FINAL
MY1 (2021) MONITORING REPORT

SHAW'S RUN MITIGATION SITE
Columbus County, North Carolina
Lumber River Basin
Cataloging Unit 03040203

DMS Project No. 100055
Full Delivery Contract No. 7515
DMS RFP No. 16-007337
USACE Action ID No. SAW-2018-01169
DWR Project No. 2018-0866

Data Collection: January – October 2021
Submission: December 2021

Prepared for:

NORTH CAROLINA DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF MITIGATION SERVICES
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Response to Monitoring Year 1 (2021) DMS Comments
Shaw's Run Mitigation Site
Lumber River Basin – CU# 03040203– Columbus County
DMS Project ID No. 100055
Contract # 7515

DMS Comments Received (Black Text) & RS Responses (Blue Text)

1. Monitoring Summary: Thank you for adding the monitoring summary with tables to the beginning of the document. Please indicate if the malfunctioning gauge has been repaired and if all gauges are now functioning. Please add the 12% hydroperiod to the table.
   Response: The malfunctioning gauge has been replaced and all monitoring gauges are now functioning properly. The 12% hydroperiod has been added to the table.

2. 1.3 Success Criteria: Coordinate data (x,y,z) are required for volunteer stems to be included in future stem count totals.
   Response: Understood.

3. 2.1 Monitoring: Please reference the visual assessment results for each section.
   Response: The visual assessment results have been referenced for each section.

4. 2.1 Monitoring Stream Summary: Provide summary information that identifies the major stream components including the constructed channel, in-stream structures, floodplain interceptors and pools and indicate the general status of their function.
   Response: We have provided summary information regarding the major stream components in section 2.1.

5. 2.1 Monitoring – Growing Season: The March 1st start date relied on bud burst only during MY1 due to the gauge malfunction and loss of data. The WETS table was used for the end date. Information from IRT indicates if temperature and vegetative indicators are used to determine the beginning of the growing season earlier in the year, you must also use the same indicators to determine the end of the growing season. The growing season is determined in the final mitigation plan and a modification to the plan would be required to change the growing season dates. A modification will require supporting pre-data including temperature, bud burst/leaf drop.
   Response: As requested, we have returned to the growing season determined from the final mitigation plan.

6. 2.1 Monitoring - Vegetation: Please include discussion of the plots where a single species exceeded 50% or where too few species were present. Are these localized or was there a trend observed onsite?
   Response: We have included a discussion of plots 2 and 3, where dominant species composition exceeded 50%, and included the text here: "In plots 2 and 3, the dominant species composition exceeded 50% for bald cypress (Taxodium distichum). Plot 2 experienced high mortality for sugarberry (Celtis laevigata) trees that were planted at as-built, which resulted in bald cypress composing 55% of woody stems in the plot. Plot 3 had a higher number of bald cypress trees planted at as-built when compared to other plots, however, the species composition is localized and there is no evidence to suggest an onsite trend. Species composition will continue to be monitored in subsequent Site visits and visual surveys will be conducted to ensure species diversity is maintained."

7. Appendix A-Visual Assessment Tables: Add the date of data collection to the tables.
   Response: The date of data collection has been added to the tables.

Digital Deliverable:

8. Please update "#of Encroachments noted" to 0 in Table 5.
   Response: # of Encroachments has been updated to 0 in Table 5.

9. Please include the vegetation performance summary table in the report.
   Response: The vegetation performance summary table has been added to the report.

Shaw's Run -- Year 1 (2021) Monitoring Summary

General Notes

- No encroachment was documented during Year 1.
- No evidence of nuisance animal activity (i.e., heavy deer browsing, beaver, etc.) observed.

Streams

- All stream restoration reaches were stable and exhibited no signs of erosion, all structures were stable (Appendix C).

Vegetation

- Measurements of all 7 permanent plots resulted in an average of 544 planted stems/acre. Additionally, all individual plots met success criteria (Appendix B).

Wetlands

- All groundwater gauges met success criteria for the year 1 (2021) monitoring period except Gauges 1 and 2 (Appendix D). Gauge 2 likely would have met success criteria, however, the gauge malfunctioned at the beginning of the growing season.

Summary of Monitoring Period/Hydrology Success Criteria by Year

Gauge	12% Hydroperiod Success Criteria Achieved/Max Consecutive Days During Growing Season (Percentage)						
	Year 1 (2021)	Year 2 (2022)	Year 3 (2023)	Year 4 (2024)	Year 5 (2025)	Year 6 (2026)	Year 7 (2027)
1*	No - 5 days (1.9%)						
2^	No - 15 days (5.8%)						
3	Yes - 44 days (17.1%)						
4	Yes - 38 days (14.8%)						
5	Yes - 34 days (13.2%)						
6	Yes - 52 days (20.2%)						
7	Yes - 36 days (14.0%)						
8	Yes - 38 days (14.8%)						
9	Yes - 37 days (14.4%)						

* Gauge 1 is not located in a credit generating area.

^ Gauge 2 likely would have met success criteria, however, logger failure occurred at the start of the growing season.

Site Maintenance Report (2021)

Invasive Species Work	Maintenance work
5/21/2021 Privet, Chinaberry, Mimosa, Cattail, Chinese Tallow, and veg within tribs	None

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APPENDICES

1.0 PROJECT SUMMARY

Restoration Systems, LLC has established the North Carolina Division of Mitigation Services (NCDMS) Shaw's Run Mitigation Site.

1.1 Project Background, Components, and Structure

The Shaw's Run Mitigation Site (hereafter referred to as the "Site") encompasses 9.44 acres of disturbed forest and agricultural fields along warm water, unnamed tributaries to Greene Branch. The Site is located approximately 2 miles west of Chadbourn, NC, south of NC Highway 76 in Columbus County.

Before construction, Site land use consisted of agricultural row crops and disturbed forest. Row crop production extended to, and abutted, ditched stream margins. Herbaceous vegetation and a few shrubby species grew within the ditches, which were regularly maintained by bush hogging and herbicide application. As the ditch descended the valley towards Greene Branch, soils changed from the Goldsboro and Lynchburg soil series (moderately well and somewhat poorly drained) to the Muckalee soil series (poorly drained), and disturbed forest vegetation became more prevalent along stream margins and floodplains. Stream channels were cleared, dredged and straightened, plowed annually for row crops, eroded vertically and laterally, and received extensive sediment and nutrient inputs from agriculture chemicals and sediment. The entire stream channel was ditched and cleared of vegetation which contributed to sediment export from the Site. In addition, stream-side wetlands were cleared and drained by channel downcutting, drain tile installation, and adjacent land uses. Preconstruction Site conditions resulted in degraded water quality, a loss of aquatic habitat, reduced nutrient and sediment retention, and unstable channel characteristics (loss of horizontal flow vectors that maintain pools and an increase in erosive forces to channel bed and banks). Site restoration activities restored riffle-pool morphology, aided in energy dissipation, increased aquatic habitat, stabilized channel banks, and greatly reduced sediment loss from channel banks.

Proposed Site restoration activities generated 2285.000 Stream Mitigation Units (SMUs) and 5.862 Riparian Wetland Mitigation Units (WMUs) as described in Table 1.

Additional activities that occurred at the Site included the following.

- Planting 7.7 acres of the Site with 8300 stems (planted species are included in Table 6, Appendix B).

Deviations from the construction plans included the following.

- The easement was updated from the construction plans. Construction plans had an older easement that was not the proper (recorded) easement boundary.
- Woody material was placed in the channel riffles.
- Several log cross vanes were not installed due to Site conditions, including low slope causing the vanes to not be necessary. Log vanes removed from the project include stations 0+30, 7+20, 7+85, and 9+10 along UT1, and stations 0+30, 0+80, 1+10, 1+75, 2+05, 2+40, and 4+05 along UT2.

Table 1. Shaw's Run (ID-100055) Project Mitigation Quantities and Credits

Project Segment	Original Mitigation Plan Ft/Ac	As-Built Ft/Ac	Original Mitigation Category	Original Restoration Level	Original Mitigation Ratio (X:1)	Credits		Comments
Stream								
UT1	1919	1912	Warm	R	1.00000	1,919.000		
UT2	366	366	Warm	R	1.00000	366.000		
					Total:	**2,285.000**		
Wetland								
Wetland R	5.852	5.852	R	REE	1.00000	5.852		
Wetland E	0.103	0.103	R	P	10.00000	0.010		
					Total:	**5.862**		

Project Credits

	Stream			Riparian	Non-Rip	Coastal
Restoration Level	Warm	Cool	Cold	Wetland	Wetland	Marsh
Restoration	2,285.000	0.000	0.000	0.000	0.000	0.000
Re-establishment				5.852	0.000	0.000
Rehabilitation				0.000	0.000	0.000
Enhancement				0.000	0.000	0.000
Enhancement I	0.000	0.000	0.000			
Enhancement II	0.000	0.000	0.000			
Creation				0.000	0.000	0.000
Preservation	0.000	0.000	0.000	0.010	0.000	
Totals	**2,285.000**	**0.000**	**0.000**	**5.862**	**0.000**	**0.000**

Total Stream Credit **2,285.000**
Total Wetland Credit **5.862**

Site design was completed in March 2019. Construction started on March 13, 2020, and ended within a final walkthrough on June 25, 2020. The Site was planted on December 20, 2020. Completed project activities, reporting history, completion dates, project contacts are summarized in Tables 15-16 (Appendix E).

