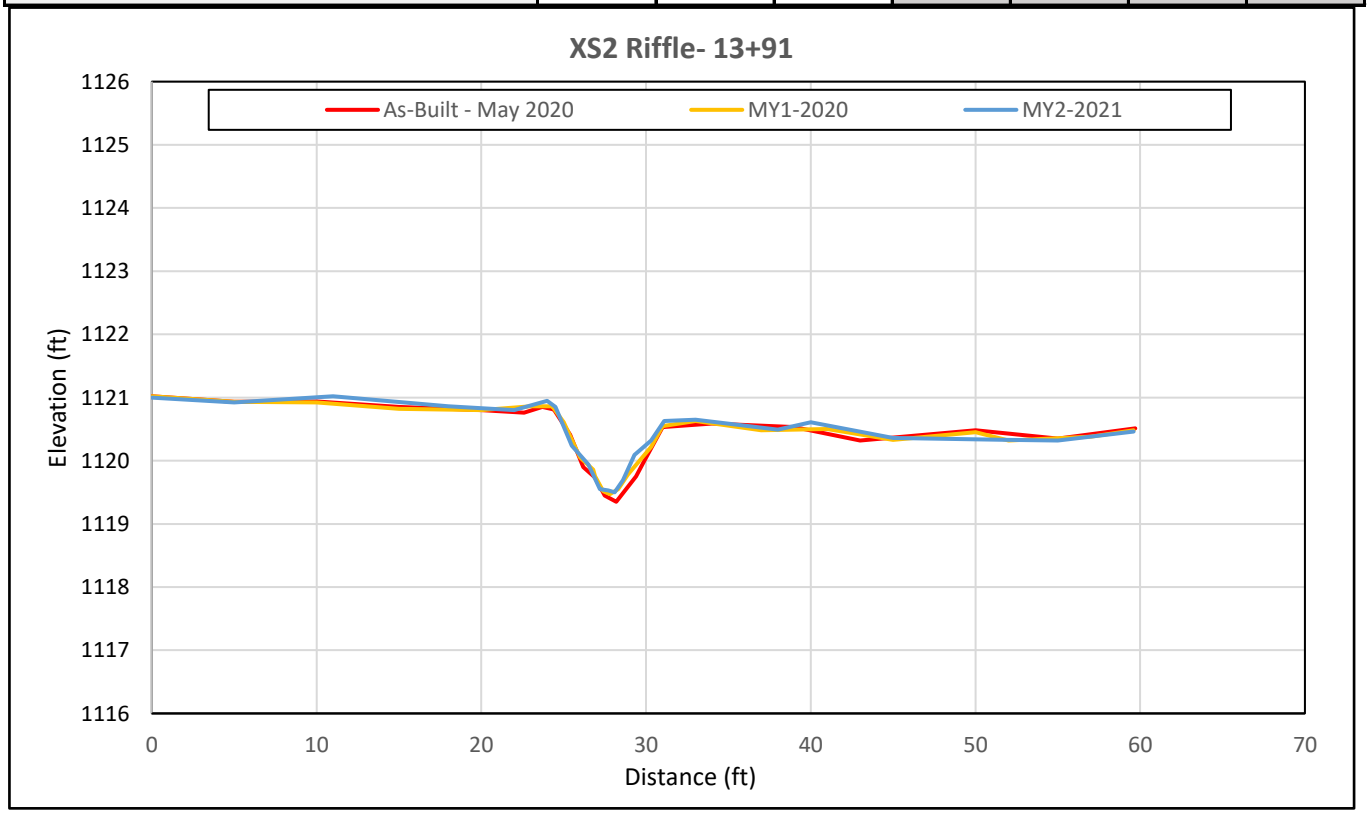
Rosgen Stream Type - B4

Station 13+91 - Riffle

XS2 looking upstream

XS2 looking downstream

	MY0	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Elevation - Based on AB Bankfull Area	1120.53	1120.61	1120.65				
Bank Height Ratio - Based on AB-Bankfull Area	1.00	0.94	0.98				
Thalweg Elevation	1119.35	1119.47	1119.50				
LTOB Elevation	1120.53	1120.55	1120.63				
LTOB Max Depth	1.18	1.08	1.13				
LTOB Cross Sectional Area	3.97	3.59	3.86				
Entrenchment Ratio	>10.12	>10.11	>10.17				



Cross Section Plot - MY2 - November 2021

XS3 - UT1 Reach 3

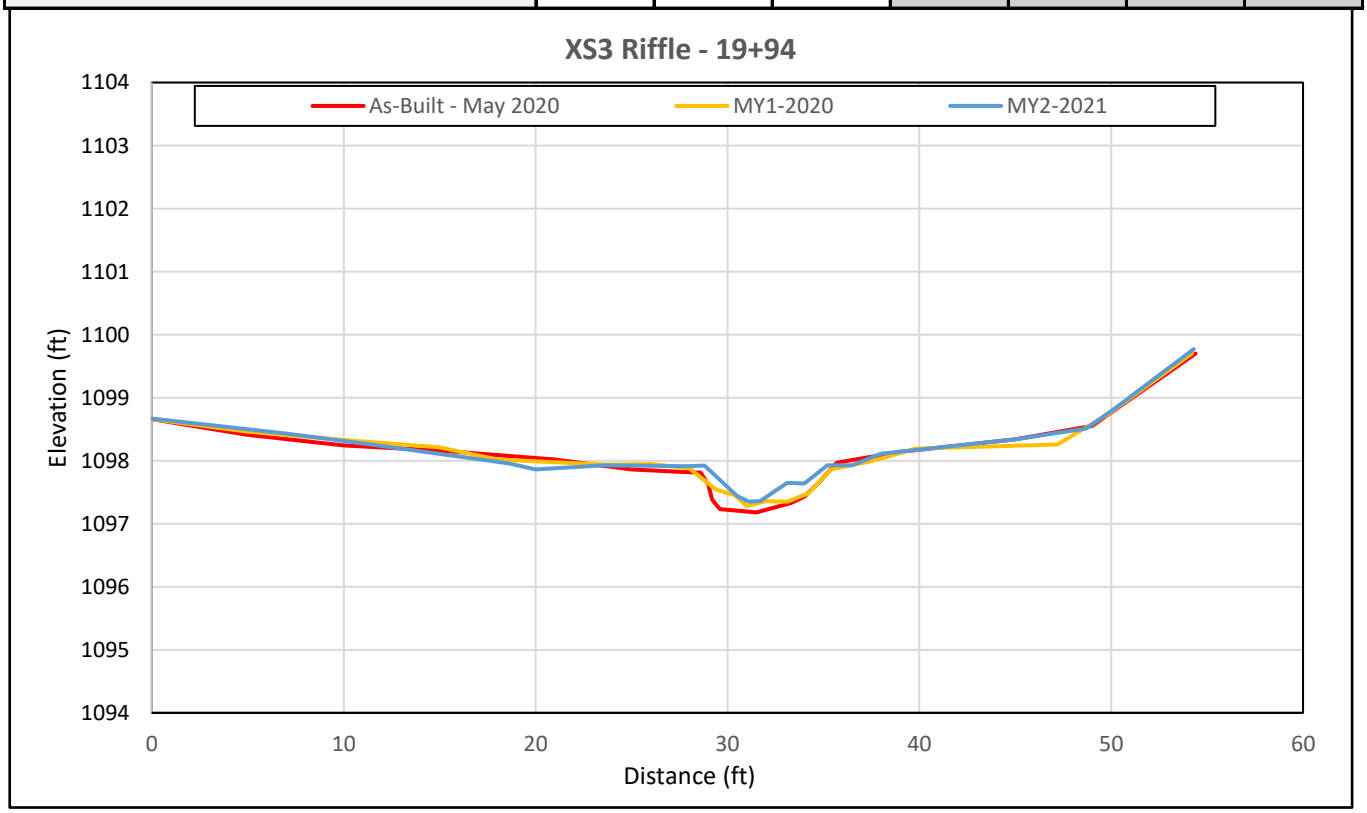
Rosgen Stream Type - C4

Station 19+94 - Riffle

XS3 looking upstream

XS3 looking downstream

	MY0	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Elevation - Based on AB Bankfull Area	1097.81	1097.90	1098.07				
Bank Height Ratio - Based on AB-Bankfull Area	1.00	0.97	0.79				
Thalweg Elevation	1097.18	1097.28	1097.35				
LTOB Elevation	1097.81	1097.88	1097.92				
LTOB Max Depth	0.63	0.60	0.57				
LTOB Cross Sectional Area	2.99	2.84	2.05				
Entrenchment Ratio	6.39	5.80	5.75				