1.2 Project Goals and Objectives

Project goals were based on the *Lumber River Basin Restoration Priorities* (RBRP) report (NCEEP 2008) and on-site preconstruction data collection of channel morphology and function observed during field investigations. The Site is located within **Targeted Local Watershed (TLW) 03040203191010** and subbasin 03-07-51. The project is not located within a Local Watershed Planning area. Project goals identified in the RBRP include the following.

1. Improve water quality through increased riparian buffer area (Project will restore approximately 7.7 acres of riparian buffer).
2. Reduce impacts from agricultural practices (Project will remove agricultural row crops from the Site).
3. Reduce impacts from impervious surfaces (Project will incorporate one marsh treatment area to treat ditches that receive roadside runoff).
4. Protection of existing resources (Project will be protected with a permanent conservation easement).

In addition to the defined Cataloging Unit (CU) goals for the Lumber River, additional goals for the area generally revolve around reducing stressors to water quality. Stressors and how each will be addressed by project activities are as follows.

1. Sedimentation - (reduction of 15.8 tons/year after mitigation is complete).
2. Nutrients – (direct reduction of 89 pounds of nitrogen and 156 pounds of phosphorus per year by removing agricultural row crops; eliminate fertilizer application; and installing a marsh treatment area).
3. Land Use Impacts (imperviousness) – (incorporation of one marsh treatment area to treat ditches that receive roadside runoff).
4. Stormwater – (reduction of bank height ratio, restoration of wetlands, reforestation, and installation of a marsh treatment area will reduce stormwater pulses).
5. Lack of Riparian Buffer – (restoration of 7.7 acres of riparian buffer).

Site-specific mitigation goals and objectives were developed through the use of North Carolina Stream Assessment Method (NC SAM) and North Carolina Wetland Assessment Method (NC WAM) analyses of preconstruction and reference stream systems at the Site (NC SFAT 2015 and NC WFAT 2010) (see Table 2 below).

Table 2. Summary: Goals, Performance, and Results

Targeted Functions	Goals	Objectives	Success Criteria
(1) HYDROLOGY			
(2) Flood Flow (Floodplain Access) (3) Streamside Area Attenuation (4) Floodplain Access (4) Wooded Riparian Buffer (4) Microtopography Wetland – Surface and Sub-Surface Storage and Retention	• Attenuate flood flow across the Site. • Minimize downstream flooding to the maximum extent possible. • Connect streams to functioning and degraded wetland systems.	• Construct new channel at historic floodplain elevation to restore overbank flows and restore jurisdictional wetlands • Plant woody riparian buffer • Cease row crop production within the easement • Deep rip floodplain soils to reduce compaction and increase soil surface roughness • Protect riparian buffers with a perpetual conservation easement	• BHR not to exceed 1.2 • Document four overbank events in separate monitoring years • Remove agricultural row crops from the easement • Monitoring wells will be successful if the water table is within 12 inches of the soil surface for 12% of the growing season • Vegetation plots will be successful if the plant density is 210 stems per acre with an average plant height of 10 feet at 7 years following planting • Conservation Easement recorded
(3) Stream Stability (4) Stream Geomorphology	• Increase stream stability within the Site so that channels are neither aggrading nor degrading.	• Construct channels with proper pattern, dimension, and longitudinal profile • Cease row crop production within the easement • Construct stable channels with grade control structures. • Plant woody riparian buffer	• Cross-section measurements indicate a stable channel • Visual documentation of stable channels and structures • BHR not to exceed 1.2 • ER of 2.2 or greater • < 10% change in BHR and ER in any given year • Remove agricultural row crops from the easement • Vegetation plots will be successful if the plant density is 210 stems per acre with an average plant height of 10 feet at 7 years following planting
(1) WATER QUALITY			

(2) Streamside Area Vegetation
(3) Upland Pollutant Filtration
(3) Thermoregulation
(2) Aquatic Life Tolerance
Wetland - Pathogen, Particulate, Soluble, and Physical Change
	• Remove direct nutrient and pollutant inputs from the Site and reduce contributions to downstream waters.	• Reduce agricultural land/inputs
		• Install marsh treatment areas
		• Plant woody riparian buffer
		• Restore jurisdictional wetlands adjacent to Site streams
		  ○ Remove drain tile
		  ○ Promote overbank flooding by P1 stream restoration.
			• Remove agricultural row crops from the easement
			• Monitoring wells will be successful if the water table is within 12 inches of the soil surface for 12% of the growing season
			• Vegetation plots will be successful if the plant density is 210 stems per acre with an average plant height of 10 feet at 7 years following planting

(1) HABITAT			
(2) In-stream Habitat (3) Substrate (2) Stream-side Habitat (3) Stream-side Habitat (3) Thermoregulation Wetland - Physical Structure, Landscape Patch Structure, and Vegetation Composition	• Improve instream and stream-side habitat.	• Construct stable channels • Plant woody riparian buffer to provide organic matter and shade • Construct new channel at historic floodplain elevation to restore overbank flows and plant woody riparian buffer • Protect riparian buffers with a perpetual conservation easement • Restore jurisdictional wetlands adjacent to Site streams	• Cross-section measurements indicate a stable channel • Visual documentation of stable channels and in-stream structures. • Monitoring wells will be successful if the water table is within 12 inches of the soil surface for 12% of the growing season • Vegetation plots will be successful if the plant density is 210 stems per acre with an average plant height of 10 feet at 7 years following planting • Conservation Easement recorded

1.3 Success Criteria

Project success criteria have been established per the October 24, 2016, NC Interagency Review Team *Wilmington District Stream and Wetland Compensatory Mitigation Update*. Monitoring and success criteria relate to project goals and objectives. From a mitigation perspective, several of the goals and objectives are assumed to be functionally elevated by restoration activities without direct measurement. Other goals and objectives will be considered successful upon achieving success criteria. The following table summarizes Site success criteria.

Success Criteria

Streams
• All streams must maintain an Ordinary High-Water Mark (OHWM), per RGL 05-05. • Continuous surface flow must be documented each year for at least 30 consecutive days. • Bank height ratio (BHR) cannot exceed 1.2 at any measured cross-section. • Entrenchment ratio (ER) must be no less than 2.2 at any measured riffle cross-section. • BHR and ER at any measure riffle cross-section should not change by more than 10% from baseline condition during any given monitoring period. • The stream project shall remain stable, and all other performance standards shall be met through four separate bankfull events, occurring in separate years, during the monitoring years 1-7.
Wetland Hydrology
• Saturation or inundation within the upper 12 inches of the soil surface for, at a minimum, 12 percent of the growing season, during average climatic conditions
Vegetation
• Within planted portions of the site, a minimum of 320 stems per acre must be present at year 3; a minimum of 260 stems per acre must be present at year 5; and a minimum of 210 stems per acre must be present at year 7. • Trees must average 7 feet in height at year 5, and 10 feet in height at year 7 in each plot. • Planted and volunteer stems are counted, provided they are included in the approved planting list for the site; natural recruits not on the planting list may be considered by the IRT on a case-by-case basis.
Visual Assessment
• Photographs at vegetation plots and cross-sections should illustrate the Site's vegetative and morphological stability on an annual basis, including no excessive erosion or degradation on the channel banks, no mid-channel bars, or vertical incision. In addition, grade control structures should remain stable.

Note: BHR will be calculated using procedures outlined in the latest approved guidance from NCDMS.

2.0 METHODS

Monitoring will be conducted by Axiom Environmental, Inc. Annual monitoring reports of the data collected will be submitted to the NCDMS by Restoration Systems no later than December 1 of each monitoring year data is collected. The monitoring schedule is summarized in the following table.

Monitoring Schedule

Resource	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Streams	X	X	X		X		X
Wetlands	X	X	X	X	X	X	X
Vegetation	X	X	X		X		X
Macroinvertebrates			X		X		X
Visual Assessment	X	X	X	X	X	X	X
Report Submittal	X	X	X	X	X	X	X

*Visual Assessment will be complemented by permanent photographic points located at each permanent cross-section and vegetation plot.

2.1 Monitoring

The monitoring parameters are summarized in the following table.

Monitoring Summary

Stream Parameters				
Parameter	**Method**	**Schedule/Frequency**	**Number/Extent**	**Data Collected/Reported**
Stream Profile	Full longitudinal survey	As-built (unless otherwise required)	All restored stream channels	Graphic and tabular data.
Stream Dimension	Cross-sections	Years 1, 2, 3, 5, and 7	Total of 10 cross-sections on restored channels	Graphic and tabular data.
Channel Stability	Visual Assessments	Yearly	All restored stream channels	Areas of concern will be depicted on a plan view figure with a written assessment and photograph of the area included in the report.
	Additional Cross-sections	Yearly	Only if instability is documented during monitoring	Graphic and tabular data.
Stream Hydrology	Continuous monitoring surface water gauges and/or trail camera	Continuous recording through monitoring period	Surface water gauges on UT 1 and UT2	Surface water data for each monitoring period
Bankfull Events	Continuous monitoring surface water gauges and/or trail camera	Continuous recording through monitoring period	Surface water gauges on UT 1 and UT2	Surface water data for each monitoring period
	Visual/Physical Evidence	Continuous through monitoring period	All restored stream channels	Visual evidence, photo documentation, and/or rain data.
Benthic Macroinvertebrates	"Qual 4" method described in *Standard Operating Procedures for Collection and Analysis of Benthic Macroinvertebrates, Version 5.0* (NCDWR 2016)	Preconstruction, Years 3, 5, and 7 during the "index period" referenced in *Small Streams Biocriteria Development* (NCDWQ 2009)	2 stations (one at the lower end of UT 1 and one at the lower end of UT 2); however, the exact locations will be determined at the time preconstruction benthics are collected	Results* will be presented on a site-by-site basis and will include a list of taxa collected, an enumeration of *Ephemeroptera, Plecoptera,* and *Tricopetera* taxa as well as Biotic Index values.
Wetland Parameters				
Parameter	**Method**	**Schedule/Frequency**	**Number/Extent**	**Data Collected/Reported**
Wetland Reestablishment	Groundwater gauges	Years 1, 2, 3, 4, 5, 6, and 7 throughout the year with the growing season defined as March 1-November 12	9 gauges spread throughout restored wetlands	Soil temperature at the beginning of each monitoring period to verify the start of the growing season (no earlier than March 1), groundwater and rain data for each monitoring period
Vegetation Parameters				
Parameter	**Method**	**Schedule/Frequency**	**Number/Extent**	**Data Collected/Reported**
Vegetation establishment and vigor	Permanent vegetation plots 0.0247 acre (100 square meters) in size; *CVS-EEP Protocol for Recording Vegetation*, *Version 4.2* (Lee et al. 2008)	As-built, Years 1, 2, 3, 5, and 7	7 plots spread across the Site	Species, height, planted vs. volunteer, stems/acre

*Benthic Macroinvertebrate sampling data will not be tied to success criteria; however, the data may be used as a tool to observe positive gains to in-stream habitat

Stream Summary

All streams are functioning as designed, and no stream areas of concern were observed during year 1 (2021) monitoring. The constructed channel exhibits characteristics of a stable coastal plain stream with minimal changes in cross-sections when compared to the as-built stream measurement data. All in-stream structures are all functioning as designed. Grade control and bank protection structures are intact and performing as intended by controlling stream flow while preventing erosion. No floodplain interceptors installed during construction. The marsh treatment area at the top of UT-1 has been successful in intercepting surface waters draining through agricultural areas prior to discharge into UT-1. Stream morphology data is available in Appendix C. Visual assessment data is available in Appendix A, Tables 4A-B.

Wetland Summary

Summary of Monitoring Period/Hydrology Success Criteria by Year

Year	Soil Temperatures/Date Bud Burst Documented	Monitoring Period Used for Determining Success	12 Percent of Monitoring Period
2021 (Year 1)	March 1, 2021*	March 1-November 12 (257 days)	31 days

*Based on observed/documented bud burst on the Site on March 1, 2021, and soil temperature of 49.99°F documented March 8, 2021. When checked on March 1, the soil logger was damaged and wasn't replaced until March 8.

All groundwater gauges met success criteria for the year 1 (2021) monitoring period except Gauges 1 and 2 (Appendix D). Gauge 2 likely would have met success criteria; however, the logger malfunctioned at the start of the growing season. Gauge 1 is not located in a credit generating area.

Vegetation Summary

Year 1 (2021) vegetation measurements occurred on August 6, 2021. During quantitative vegetation sampling, 7 sample plots (10-meter by 10-meter) were installed within the Site as per guidelines established in CVS-EEP Protocol for Recording Vegetation, Version 4.2 (Lee et al. 2008). Measurements of all 7 plots resulted in an average of 544 planted stems/acre, excluding livestakes. All individual plots met success criteria (Tables 7-8, Appendix B). In plots 2 and 3, the dominant species composition exceeded 50% for bald cypress (*Taxodium distichum*). Plot 2 experienced high mortality for sugarberry (*Celtis laevigata*) trees that were planted at as-built, which resulted in bald cypress composing 55% of woody stems in the plot. Plot 3 had a higher number of bald cypress trees planted at as-built when compared to other plots, however, the species composition is localized and there is no evidence to suggest an onsite trend. Species composition will continue to be monitored in subsequent Site visits and visual surveys will be conducted to ensure species diversity is maintained. Visual assessment data is available in Appendix A, Table 5.

Table 3. Project Attribute Table			
Project Name	Shaw's Run		
County	Columbus County, North Carolina		
Project Area (acres)	9.44		
Project Coordinates (latitude and longitude decimal degrees)	34.3193ºN, 78.8666 ºW		
Project Watershed Summary Information			
Physiographic Province	Coastal Plain		
River Basin	Lumber		
USGS Hydrologic Unit 8-digit	3040203191010		
DWR Sub-basin	03-07-51		
Project Drainage Area (acres)	106		
Project Drainage Area Percentage of Impervious Area	<2%		
Land Use Classification	Cultivated & Other Broadleaf Deciduous Forest		
Reach Summary Information			
Parameters	**UT 1**	**UT 2**	**Reach 3**
Pre-project length (feet)	1474	283	
Post-project (feet)	1912	366	
Valley confinement (Confined, moderately confined, unconfined)	Alluvial, moderately confined to unconfined		
Drainage area (acres)	106.5	24.6	
Perennial, Intermittent, Ephemeral	Perennial/Intermitternt	Intermittent	
NCDWR Water Quality Classification	C, Sw		
Dominant Stream Classification (existing)	G5/6	F5/6	
Dominant Stream Classification (proposed)	E/C5	E/C5	
Dominant Evolutionary class (Simon) if applicable	III/IV	III/IV	
Wetland Summary Information			
Parameters	**Wetland R**	**Wetland E**	**Wetland 3**
Pre-project (acres)	0	0.103	
Post-project (acres)	5.852	0.103	
Wetland Type (non-riparian, riparian)	Riparian riverine		
Mapped Soil Series	Muckalee		
Soil Hydric Status	Hydric		
Regulatory Considerations			
Parameters	**Applicable?**	**Resolved?**	**Supporting Docs?**
Water of the United States - Section 404	Yes	Yes	JD Package (App D)
Water of the United States - Section 401	Yes	Yes	JD Package (App D)
Endangered Species Act	Yes	Yes	CE Document (App E)
Historic Preservation Act	Yes	Yes	CE Document (App E)
Coastal Zone Management Act (CZMA or CAMA)	No	--	NA
Essential Fisheries Habitat	No	--	NA