Cross Section Plot - MY2 - November 2021

XS4 - UT1 Reach 3

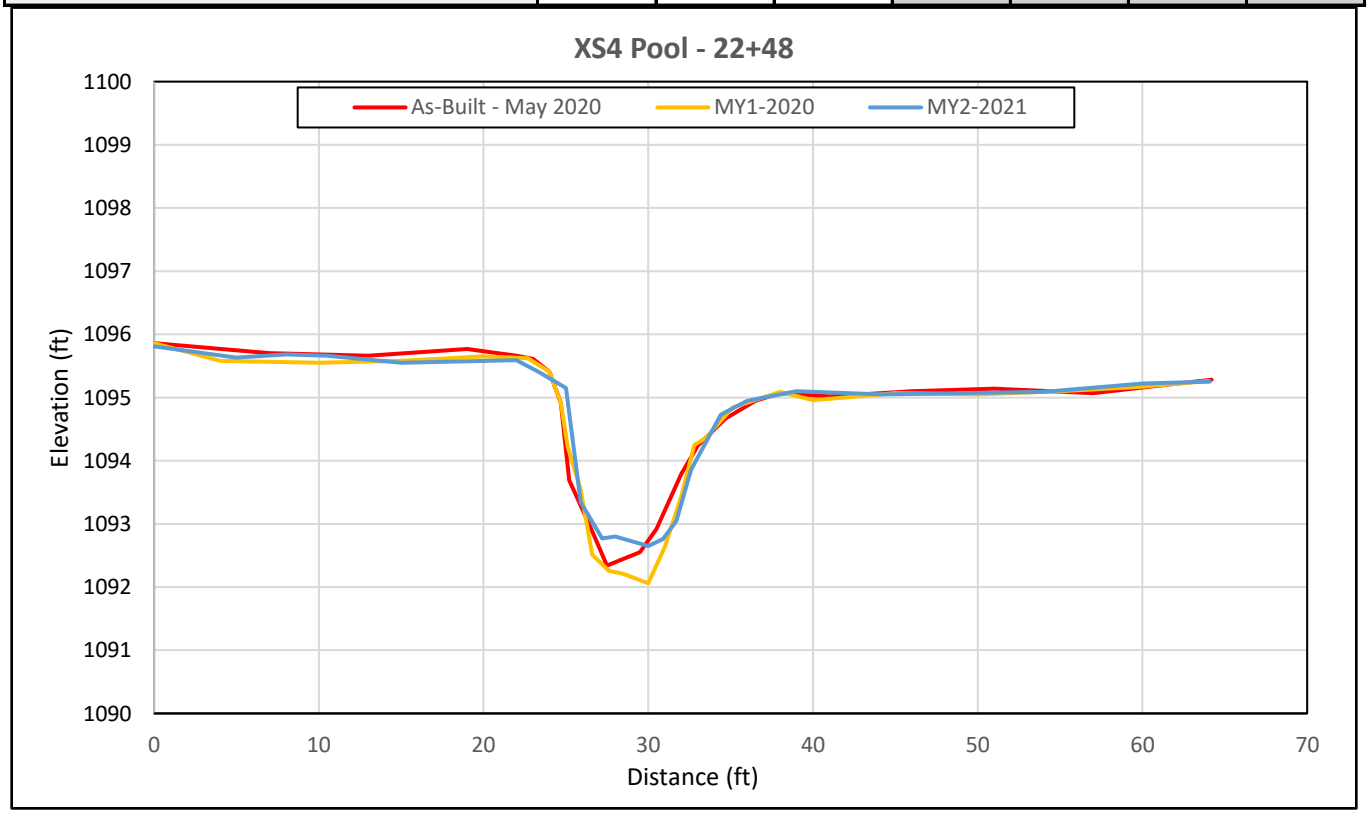
Rosgen Stream Type - C4

Station 22+48 - Pool

XS4 looking upstream

XS4 looking downstream

	MY0	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Elevation - Based on AB Bankfull Area	1094.95	1094.80	1095.02				
Bank Height Ratio - Based on AB-Bankfull Area	1.00	1.01	1.04				
Thalweg Elevation	1092.34	1092.06	1092.65				
LTOB Elevation	1094.95	1094.84	1095.10				
LTOB Max Depth	2.61	2.78	2.45				
LTOB Cross Sectional Area	16.41	16.85	17.51				
Entrenchment Ratio	-	-	-				



Cross Section Plot - MY2 - November 2021

XS5 - UT1 Reach 3

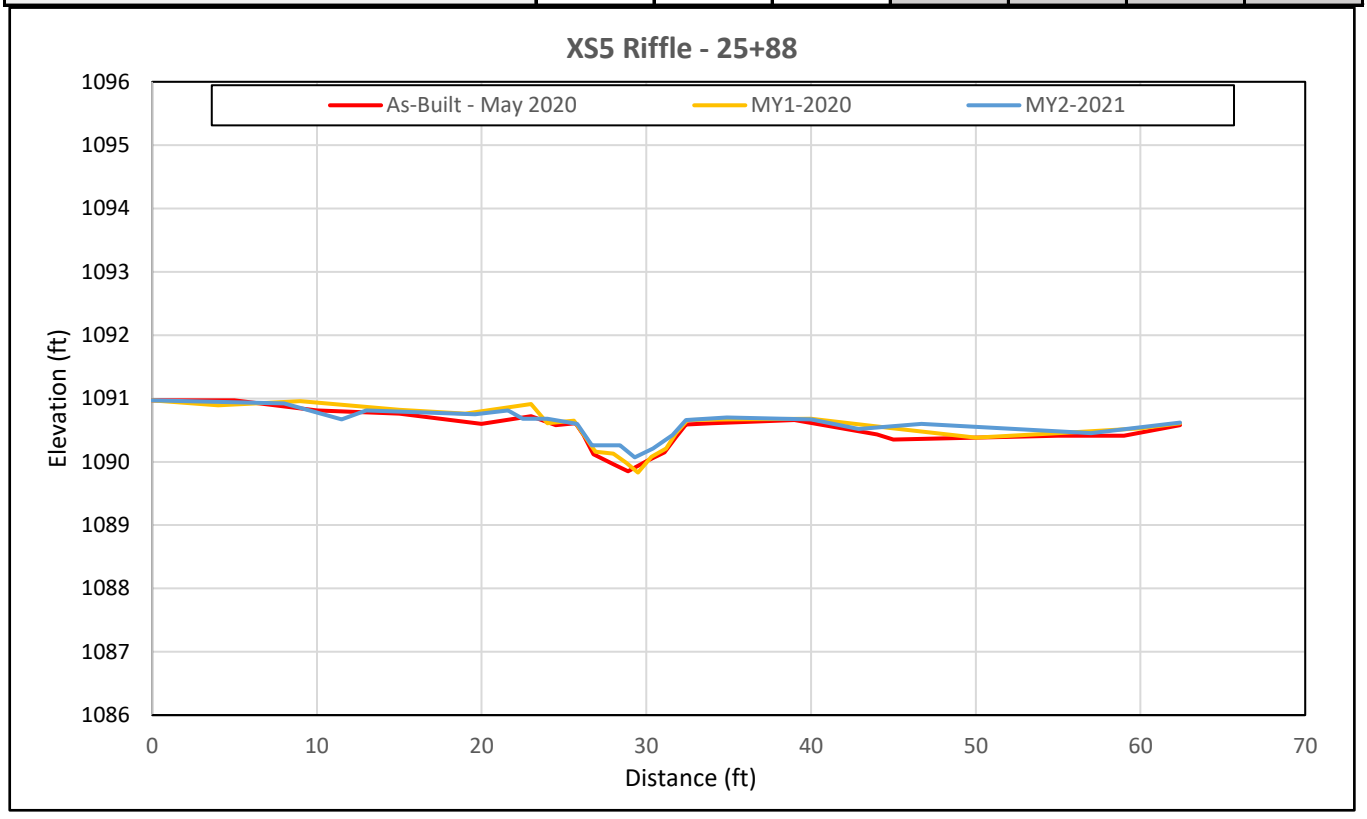
Rosgen Stream Type - C4

Station 25+88 - Riffle

XS5 looking upstream

XS5 looking downstream

	MY0	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Elevation - Based on AB Bankfull Area	1090.59	1090.64	1090.74				
Bank Height Ratio - Based on AB-Bankfull Area	1.00	1.02	0.88				
Thalweg Elevation	1089.85	1089.83	1090.07				
LTOB Elevation	1090.59	1090.66	1090.66				
LTOB Max Depth	0.74	0.83	0.59				
LTOB Cross Sectional Area	3.08	3.26	2.46				
Entrenchment Ratio	>9.39	>9.1	>9.84				



Cross Section Plot - MY2 - November 2021

XS6 - UT1 Reach 3

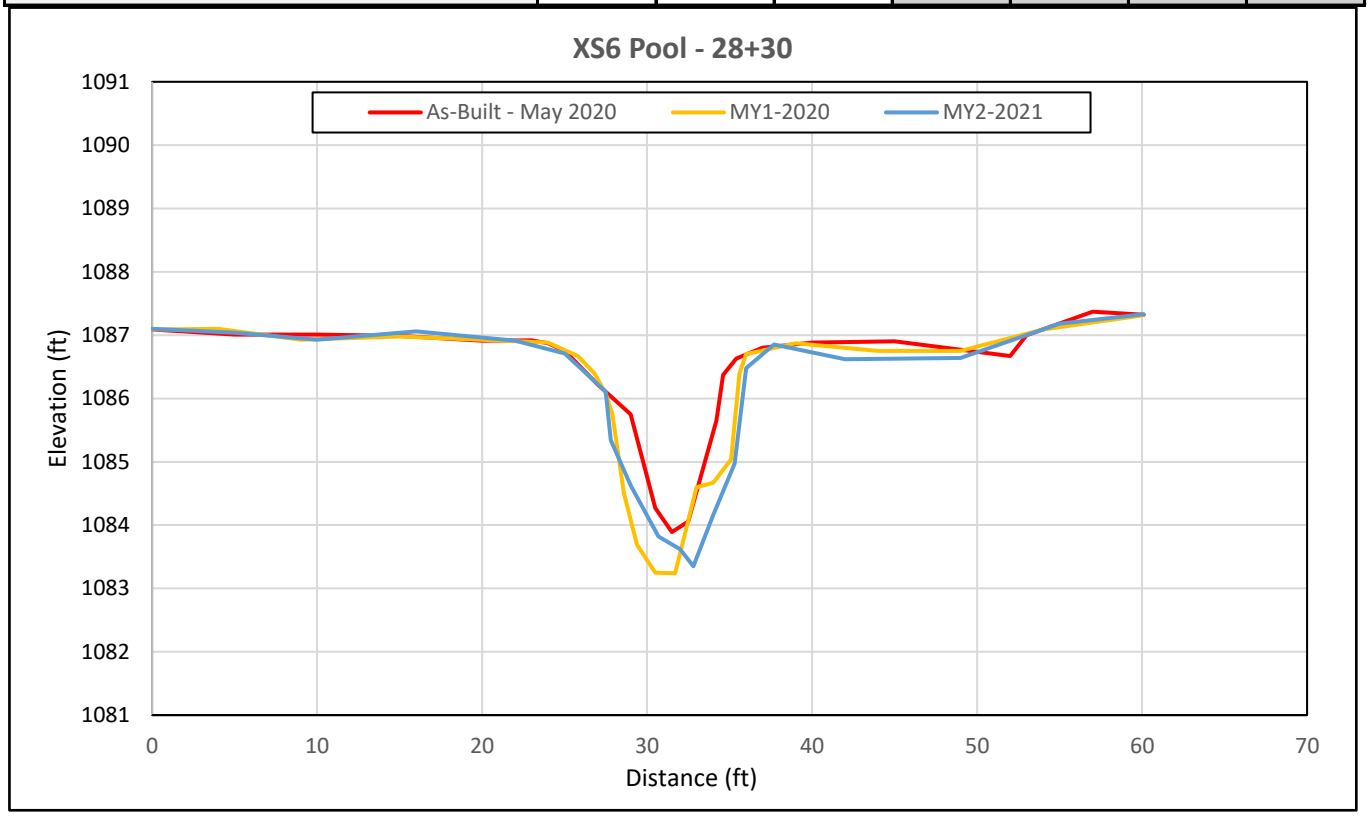
Rosgen Stream Type - C4

Station 28+30 - Pool

XS6 looking upstream

XS6 looking downstream

	MY0	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Elevation - Based on AB Bankfull Area	1086.63	1085.85	1085.82				
Bank Height Ratio - Based on AB-Bankfull Area	1.00	1.32	1.42				
Thalweg Elevation	1083.89	1083.24	1083.35				
LTOB Elevation	1086.63	1086.70	1086.85				
LTOB Max Depth	2.74	3.46	3.50				
LTOB Cross Sectional Area	12.61	19.95	22.83				
Entrenchment Ratio	-	-	-				



Cross Section Plot - MY2 - November 2021

XS7 - UT1A

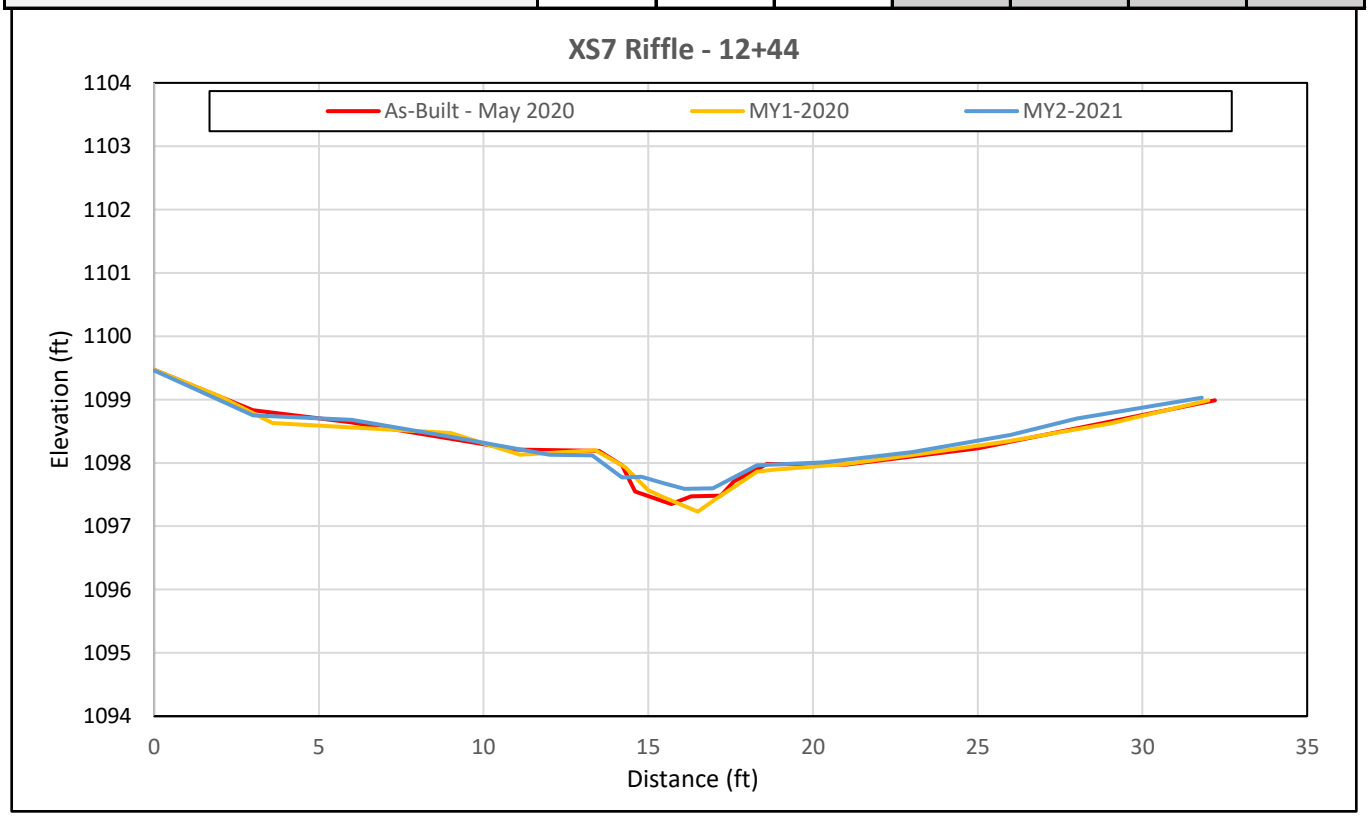
Rosgen Stream Type - B4

Station 12+44 - Riffle

XS7 looking upstream

XS7 looking downstream

	MY0	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Elevation - Based on AB Bankfull Area	1097.98	1097.96	1098.11				
Bank Height Ratio - Based on AB-Bankfull Area	1.00	0.91	0.71				
Thalweg Elevation	1097.35	1097.23	1097.59				
LTOB Elevation	1097.98	1097.89	1097.96				
LTOB Max Depth	0.63	0.66	0.37				
LTOB Cross Sectional Area	1.76	1.47	1.07				
Entrenchment Ratio	4.90	4.98	3.25				



Cross Section Plot - MY2 - November 2021

XS8 - UT1B

Rosgen Stream Type - B4

Station 11+71 - Riffle

XS8 looking upstream

XS8 looking downstream

	MY0	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Elevation - Based on AB Bankfull Area	1089.94	1090.00	1090.17				
Bank Height Ratio - Based on AB-Bankfull Area	1.00	0.76	0.47				
Thalweg Elevation	1089.59	1089.66	1089.72				
LTOB Elevation	1089.94	1089.92	1089.93				
LTOB Max Depth	0.35	0.26	0.21				
LTOB Cross Sectional Area	0.87	0.59	0.19				
Entrenchment Ratio	>5.26	>5.39	>5.69				