3.0 REFERENCES

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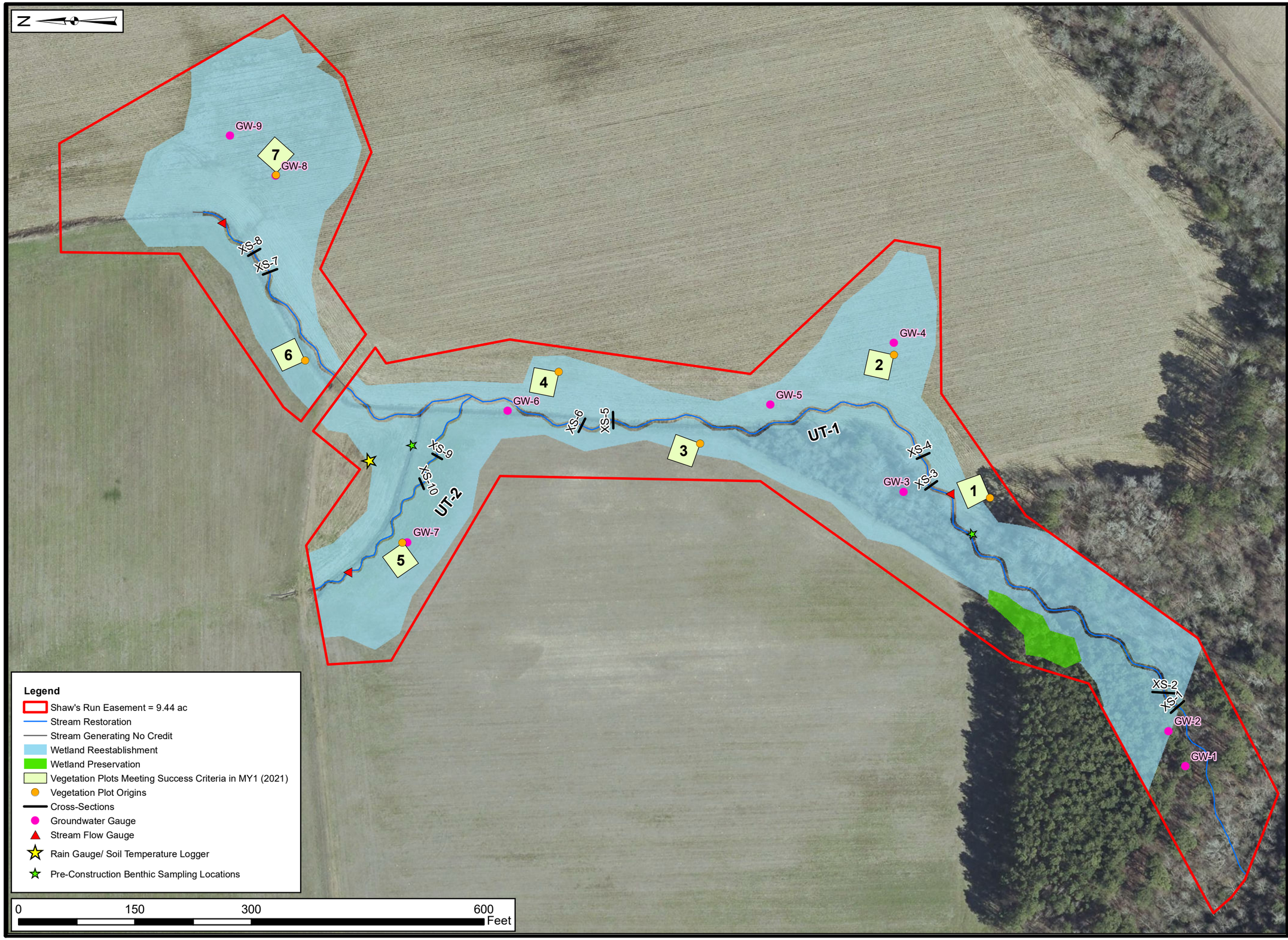
Appendix A
Visual Assessment Data

Figure 1. Current Conditions Plan View
Tables 4A-B. Stream Visual Stability Assessment
Table 5. Visual Vegetation Assessment
Vegetation Plot Photographs



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Prepared for:

RESTORATION SYSTEMS | LLC

Project:

SHAW'S RUN STREAM AND WETLAND MITIGATION SITE

Columbus County, NC

Title:

Current Conditions Plan View

Drawn by: KRJ

Date: Mar 2021

Scale: 1:1400

Project No.: 18-014

FIGURE

1

Table 4A. Visual Stream Stability Assessment

Reach UT 1
Assessed Stream Length 1912
Assessed Bank Length 3824

Survey Date: September 24, 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.	36	36		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)	36	36		100%

Table 4B. Visual Stream Stability Assessment

Reach UT 2
Assessed Stream Length 366
Assessed Bank Length 732

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.	9	9		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)	9	9		100%

Table 5. Visual Vegetation Assessment

Planted acreage **7.7** **Survey Date: September 24, 2021**

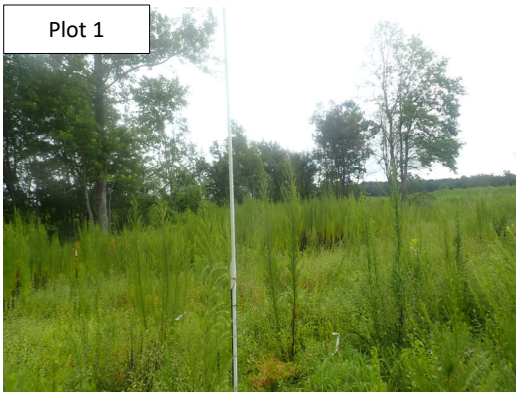
Vegetation Category	Definitions	Mapping Threshold	Combined Acreage	% of Planted Acreage
Bare Areas	Very limited cover of both woody and herbaceous material.	0.10 acres	0.00	0.0%
Low Stem Density Areas	Woody stem densities clearly below target levels based on current MY stem count criteria.	0.10acres	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.	0.10 acres	0.00	0.0%
		Cumulative Total	0.00	0.0%

Easement Acreage **9.44**

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.	0.10 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	0 Encroachments noted	

Shaw's Run Mitigation Site
MY1 (2021) Vegetation Monitoring Photographs (taken August 2021)

Plot 1



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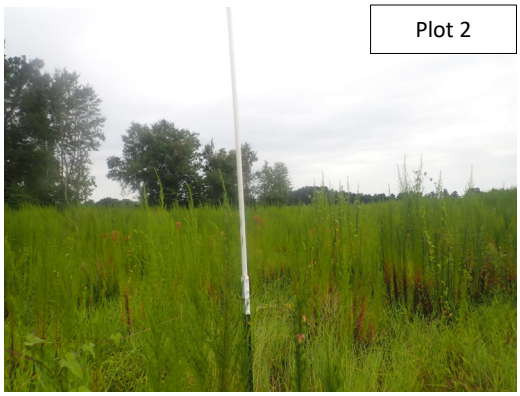

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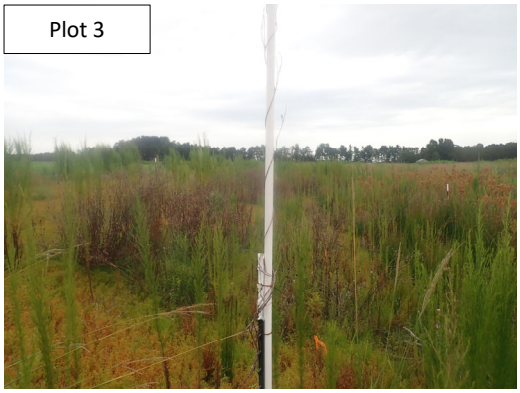

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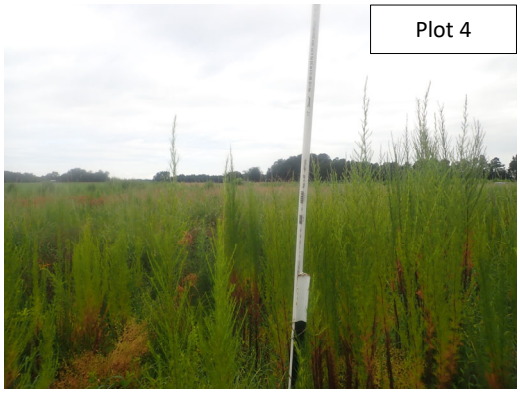
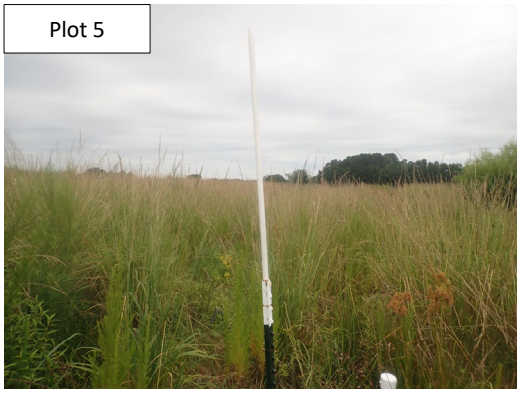


Plot 5



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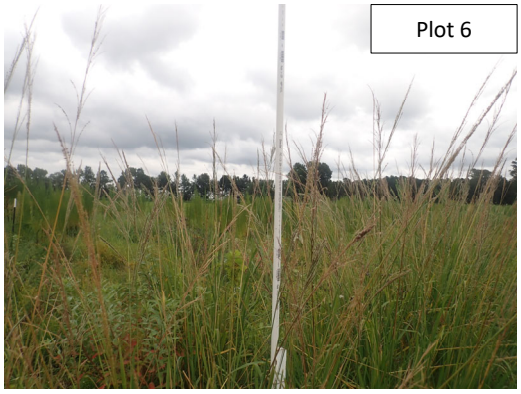
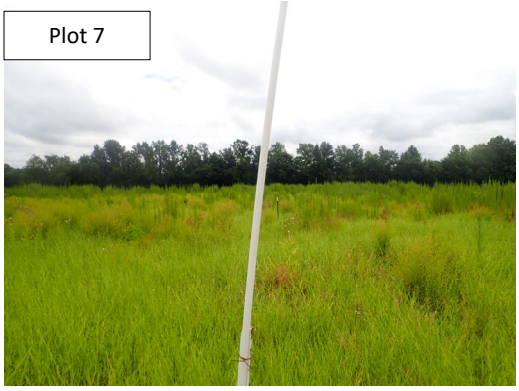


Plot 7



Appendix B
Vegetation Data

Table 6. Planted Bare-Root Woody Vegetation
Table 7. Vegetation Plot Counts and Densities
Table 8. Vegetation Plot Data Table from Vegetation Data Entry Tool
Table 9. Vegetation Performance Standards Summary Table