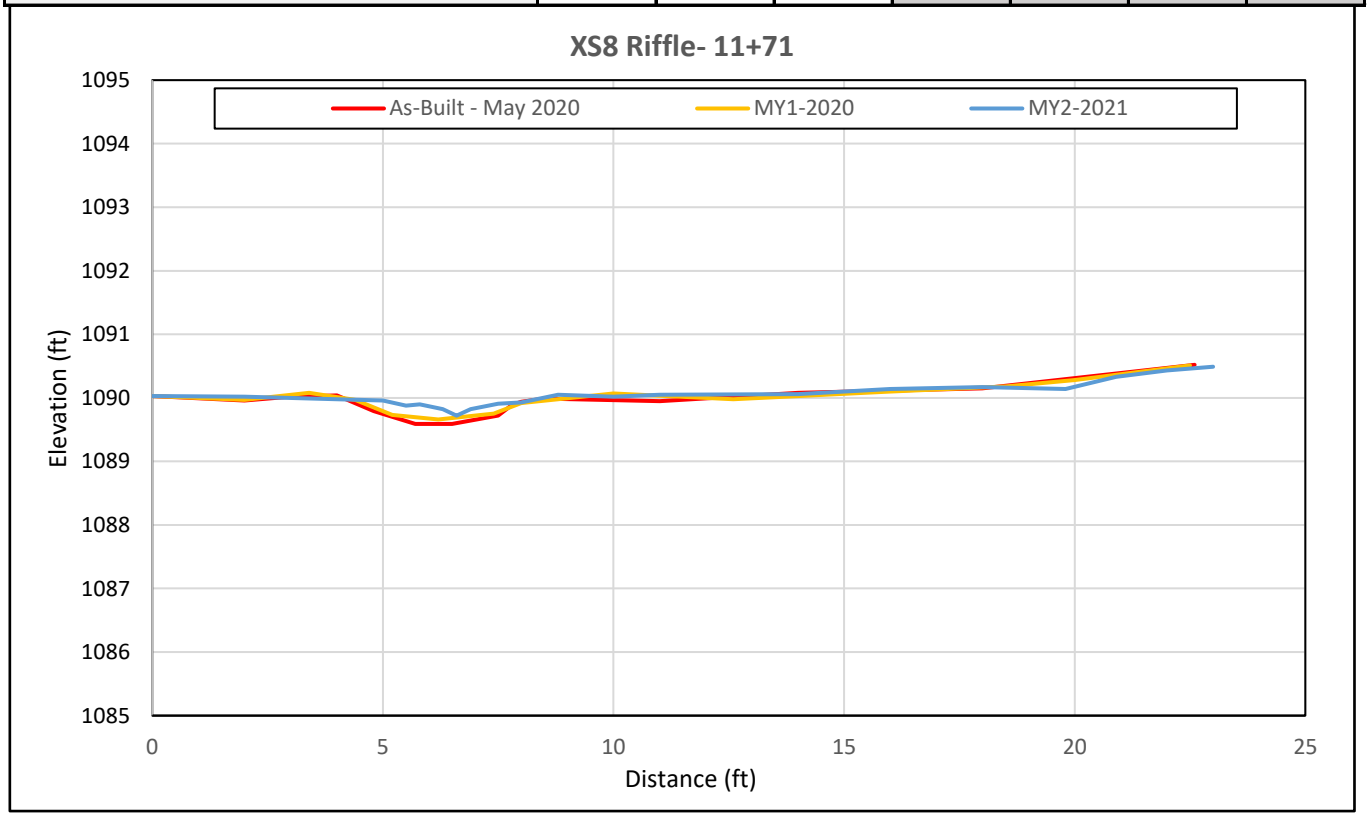


Table 8a. Baseline Stream Data Summary
Greenbrier Stream Mitigation Project (DMS No. 100086) - UT1 Reach 1 (843 feet)

Parameter	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)	2.6	12	6.2	4.3	4.8	4.8	5.3	0.7	2	3.26	6.2	-	6.6	-	-	5.7	6.2	6.7	-	5.9	-	-	-	1
Floodprone Width (ft)				20.0	26.5	26.5	33.0	9.2	2	8.7	11.2	-	13.7	-	-	25.0	35.0	45.0	-	>59.7	-	-	-	1
Bankfull Mean Depth (ft)	0.4	1.4	0.5	0.5	0.6	0.6	0.8	0.2	2	0.5	0.6	-	0.6	-	-	0.4	0.5	0.6	-	0.7	-	-	-	1
[1]Bankfull Max Depth (ft)				0.7	0.9	0.9	1.1	0.2	2	0.7	0.7	-	0.8	-	-	0.5	0.6	0.7	-	1.2	-	-	-	1
Bankfull Cross Sectional Area (ft^2)	1.8	8	3.1	2.6	2.9	2.9	3.3	0.5	2	2.3	2.7	-	3.2	-	-	2.7	3.0	3.3	-	4.0	-	-	-	1
Width/Depth Ratio				5.6	8.4	8.4	11.1	3.9	2	12.0	15.0	-	18	-	-	11.0	13.0	15.0	-	8.8	-	-	-	1
Entrenchment Ratio				1.6	1.7	1.7	1.9	0.2	2	1.4	1.8	-	2.2	-	-	4.0	5.7	7.3	-	>10.1	-	-	-	1
[1]Bank Height Ratio				1.5	2.1	2.1	2.8	0.9	2	1.0	1.0	-	1.0	-	-	1.0	1.0	1.0	-	1.0	-	-	-	1
Profile																								
Riffle Length (ft)				N/A	N/A	N/A	N/A	N/A	N/A	Total riffle length 60-70% of reach length						7	17	33	16	26	24	39	8	14
Riffle Slope (ft/ft)				0.027	0.032	0.032	0.038	0.008	2	0.019	0.025	-	0.032	-	-	0.0385	0.051	0.063	0.018	0.0279	0.028	0.039	0.0049	14
Pool Length (ft)				N/A	N/A	N/A	N/A	N/A	N/A	Total pool length 30-40% of reach length						6	11	19	8	14	15	19	3	14
Pool Max depth (ft)				0.6	1.3	1.3	1.9	0.9	2	1.11	1.5	-	1.9	-	-	1.3	1.4	1.5	1.4	2.0	2.0	2.9	0.4	14
Pool Spacing (ft)				40.0	80.0	80.0	120.0	56.6	25	3.1	17.2	-	31.2	-	-	3	17	31	28	42	40	60	11	14
Pattern																								
Channel Beltwidth (ft)				6.0	19.0	20.0	38.0	11.4	8	N/A	N/A	-	N/A	-	-	N/A	N/A	N/A	17.2	20.4	20.5	23.8	2.0	8
Radius of Curvature (ft)				37.0	46.8	47.5	55.0	7.9	4	N/A	N/A	-	N/A	-	-	N/A	N/A	N/A	21.7	32.0	27.9	51.7	10.7	10
Rc:Bankfull width (ft/ft)				7.7	9.7	9.9	11.4	1.7	4	N/A	N/A	-	N/A	-	-	N/A	N/A	N/A	3.7	5.4	4.7	8.8	1.8	10
Meander Wavelength (ft)				66.0	111.7	86.0	224.0	57.8	11	N/A	N/A	-	N/A	-	-	N/A	N/A	N/A	50.0	93.1	99.0	113.0	19.1	9
Meander Width Ratio				1.2	4.0	4.2	7.9	2.4	8	N/A	N/A	-	N/A	-	-	N/A	N/A	N/A	2.9	3.5	3.5	4.0	0.3	8
Transport parameters																								
Reach Shear Stress (competency) lb/f^2				0.45												0.82			1.24					
Max part size (mm) mobilized at bankfull				84												142			160					
Stream Power (transport capacity) lb/s				23												36			34					
Additional Reach Parameters																								
Rosgen Classification				B4c						B4						B4			B4					
Bankfull Velocity (fps)	2.8	1.9	2.0	2.79												2.3			1.8					
Bankfull Discharge (cfs)	5	15	6.2	7												7								
Valley length (ft)				865						-						865								
Channel Thalweg length (ft)				926						-						919			852					
Sinuosity (ft)				1.07						1.1-1.2						1.03			1.02					
Water Surface Slope (Channel) (ft/ft)				0.018						-						0.035			0.032					
BF slope (ft/ft)				0.019						-						0.036			0.032					
[3]Bankfull Floodplain Area (acres)				0.5						-						0.7			0.95					
[4]% of Reach with Eroding Banks				-						-														
Channel Stability or Habitat Metric				-						-														
Biological or Other				-						-														

Table 8b. Baseline Stream Data Summary
Greenbrier Stream Mitigation Project (DMS No. 100086) - UT1 Reach 3 (1097 feet)