Table 6. Planted Bare Root Woody Vegetation
Shaw's Run Mitigation Site

Species	Total*
Acres	**7.7**
Betula nigra	800
Celtis laevigata	100
Cephalanthus occidentalis	800
Cornus amomum	700
Diospyros virginiana	300
Fraxinus pennsylvanica	300
Liriodendron tulipifera	500
Nyssa sylvatica	1000
Platanus occidentalis	1000
Quercus laurifolia	400
Quercus lyrata	400
Quercus nigra	300
Quercus pagoda	400
Quercus phellos	300
Taxodium distichum	1000
TOTALS	8300
Average Stems/Acre	**1078**

Table 7. Planted Vegetation Totals
Shaw's Run Mitigation Site

Plot #	Planted Stems/Acre	Success Criteria Met?
1	607	Yes
2	445	Yes
3	648	Yes
4	486	Yes
5	526	Yes
6	648	Yes
7	445	Yes
Average Planted Stems/Acre	**544**	**Yes**

Table 8. Vegetation Plot Data Table from Vegetation Data Entry Tool

Planted Acreage	7.7
Date of Initial Plant	2020-12-20
Date(s) of Supplemental Plant(s)	#N/A
Date(s) Mowing	#N/A
Date of Current Survey	8/6/2021
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 F		Veg Plot 6 F		Veg Plot 7 F	
					Planted	Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total
Species Included in Approved Mitigation Plan	Betula nigra	river birch	Tree	FACW							1	1					4	4
	Celtis laevigata	sugarberry	Tree	FACW							2	2	1	1			1	1
	Celtis occidentalis	common hackberry	Tree	FACU											1	1		
	Cephalanthus occidentalis	common buttonbush	Shrub	OBL	1	1												
	Cornus amomum	silky dogwood	Shrub	FACW	1	1									2	2		
	Diospyros virginiana	common persimmon	Tree	FAC							1	1						
	Fraxinus pennsylvanica	green ash	Tree	FACW			2	2										
	Liriodendron tulipifera	tuliptree	Tree	FACU	2	2									2	2		
	Nyssa sylvatica	blackgum	Tree	FAC	3	3							2	2			2	2
	Platanus occidentalis	American sycamore	Tree	FACW	2	2					1	1	1	1	7	7		
	Quercus lyrata	overcup oak	Tree	OBL			1	1					1	1				
	Quercus nigra	water oak	Tree	FAC			1	1	4	4			2	2			1	1
	Quercus pagoda	cherrybark oak	Tree	FACW							1	1	1	1				
	Quercus phellos	willow oak	Tree	FACW	3	3			2	2	1	1						
	Quercus sp.				3	3	1	1			5	5	2	2	1	1	3	3
	Taxodium distichum	bald cypress	Tree	OBL			6	6	10	10			3	3	3	3		
Sum	Performance Standard				15	15	11	11	16	16	12	12	13	13	16	16	11	11
Mitigation Plan Performance Standard	Current Year Stem Count					15		11		16		12		13		16		11
	Stems/Acre					607		445		648		486		526		648		445
	Species Count					7		5		3		7		8		6		5
	Dominant Species Composition (%)					20		55		62		42		23		44		36
	Average Plot Height					2		2		2		2		2		2		2
	% Invasives					0		0		0		0		0		0		0
Post Mitigation Plan Performance Standard	Current Year Stem Count					15		11		16		12		13		16		11
	Stems/Acre					607		445		648		486		526		648		445
	Species Count					7		5		3		7		8		6		5
	Dominant Species Composition (%)					20		55		62		42		23		44		36
	Average Plot Height					2		2		2		2		2		2		2
	% Invasives					0		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 9. 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												
Monitoring Year 1	607	2	7	0	445	2	5	0	648	2	3	0
Monitoring Year 0	688	2	7	0	607	2	6	0	648	1	3	0
	Veg Plot 4 F				Veg Plot 5 F				Veg Plot 6 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												
Monitoring Year 1	486	2	7	0	526	2	8	0	648	2	6	0
Monitoring Year 0	567	2	8	0	607	2	8	0	769	1	7	0
	Veg Plot 7 F											
	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives								
Monitoring Year 7												
Monitoring Year 5												
Monitoring Year 3												
Monitoring Year 2												
Monitoring Year 1	445	2	5	0								
Monitoring Year 0	567	1	6	0								

*Each monitoring year represents a different plot for the random vegetation plot "groups". Random plots are denoted with an R, and fixed plots with an F.

Appendix C
Stream Geomorphology Data

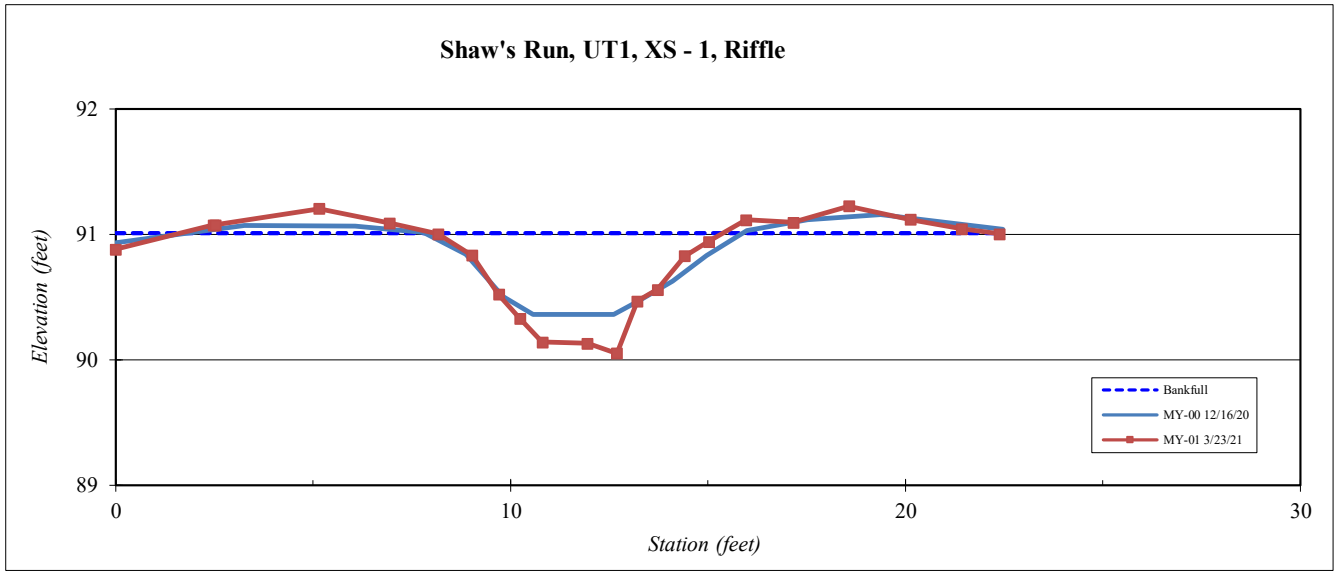
Cross-Sections with Annual Overlays
Table 10A-B. Baseline Stream Data Summary Tables
Table 11. Cross-Section Morphology Monitoring Summary

Site	Shaw's Run
Watershed:	Lumber River Basin, 03040203
XS ID	UT1, XS -1, Riffle
Feature	Riffle
Date:	3/23/2021
Field Crew:	Harris, Perkinson

Station	Elevation
0.0	90.7
2.5	91.0
2.5	91.0
5.1	91.1
6.9	91.0
8.2	90.9
9.0	90.7
9.7	90.3
10.2	90.1
10.8	89.9
11.9	89.9
12.7	89.8
13.2	90.3
13.7	90.4
14.4	90.7
15.0	90.8
16.0	91.0
17.2	91.0
18.6	91.1
20.1	91.0
21.4	90.92
22.4	90.9

SUMMARY DATA	
Bankfull Elevation:	90.8
Bank Hieght Ratio:	1.0
Thalweg Elevation:	89.8
LTOB Elevation:	90.8
LTOB Max Depth:	1.0
LTOB Cross Sectional Area:	3.7

Stream Type	E/C 5

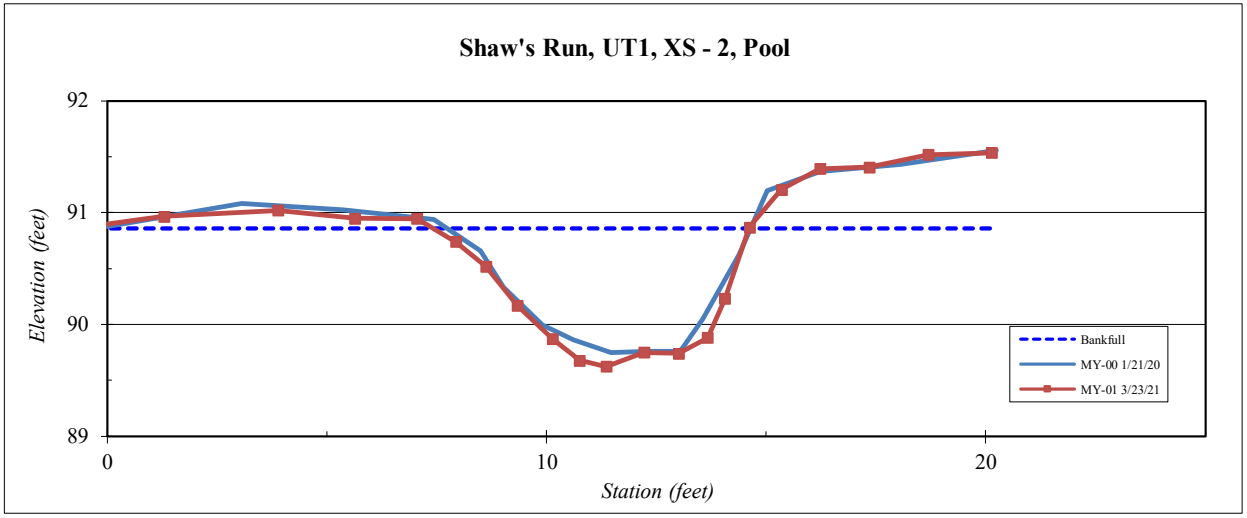


Site	Shaw's Run
Watershed:	Lumber River Basin, 03040203
XS ID	UT1, XS - 2, Pool
Feature	Pool
Date:	3/23/2021
Field Crew:	Harris, Perkinson

Station	Elevation
-0.3	90.9
1.3	91.0
3.9	91.0
5.6	90.9
7.1	90.9
7.9	90.7
8.6	90.5
9.3	90.2
10.1	89.9
10.8	89.7
11.4	89.6
12.2	89.7
13.0	89.7
13.7	89.9
14.1	90.2
14.6	90.9
15.3	91.2
16.2	91.4
17.4	91.4
18.7	91.5
20.1	91.5

SUMMARY DATA	
Bankfull Elevation:	90.9
Bank Hieght Ratio:	1.0
Thalweg Elevation:	89.6
LTOB Elevation:	90.9
LTOB Max Depth:	1.2
LTOB Cross Sectional Area:	5.7

Stream Type	E/C 5

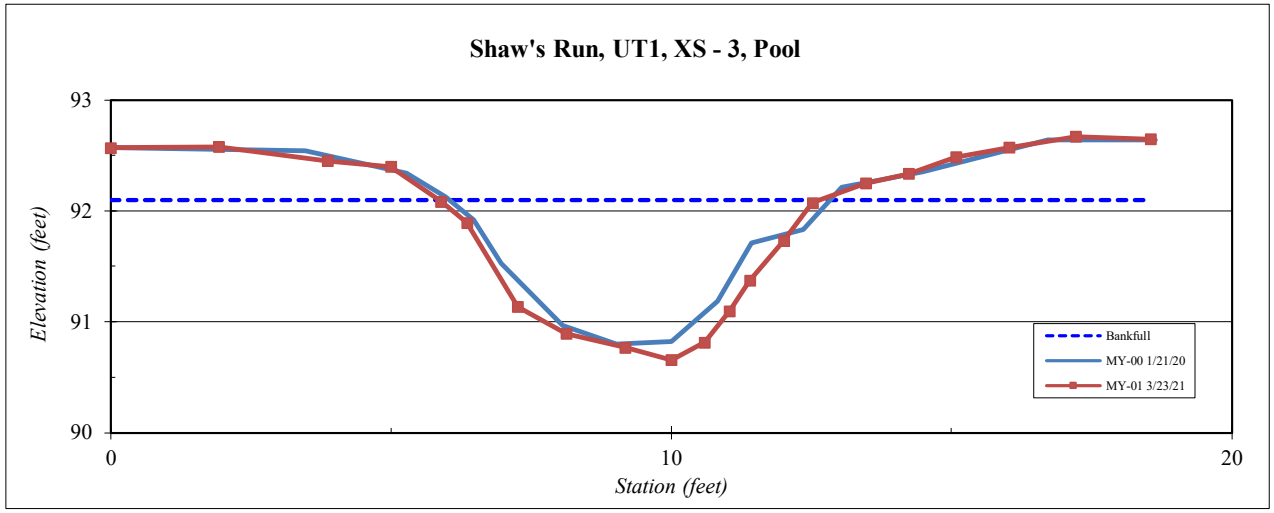


Site	Shaw's Run
Watershed:	Lumber River Basin, 03040203
XS ID	UT1, XS - 3, Pool
Feature	Pool
Date:	3/23/2021
Field Crew:	Harris, Perkinson

Station	Elevation
0.0	92.6
1.9	92.6
3.9	92.5
5.0	92.4
5.9	92.1
6.4	91.9
7.3	91.1
8.1	90.9
9.2	90.8
10.0	90.7
10.6	90.8
11.0	91.1
11.4	91.4
12.0	91.7
12.5	92.1
13.5	92.2
14.2	92.3
15.1	92.5
16.0	92.6
17.2	92.7
18.6	92.6

SUMMARY DATA	
Bankfull Elevation:	92.1
Bank Hieght Ratio:	1.0
Thalweg Elevation:	90.7
LTOB Elevation:	92.1
LTOB Max Depth:	1.4
LTOB Cross Sectional Area:	6.1

Stream Type	E/C 5

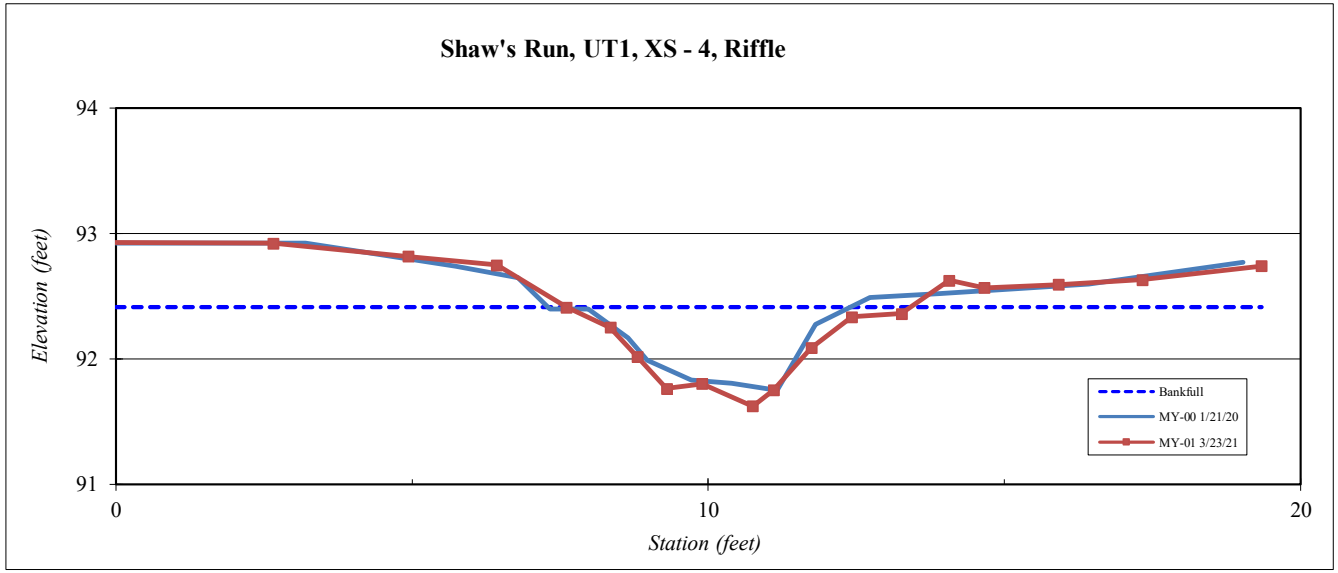


Site	Shaw's Run
Watershed:	Lumber River Basin, 03040203
XS ID	UT1, XS - 4, Riffle
Feature	Riffle
Date:	3/23/2021
Field Crew:	Harris, Perkinson

Station	Elevation
-0.1	92.8
2.7	92.8
4.9	92.7
6.4	92.6
7.6	92.2
8.3	92.0
8.8	91.8
9.3	91.5
9.9	91.5
10.8	91.3
11.1	91.5
11.7	91.8
12.4	92.1
13.3	92.1
14.1	92.4
14.7	92.4
15.9	92.4
17.3	92.5
19.3	92.6

SUMMARY DATA	
Bankfull Elevation:	92.2
Bank Hieght Ratio:	1.0
Thalweg Elevation:	91.3
LTOB Elevation:	92.2
LTOB Max Depth:	0.9
LTOB Cross Sectional Area:	2.5