Parameter	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)	2.7	12	8.0	7.1	9.3	9.3	11.5	3.1	2	3.3	4.8	-	6.2	-	-	7.1	7.6	8.1	6.6	6.6	6.6	6.7	0.0	2
Floodprone Width (ft)				11.4	15.3	15.3	19.1	5.5	2	7.6	7.8	-	8.1	-	-	20.0	54.0	88.0	42.3	52.3	52.3	>62.4	-	2
Bankfull Mean Depth (ft)	0.4	1.5	0.6	0.4	0.5	0.5	0.6	0.1	2	0.4	0.5	-	0.6	-	-	0.4	0.6	0.8	0.5	0.5	0.5	0.5	0.0	2
[1]Bankfull Max Depth (ft)				0.8	0.9	0.9	0.9	0.1	2	0.6	0.7	-	0.7	-	-	0.7	0.8	0.9	0.6	0.7	0.7	0.7	0.1	2
Bankfull Cross Sectional Area (ft^2)	2	10	4.8	4.1	4.3	4.3	4.6	0.4	2	1.3	2.4	-	3.6	-	-	4.1	4.5	5.0	3.0	3.0	3.0	3.1	0.1	2
Width/Depth Ratio				12.4	20.6	20.6	28.7	11.5	2	12	14	-	15	-	-	12.0	15.0	18.0	14.5	14.6	14.6	14.7	0.2	2
Entrenchment Ratio				1.6	1.7	1.7	1.7	0.1	2	1.6	1.7	-	1.7	-	-	4.0	5.7	7.3	6.4	7.9	7.9	>9.4	-	2
[1]Bank Height Ratio				2.2	2.9	2.9	3.5	0.9	2	1.0	1.0	-	1.0	-	-	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	2
Profile																								
Riffle Length (ft)				N/A	N/A	N/A	N/A	N/A	N/A	Total riffle length 60-70% of reach length						13	21	40	12	29	28	49	10	12
Riffle Slope (ft/ft)				0.016	0.031	0.031	0.046	0.021	2	0.018	0.020	-	0.023	-	-	0.014	0.019	0.023	0.010	0.0168	0.0165	0.025	0.0052	12
Pool Length (ft)				N/A	N/A	N/A	N/A	N/A	N/A	Total pool length 30-40% of reach length						9	21	30	23	28	26	42	6	12
Pool Max depth (ft)				0.9	1.0	1.0	1.1	0.1	2	0.7	1.2	-	1.7	-	-	1.4	1.5	1.7	1.8	2.2	2.2	2.9	0.3	12
Pool Spacing (ft)				N/A	N/A	N/A	N/A	N/A	N/A	17	25	-	33	-	-	26	40	53	30	47	47	62	8	12
Pattern																								
Channel Beltwidth (ft)				8.0	13.8	12.0	23.0	5.0	15.0	16.6	27.3	-	38.0	-	-	27.0	44.0	61.0	29.3	33.5	33.6	37.9	2.5	21
Radius of Curvature (ft)				14.0	28.1	26.0	44.0	11.6	7.0	9.5	11.9	-	14.3	-	-	15.0	19.0	23.0	17.5	22.5	22.4	26.2	2.7	20
Rc:Bankfull width (ft/ft)				1.5	3.0	2.8	4.7	1.2	7.0	2.0	2.5	-	3.0	-	-	2.0	2.5	3.0	2.6	3.4	3.4	3.9	0.4	20
Meander Wavelength (ft)				36.0	71.8	61.0	128.0	29.0	15.0	33.3	49.9	-	66.5	-	-	53.0	80.0	107.0	51.0	67.7	64.5	87.0	9.4	20
Meander Width Ratio				3.9	7.7	6.6	13.8	29.0	15.0	3.5	5.8	-	8.0	-	-	3.5	5.8	8.0	4.4	5.0	5.1	5.7	0.4	8
Transport parameters																								
Reach Shear Stress (competency) lb/f^2				0.79												0.54			0.38					
Max part size (mm) mobilized at bankfull				87.8												79.6			75.0					
Stream Power (transport capacity) lb/s				18												19			24					
Additional Reach Parameters																								
Rosgen Classification				B4						C4						C4			C4					
Bankfull Velocity (fps)	3.0	6.0	2.2	3.1												2.8			4.1					
Bankfull Discharge (cfs)	6	60	10.4	12.5												12.5								
Valley length (ft)				902						-						902								
Channel Thalweg length (ft)				991.6						-						1097			1141					
Sinuosity (ft)				1.09						1.2 to 1.4						1.22			1.26					
Water Surface Slope (Channel) (ft/ft)				0.015						-						0.013			0.014					
BF slope (ft/ft)				0.016						-						0.016			0.014					
[3]Bankfull Floodplain Area (acres)				0.3						-						1.1			1.6					
[4]% of Reach with Eroding Banks				-						-														
Channel Stability or Habitat Metric				-						-														
Biological or Other				-						-														

Table 8c. Baseline Stream Data Summary
Greenbrier Stream Mitigation Project (DMS No. 100086) - UT1A (148.5 feet)

Parameter	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)	1	8	3.5	3.8	3.8	3.8	3.8	-	1	1.6	2.5	-	3.5	-	-	3.1	3.6	4.1	-	4.5	-	-	-	1
Floodprone Width (ft)				4.7	4.7	4.7	4.7	-	1	3.5	4.5	-	5.5	-	-	5.0	7.5	10.0	-	22.3	-	-	-	1
Bankfull Mean Depth (ft)	0.3	1	0.3	0.1	0.1	0.1	0.1	-	1	0.3	0.3	-	0.4	-	-	0.2	0.3	0.4	-	0.4	-	-	-	1
[1]Bankfull Max Depth (ft)				0.3	0.3	0.3	0.3	-	1	0.4	0.4	-	0.5	-	-	0.3	0.4	0.5	-	0.6	-	-	-	1
Bankfull Cross Sectional Area (ft^2)	1	6	1.1	0.5	0.5	0.5	0.5	-	1	0.7	0.9	-	1.1	-	-	0.9	1.0	1.1	-	1.8	-	-	-	1
Width/Depth Ratio				26.8	26.8	26.8	26.8	-	1	12.0	15.0	-	18	-	-	10.0	12.9	15.0	-	11.6	-	-	-	1
Entrenchment Ratio				1.3	1.3	1.3	1.3	-	1	1.4	1.8	-	2.2	-	-	1.4	2.1	2.8	-	4.9	-	-	-	1
[1]Bank Height Ratio				14.8	14.8	14.8	14.8	-	1	1.0	1.0	-	1.1	-	-	1.0	1.0	1.0	-	1.0	-	-	-	1
Profile																								
Riffle Length (ft)				N/A	N/A	N/A	N/A	N/A	N/A	Total riffle length 60-70% of reach length						4.0	8.0	11.0	9	14	15	19	4	5
Riffle Slope (ft/ft)				0.029	0.070	0.070	0.110	0.057	2	0.086	0.113	-	0.140	-	-	0.023	0.030	0.036	0.012	0.0292	0.032	0.047	0.0122	5
Pool Length (ft)				N/A	N/A	N/A	N/A	N/A	N/A	Total pool length 30-40% of reach length						3.0	5.0	12.0	5	12	12	20	5	5
Pool Max depth (ft)				N/A	N/A	N/A	N/A	N/A	N/A	0.7	0.9	-	1.2	-	-	0.6	0.7	0.8	0.5	0.8	0.9	0.9	0.2	5
Pool Spacing (ft)				N/A	N/A	N/A	N/A	N/A	N/A	1.3	6.9	-	12.5	-	-	2.0	10.0	18.0	18	23	22	32	5	4
Pattern																								
Channel Beltwidth (ft)				N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-	N/A	-	-	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Radius of Curvature (ft)				N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-	N/A	-	-	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Rc:Bankfull width (ft/ft)				N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-	N/A	-	-	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Meander Wavelength (ft)				N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-	N/A	-	-	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Meander Width Ratio				N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-	N/A	-	-	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Transport parameters																								
Reach Shear Stress (competency) lb/f^2				0.68												0.35			0.40					
Max part size (mm) mobilized at bankfull				N/A												N/A			80					
Stream Power (transport capacity) lb/s				38												10			7					
Additional Reach Parameters																								
Rosgen Classification				F4						B4						B4			B4					
Bankfull Velocity (fps)	3.0	2.0	1.6	3.8												2			1.1					
Bankfull Discharge (cfs)	3	12	1.8	2.0												2.0								
Valley length (ft)				114						-						144								
Channel Thalweg length (ft)				115						-						148.5			153					
Sinuosity (ft)				1.01						1.1 to 1.2						1.03			1.06					
Water Surface Slope (Channel) (ft/ft)				0.078						-						0.020			0.018					
BF slope (ft/ft)				0.078						-						0.021			0.018					
[3]Bankfull Floodplain Area (acres)				0.01						-						0.02			0.13					
[4]% of Reach with Eroding Banks				-						-														
Channel Stability or Habitat Metric				-						-														
Biological or Other				-						-														

Table 8d. Baseline Stream Data Summary
Greenbrier Stream Mitigation Project (DMS No. 100086) - UT1B (247.50 feet)

Parameter	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)	1	8	3.5	4.7	4.7	4.7	4.7	-	1	1.7	2.7	-	3.7	-	-	3.1	3.6	4.1	-	3.7	-	-	-	1
Floodprone Width (ft)				6.1	6.1	6.1	6.1	-	1	3.8	4.9	-	6.0	-	-	5.0	7.5	10.0	-	>19.34	-	-	-	1
Bankfull Mean Depth (ft)	0.3	1	0.3	0.5	0.5	0.5	0.5	-	1	0.3	0.4	-	0.4	-	-	0.2	0.3	0.4	-	0.2	-	-	-	1
[1]Bankfull Max Depth (ft)				0.8	0.8	0.8	0.8	-	1	0.4	0.5	-	0.5	-	-	0.3	0.4	0.5	-	0.4	-	-	-	1
Bankfull Cross Sectional Area (ft^2)	1	6	1.1	2.3	2.3	2.3	2.3	-	1	0.9	1.1	-	1.3	-	-	0.9	1.0	1.1	-	0.9	-	-	-	1
Width/Depth Ratio				9.9	9.9	9.9	9.9	-	1	12.0	15.0	-	18.0	-	-	10.0	12.9	15.0	-	15.3	-	-	-	1
Entrenchment Ratio				1.3	1.3	1.3	1.3	-	1	1.4	1.8	-	2.2	-	-	1.4	2.1	2.8	-	>5.26	-	-	-	1
[1]Bank Height Ratio				7.6	7.6	7.6	7.6	-	1	1.0	1.0	-	1.1	-	-	1.0	1.0	1.0	-	1.0	-	-	-	1
Profile																								
Riffle Length (ft)				N/A	N/A	N/A	N/A	N/A	N/A	Total riffle length 60-70% of reach length						8.0	10.0	15.0	15	18	19	20	2	3
Riffle Slope (ft/ft)				0.035	0.039	0.039	0.042	0.005	2	0.026	0.035	-	0.043	-	-	0.019	0.024	0.030	0.050	0.055	0.055	0.060	0.0041	3
Pool Length (ft)				N/A	N/A	N/A	N/A	N/A	N/A	Total pool length 30-40% of reach length						5.0	12.0	15.0	12	15	12	20	4	3
Pool Max depth (ft)				N/A	N/A	N/A	N/A	N/A	N/A	0.7	1.0	-	1.3	-	-	0.6	0.7	0.8	0.6	0.9	1.0	1.1	0.2	3
Pool Spacing (ft)				N/A	N/A	N/A	N/A	N/A	N/A	1.4	7.5	-	13.7	-	-	2.0	10.0	18.0	27	29	27	34	3	3
Pattern																								
Channel Beltwidth (ft)				N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-	N/A	-	-	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Radius of Curvature (ft)				N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-	N/A	-	-	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Rc:Bankfull width (ft/ft)				N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-	N/A	-	-	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Meander Wavelength (ft)				N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-	N/A	-	-	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Meander Width Ratio				N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-	N/A	-	-	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Transport parameters																								
Reach Shear Stress (competency) lb/f^2				0.75												0.3			0.37					
Max part size (mm) mobilized at bankfull				N/A												N/A			75					
Stream Power (transport capacity) lb/s				11												10			15					
Additional Reach Parameters																								
Rosgen Classification				G4						B4						B4			B4					
Bankfull Velocity (fps)	3.0	2.0	1.6	1												2.3			2.6					
Bankfull Discharge (cfs)	3	12	1.8	2.3												2.3								
Valley length (ft)				181						-						215								
Channel Thalweg length (ft)				195						-						248			228					
Sinuosity (ft)				1.08						1.1 to 1.2						1.15			1.06					
Water Surface Slope (Channel) (ft/ft)				0.0239						-						0.017			0.026					
BF slope (ft/ft)				0.0239						-						0.02			0.026					
[3]Bankfull Floodplain Area (acres)				0.03						-						0.04			0.18					
[4]% of Reach with Eroding Banks				-						-														
Channel Stability or Habitat Metric				-						-														
Biological or Other				-						-														