Stream Type	E/C 5

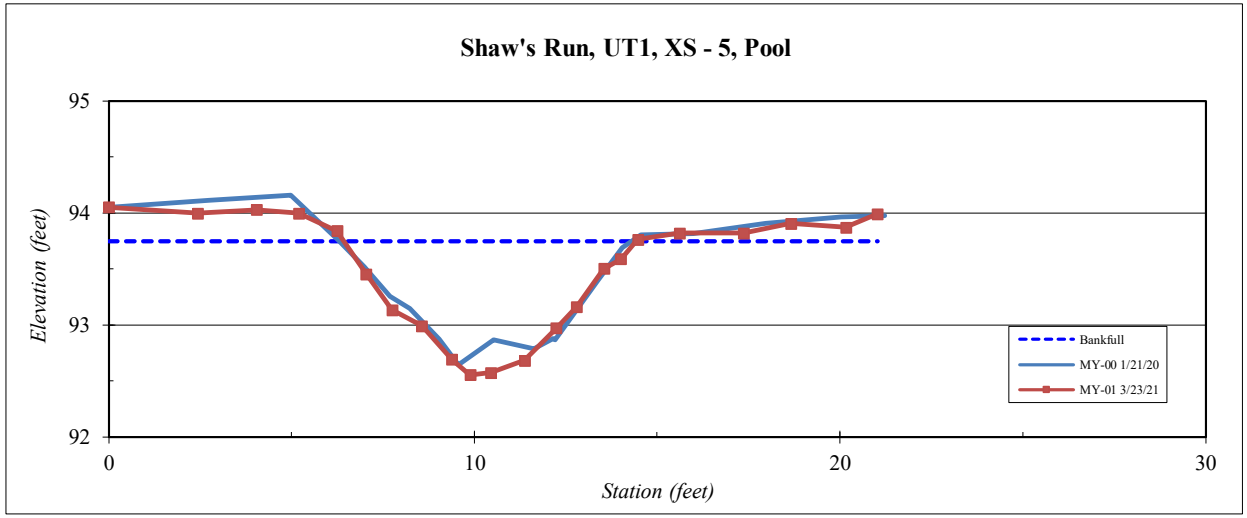


Site	Shaw's Run
Watershed:	Lumber River Basin, 03040203
XS ID	UT1, XS - 5, Pool
Feature	Pool
Date:	3/23/2021
Field Crew:	Harris, Perkinson

Station	Elevation
0.0	94.1
2.4	94.0
4.0	94.0
5.2	94.0
6.2	93.8
7.0	93.5
7.7	93.1
8.6	93.0
9.4	92.7
9.9	92.6
10.5	92.6
11.4	92.7
12.2	93.0
12.8	93.2
13.5	93.5
14.0	93.6
14.5	93.8
15.6	93.8
17.4	93.8
18.7	93.9
20.2	93.9
21.0	94.0

SUMMARY DATA	
Bankfull Elevation:	93.8
Bank Hieght Ratio:	1.0
Thalweg Elevation:	92.6
LTOB Elevation:	93.8
LTOB Max Depth:	1.2
LTOB Cross Sectional Area:	5.6

Stream Type	E/C 5



Site	Shaw's Run
Watershed:	Lumber River Basin, 03040203
XS ID	UT1, XS -6, Riffle
Feature	Riffle
Date:	3/23/2021
Field Crew:	Harris, Perkinson

Station	Elevation
0.0	94.2
1.5	94.2
3.5	94.2
4.7	94.2
5.4	94.1
5.9	93.9
6.5	93.7
7.1	93.5
7.4	93.3
8.2	93.3
9.1	93.3
9.7	93.3
10.5	93.4
11.0	93.6
11.7	93.7
12.3	93.9
12.8	94.1
13.5	94.3
15.0	94.3
16.8	94.5
19.1	94.33

SUMMARY DATA	
Bankfull Elevation:	94.2
Bank Hieght Ratio:	1.0
Thalweg Elevation:	93.3
LTOB Elevation:	94.2
LTOB Max Depth:	0.9
LTOB Cross Sectional Area:	4.8

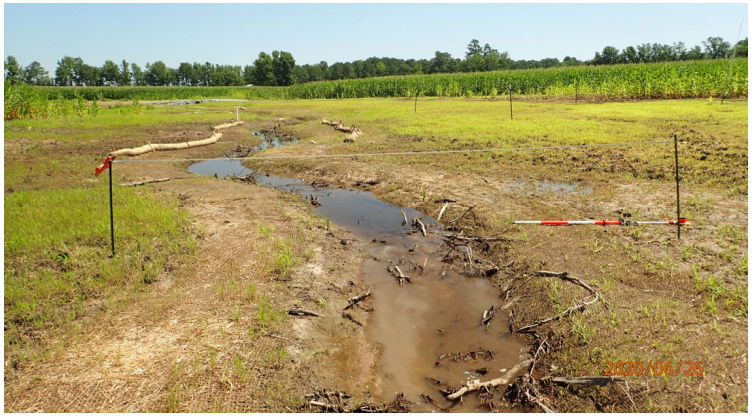
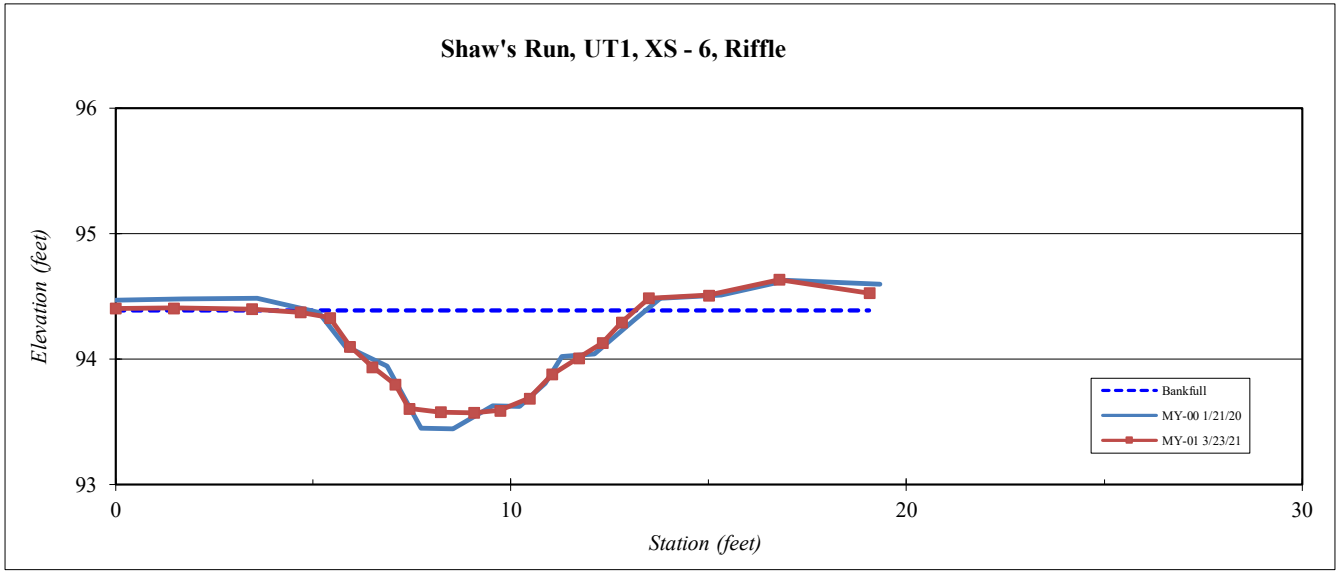


*Photo taken June 26 2020

Stream Type	E/C 5

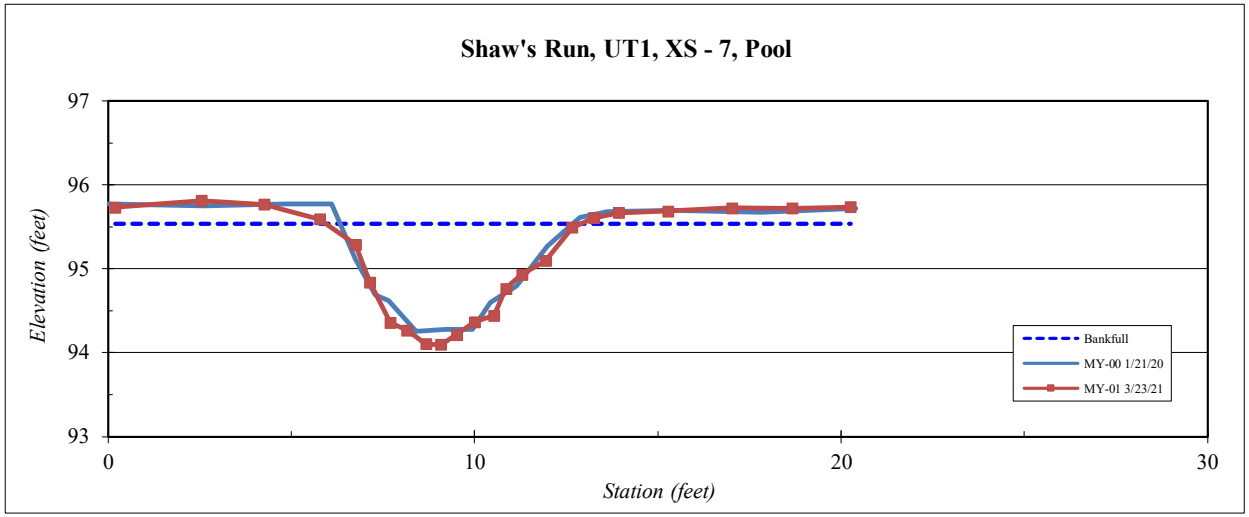


Site	Shaw's Run
Watershed:	Lumber River Basin, 03040203
XS ID	UT1, XS - 7, Pool
Feature	Pool
Date:	3/23/2021
Field Crew:	Harris, Perkinson