Table 9. Monitoring Data - Cross-Section Morphology Data Table
Greenbrier Stream Mitigation Project (DMS No. 100086)

	UT1 Reach 1 (Rosgen Stream Type - B4)														UT1 Reach 3 (Rosgen Stream Type - C4)													
	Cross Section 1 (Pool)							Cross Section 2 (Riffle)							Cross Section 3 (Riffle)							Cross Section 4 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+	MY0	MY1	MY2	MY3	MY5	MY7	MY+	MY0	MY1	MY2	MY3	MY5	MY7	MY+	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-Bankfull[1] Area	1127.92	1127.87	1128.35					1120.53	1120.61	1120.65					1097.81	1097.90	1098.07					1094.95	1094.80	1095.02				
Bank Height Ratio - Based on AB Bankfull[1] Area	1.00	1.09	0.80					1.00	0.94	0.98					1.00	0.97	0.79					1.00	1.01	1.04				
Thalweg Elevation	1126.47	1126.23	1126.82					1119.35	1119.47	1119.50					1097.18	1097.28	1097.35					1092.34	1092.06	1092.65				
LTOB[2] Elevation	1127.92	1128.02	1128.04					1120.53	1120.55	1120.63					1097.81	1097.88	1097.92					1094.95	1094.84	1095.10				
LTOB[2] Max Depth (ft)	1.45	1.79	1.22					1.18	1.08	1.13					0.63	0.60	0.57					2.61	2.78	2.45				
LTOB[2] Cross Sectional Area (ft^2)	6.70	7.87	4.17					3.97	3.59	3.86					2.99	2.84	2.05					16.41	16.85	17.51				
Entrenchment Ratio	-	-	-					>10.12	>10.11	>10.17					6.39	5.80	5.75					-	-	-				

	UT1 Reach 3 (Rosgen Stream Type - C4)														UT1A (Rosgen Stream Type - B4)							UT1B (Rosgen Stream Type - B4)						
	Cross Section 5 (Riffle)							Cross Section 6 (Pool)							Cross Section 7 (Riffle)							Cross Section 8 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+	MY0	MY1	MY2	MY3	MY5	MY7	MY+	MY0	MY1	MY2	MY3	MY5	MY7	MY+	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-Bankfull[1] Area	1090.59	1090.64	1090.74					1086.63	1085.85	1085.82					1097.98	1097.96	1098.11					1089.94	1090.00	1090.17				
Bank Height Ratio - Based on AB Bankfull[1] Area	1.00	1.02	0.88					1.00	1.32	1.42					1.00	0.91	0.71					1.00	0.76	0.47				
Thalweg Elevation	1089.85	1089.83	1090.07					1083.89	1083.24	1083.35					1097.35	1097.23	1097.59					1089.59	1089.66	1089.72				
LTOB[2] Elevation	1090.59	1090.66	1090.06					1086.63	1086.70	1086.85					1097.98	1097.89	1097.96					1089.94	1089.92	1089.93				
LTOB[2] Max Depth (ft)	0.74	0.83	0.59					2.74	3.46	3.50					0.63	0.66	0.37					0.35	0.26	0.21				
LTOB[2] Cross Sectional Area (ft^2)	3.08	3.26	2.46					12.61	19.95	22.83					1.76	1.47	1.07					0.87	0.59	0.19				
Entrenchment Ratio	>9.39	>9.1	>9.84					-	-	-					4.90	4.98	3.25					>5.26	>5.39	>5.69				

The above morphology parameters reflect the 2018 guidance that arose from the mitigation technical workgroup consisting of DMS, the IRT and industry mitigation providers/practitioners. The outcome resulted in the focus on three primary morphological parameters of interest for the purposes of tracking channel change moving forward. They are the bank height ratio using a constant As-built bankfull area and the cross sectional area and max depth based on each years low top of bank. These are calculated as follows:

1 - Bank Height Ratio (BHR) takes the As-built bankful area as the basis for adjusting each subsequent years bankfull elevation. For example if the As-built bankfull area was 10 ft2, then the MY1 bankfull elevation would be adjusted until the calculated bankfull area within the MY1 cross section survey = 10 ft2. The BHR would then be calculated with the difference between the low top of bank (LTOB) elevation for MY1 and the thalweg elevation for MY1 in the numerator with the difference between the MY1 bankfull elevation and the MY1 thalweg elevation in the denominator. This same process is then carried out in each successive year.
2 - LTOB Area and Max depth - These are based on the LTOB elevation for each years survey (The same elevation used for the LTOB in the BHR calculation). Area below the LTOB elevation will be used and tracked for each year as above. The difference between the LTOB elevation and the thalweg elevation (same as in the BHR calculation) will be recroded and tracked above as LTOB max depth.

Note: The smaller the channel the closer the survey measurements are to their limit of reliable detection, therefore inter-annual variation in morphological measurement (as a percentage) is by default magnified as channel size decereases. Some of the variability above is the result of this factor and some is due to the large amount of depositional sediments observed.

Appendix D

Hydrologic Data

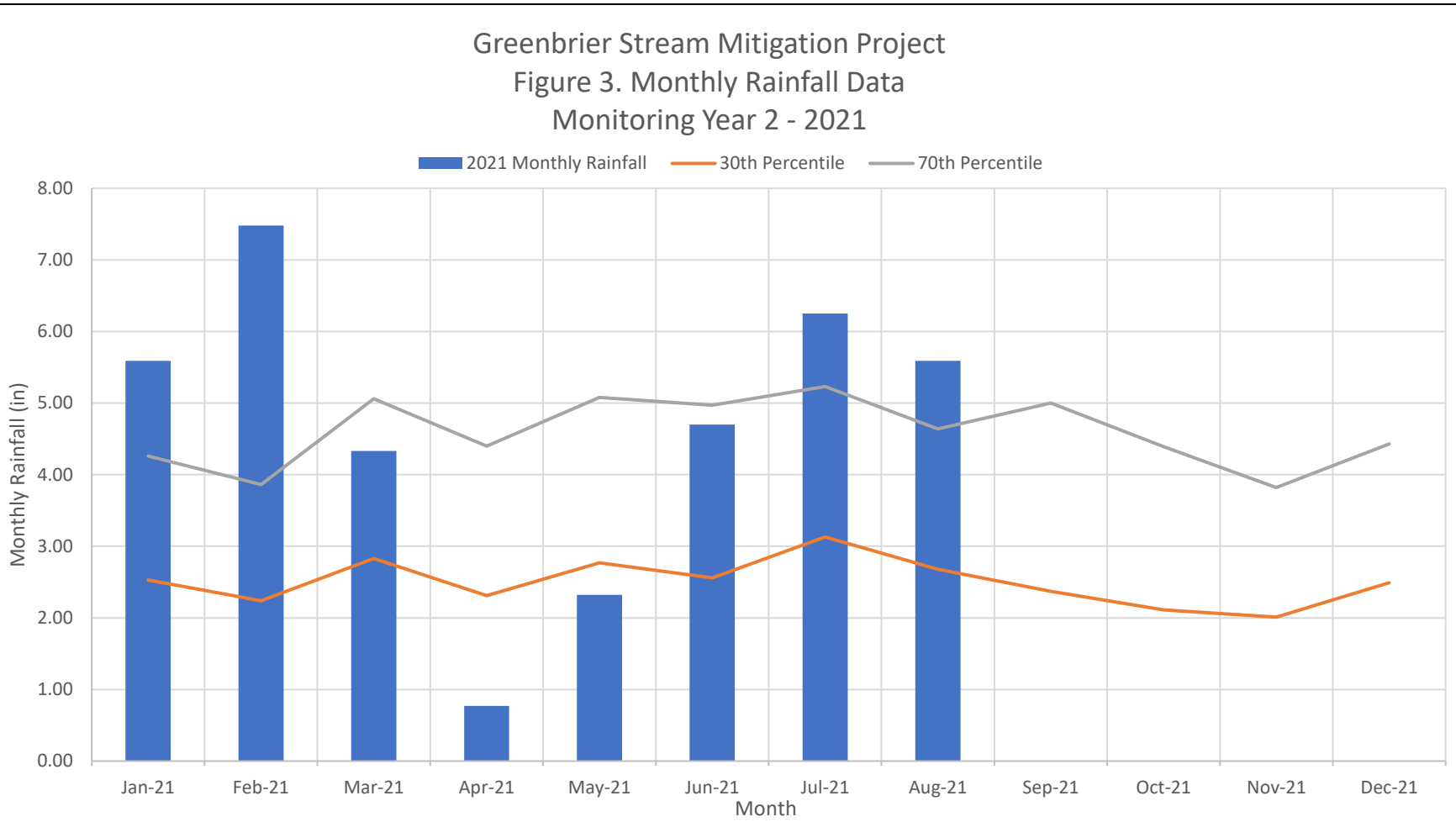
Table 10. Bankfull Event Verification

Figure 3. Monthly Rainfall Data

Precipitation and Water Level Hydrographs

Table 10. Bankfull Event Verification
Greenbrier Stream Mitigation Project (DMS No. 100086)

Overbank Events							
Gage ID	**MY1 (2020)**	**MY2 (2021)**	**MY3 (2022)**	**MY4 (2023)**	**MY5 (2025)**	**MY6 (2026)**	**MY7 (2027)**
UT1 Reach 1 - GBSG1	6 separate events: 5/27/2020 5/29/2020 8/9/2020-8/11/2020 8/21/2020 9/29/2020 10/11/2020	1 event: 9/22/2021	-	-	-	-	-
UT1A - GBSG2	4 separate events: 8/21/2020 9/29/2020 10/11/2020 10/25/2020	0 events	-	-	-	-	-
UT1B - GBSG3	10 separate events: 5/21/2020 5/24/2020 5/27/2020 5/29/2020 8/15/2020 8/17/2020 8/21/2020 9/29/2020 10/11/2020 10/25/2020	0 events	-	-	-	-	-

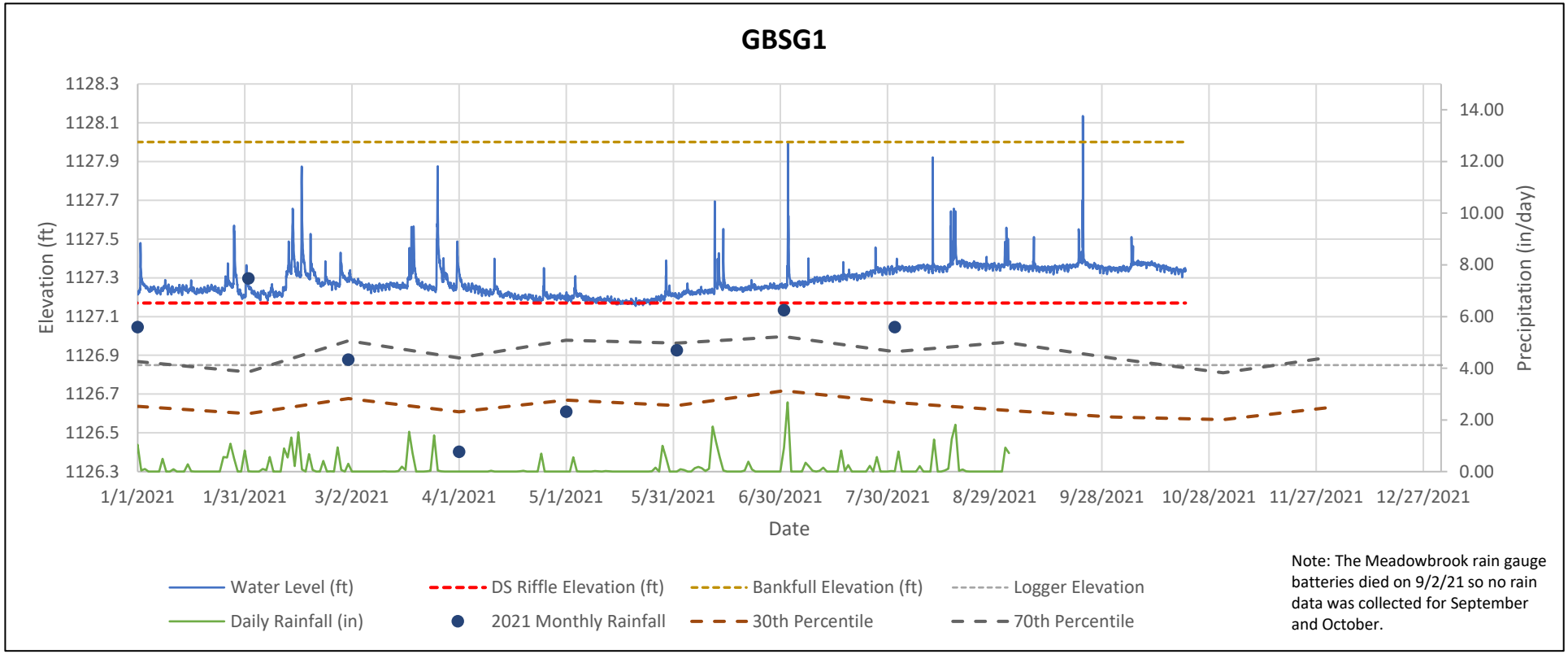


Note: Historic rainfall data from WETS Station: Yadkinville 6 E, NC, 1971-2019. Project rainfall data from HOBO Tipping Bucket Rain Gauge located at the

Rainfall Summary							
	2020	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
Annual Precip Total	87.91	37.03	-	-	-	-	-
WETS 30th Percentile	41.65	41.65	-	-	-	-	-
WETS 70th Percentile	49.68	49.68	-	-	-	-	-
Normal	Y	Y	-	-	-	-	-

*Note: The batteries in the Meadow Brook tipping bucket rain gauge died on 9/2/21 so no rain data was collected from September to October.

Greenbrier Stream Mitigation Project
Year 2 (2021) Streamflow Data



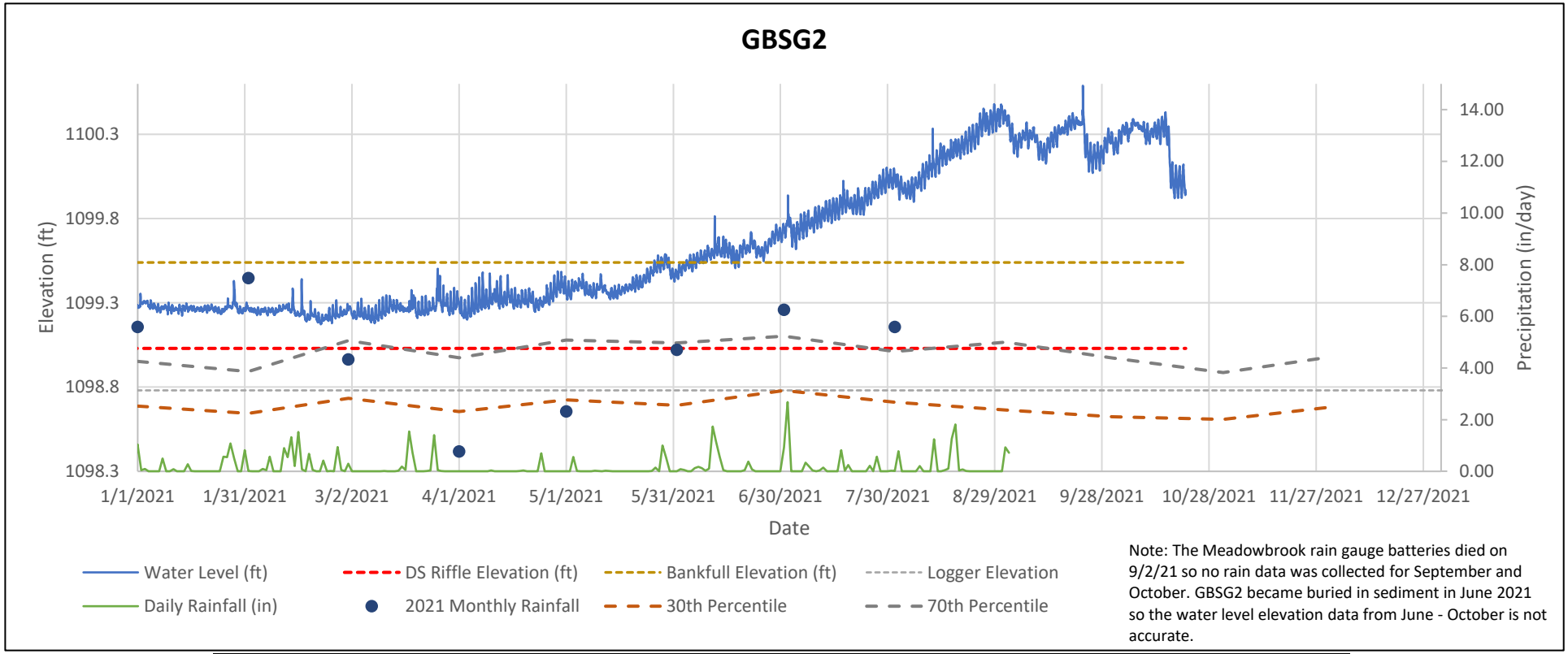
Note: The Meadowbrook rain gauge batteries died on 9/2/21 so no rain data was collected for September and October.

Site Info	
Stream	Greenbrier Stream Mitigation Project
Reach	UT1 Reach 1
Date Installed	4/29/2020
Serial Number	20727108
Reach Type	Perennial

*Rainfall data from HOBO Tipping Bucket Rain Gauge located at the Meadow Brook Stream Restoration Site, 0.75 miles SE.

Year 2 (2021) Streamflow Data	
Gauge ID	GBSG1
Start Date	1/1/2021
End Date	12/31/2021
Flow Criteria (Days)	30
Recordings Per Day	24
Logger Elevation (ft)	1126.91
Controlling Grade Elevation (ft)	1127.17
Bankfull Elevation (ft)	1128
Most Consecutive Days of Flow	294
Total Days of Flow	294
Max High Water Level Above Bankfull (ft)	0.13
Bankfull Events	1
Meets Success Criteria	Yes

Greenbrier Stream Mitigation Project
Year 2 (2021) Streamflow Data



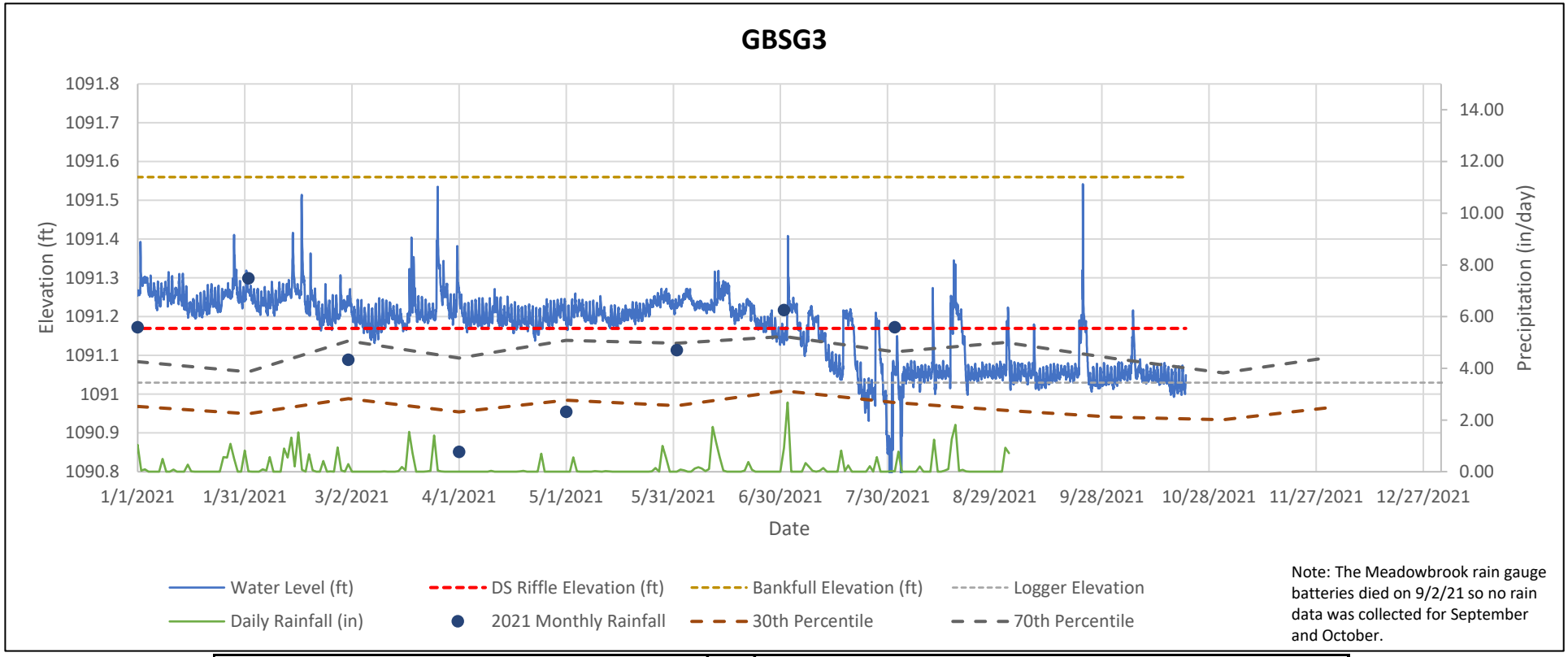
Note: The Meadowbrook rain gauge batteries died on 9/2/21 so no rain data was collected for September and October. GBSG2 became buried in sediment in June 2021 so the water level elevation data from June - October is not accurate.

Site Info	
Stream	Greenbrier Stream Mitigation Project
Reach	UT1A
Date Installed	4/29/2020
Serial Number	20727105
Reach Type	Intermittent

*Rainfall data from HOBO Tipping Bucket Rain Gauge located at the Meadow Brook Stream Restoration Site, 0.75 miles SE.

Year 2 (2021) Streamflow Data	
Gauge ID	GBSG2
Start Date	1/1/2021
End Date	12/31/2021
Flow Criteria (Days)	30
Recordings Per Day	24
Logger Elevation (ft)	1098.78
Controlling Grade Elevation (ft)	1099.03
Bankfull Elevation (ft)	1099.54
Most Consecutive Days of Flow	294
Total Days of Flow	294
Max High Water Level Above Bankfull (ft)	-
Bankfull Events	-
Meets Success Criteria	Yes

Greenbrier Stream Mitigation Project
Year 2 (2021) Streamflow Data



Note: The Meadowbrook rain gauge batteries died on 9/2/21 so no rain data was collected for September and October.

Site Info	
Stream	Greenbrier Stream Mitigation Project
Reach	UT1B
Date Installed	4/29/2020
Serial Number	20758210
Reach Type	Intermittent

*Rainfall data from HOBO Tipping Bucket Rain Gauge located at the Meadow Brook Stream Restoration Site, 0.75 miles SE.

Year 2 (2021) Streamflow Data	
Gauge ID	GBSG3
Start Date	1/1/2021
End Date	12/31/2021
Flow Criteria (Days)	30
Recordings Per Day	24
Logger Elevation (ft)	1091.03
Controlling Grade Elevation (ft)	1091.17
Bankfull Elevation (ft)	1091.56
Most Consecutive Days of Flow	186
Total Days of Flow	208
Max High Water Level Above Bankfull (ft)	-
Bankfull Events	0
Meets Success Criteria	Yes

Appendix E

Project Timeline and Contact Info

Table 11. Project Activity and Reporting History

Table 12. Project Contacts Table

Table 11. Project Activity and Reporting History
Greenbrier Stream Mitigation Project (NCDMS Project No. 100086)

Elapsed Time Since grading complete: **1 yrs 7 months**
Elapsed Time Since planting complete: **1 yrs 7 months**
Number of reporting Years[1]: **2**

Activity or Deliverable	Data Collection Complete	Completion or Delivery
Institution Date	--	Jun-18
404 permit date	--	Feb-20
Final Mitigation Plan	2018 - 2019	Dec-19
Final Design – Construction Plans	--	Feb-20
Site Earthwork	March - April 2020	Apr-20
Bare-root plantings	--	Apr-20
As-built Survey	May-20	May-20
As-built Baseline Monitoring Report	May-20	Jul-20
Year 1 Monitoring	Nov-20	Nov-20
Supplemental Bare-root plantings	--	Mar-21
Year 2 Monitoring	Oct-21	Nov-21
Year 3 Monitoring	2022	Nov-22
Year 4 Monitoring	2023	Nov-23
Year 5 Monitoring	2024	Nov-24
Year 6 Monitoring	2025	Nov-25
Year 7 Monitoring	2026	Nov-26

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

Table 12. Project Contacts Table
Greenbrier Stream Mitigation Project (NCDMS Project No. 100086)

Designer Primary project design POC	Ecosystem Planning and Restoration, PLLC 1150 SE Maynard Road, Suite 140, Cary, NC 27511 Kevin Tweedy, PE (919) 388-0787
Construction Contractor Construction contractor POC	North State Environmental 2889 Lowery St, Winston-Salem, NC 27101 Darrell Westmoreland
Survey Contractor Survey contractor POC	Kinder Land Surveying 203 W. Lebanon St., Mount Airy, NC 27030 Frank Kinder (336) 783-4200
Planting Contractor Planting contractor POC	North State Environmental 2889 Lowery St, Winston-Salem, NC 27101 Darrell Westmoreland
Seeding Contractor Contractor POC	North State Environmental 2889 Lowery St, Winston-Salem, NC 27101 Darrell Westmoreland
Seed Mix Source	Green Resource, Colfax, NC 336-855-6363
Nursery Stock Supplier	Dykes and Son Nursery, McMinnville, TN 931-668-8833
Live Stake Supplier	Foggy Mountain Nursery, Lansing, NC 336-384-5323
Monitoring Performers	Ecosystem Planning and Restoration, PLLC
Stream Monitoring POC	Jake Byers, EPR (828) 348-8580
Vegetation Monitoring POC	Amy James, EPR (919) 388-0787