Station	Elevation
0.2	95.7
2.5	95.8
4.3	95.8
5.8	95.6
6.8	95.3
7.1	94.8
7.7	94.4
8.2	94.3
8.7	94.1
9.1	94.1
9.5	94.2
10.0	94.4
10.5	94.4
10.9	94.8
11.3	94.9
11.9	95.1
12.7	95.5
13.3	95.6
13.9	95.7
15.3	95.7
17.0	95.7
18.7	95.7
20.3	95.7

SUMMARY DATA	
Bankfull Elevation:	95.5
Bank Hieght Ratio:	1.0
Thalweg Elevation:	94.1
LTOB Elevation:	95.6
LTOB Max Depth:	1.5
LTOB Cross Sectional Area:	5.6

Stream Type	E/C 5

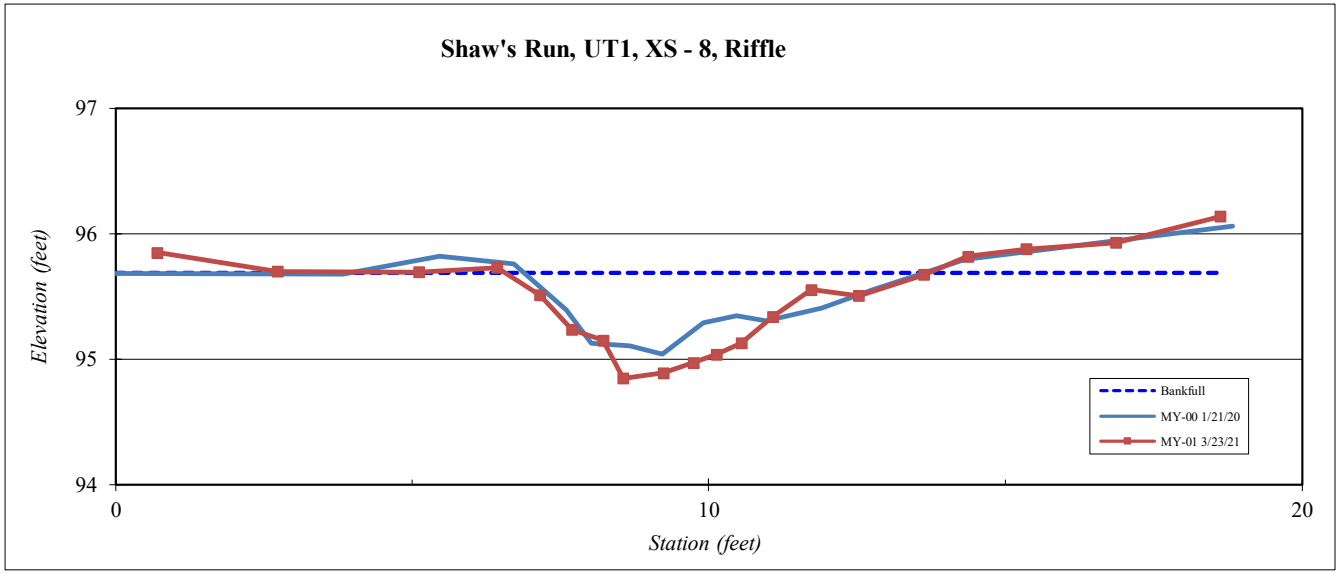


Site	Shaw's Run
Watershed:	Lumber River Basin, 03040203
XS ID	UT1, XS -8, Riffle
Feature	Riffle
Date:	3/23/2021
Field Crew:	Harris, Perkinson

Station	Elevation
0.7	95.7
2.7	95.5
5.1	95.5
6.4	95.6
7.2	95.3
7.7	95.0
8.2	94.9
8.6	94.6
9.2	94.6
9.7	94.7
10.1	94.8
10.5	94.9
11.1	95.1
11.7	95.4
12.5	95.3
13.6	95.5
14.4	95.7
15.4	95.7
16.9	95.8
18.6	96.0

SUMMARY DATA	
Bankfull Elevation:	95.5
Bank Hieght Ratio:	1.0
Thalweg Elevation:	94.6
LTOB Elevation:	95.6
LTOB Max Depth:	1.0
LTOB Cross Sectional Area:	3.2

Stream Type	E/C 5

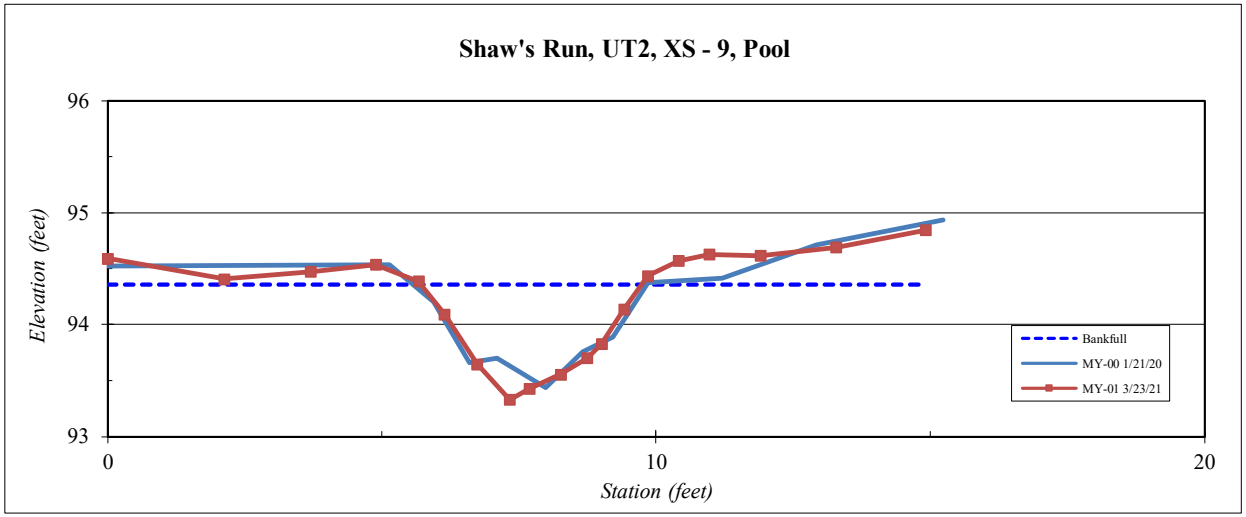


Site	Shaw's Run
Watershed:	Lumber River Basin, 03040203
XS ID	UT2, XS - 9, Pool
Feature	Pool
Date:	3/23/2021
Field Crew:	Harris, Perkinson

Station	Elevation
0.0	94.6
2.1	94.4
3.7	94.5
4.9	94.5
5.7	94.4
6.1	94.1
6.7	93.6
7.3	93.3
7.7	93.4
8.3	93.6
8.7	93.7
9.0	93.8
9.4	94.1
9.9	94.4
10.4	94.6
11.0	94.6
11.9	94.6
13.3	94.7
14.9	94.8

SUMMARY DATA	
Bankfull Elevation:	94.4
Bank Hieght Ratio:	1.0
Thalweg Elevation:	93.3
LTOB Elevation:	94.4
LTOB Max Depth:	1.1
LTOB Cross Sectional Area:	2.4

Stream Type	E/C 5



Site	Shaw's Run
Watershed:	Lumber River Basin, 03040203
XS ID	UT2, XS -10, Riffle
Feature	Riffle
Date:	3/23/2021
Field Crew:	Harris, Perkinson

Station	Elevation
-0.2	94.7
1.9	94.6
3.6	94.5
4.6	94.5
5.2	94.4
5.6	94.4
5.9	94.2
6.5	94.0
6.9	94.0
7.3	94.1
7.9	94.0
8.2	94.2
8.7	94.4
9.2	94.3
10.0	94.5
11.4	94.6
12.8	94.6
13.9	94.8
15.1	94.7

SUMMARY DATA	
Bankfull Elevation:	94.6
Bank Hieght Ratio:	1.1
Thalweg Elevation:	94.0
LTOB Elevation:	94.6
LTOB Max Depth:	0.6
LTOB Cross Sectional Area:	1.8

*Photo taken June 26 2020

Stream Type	E/C 5

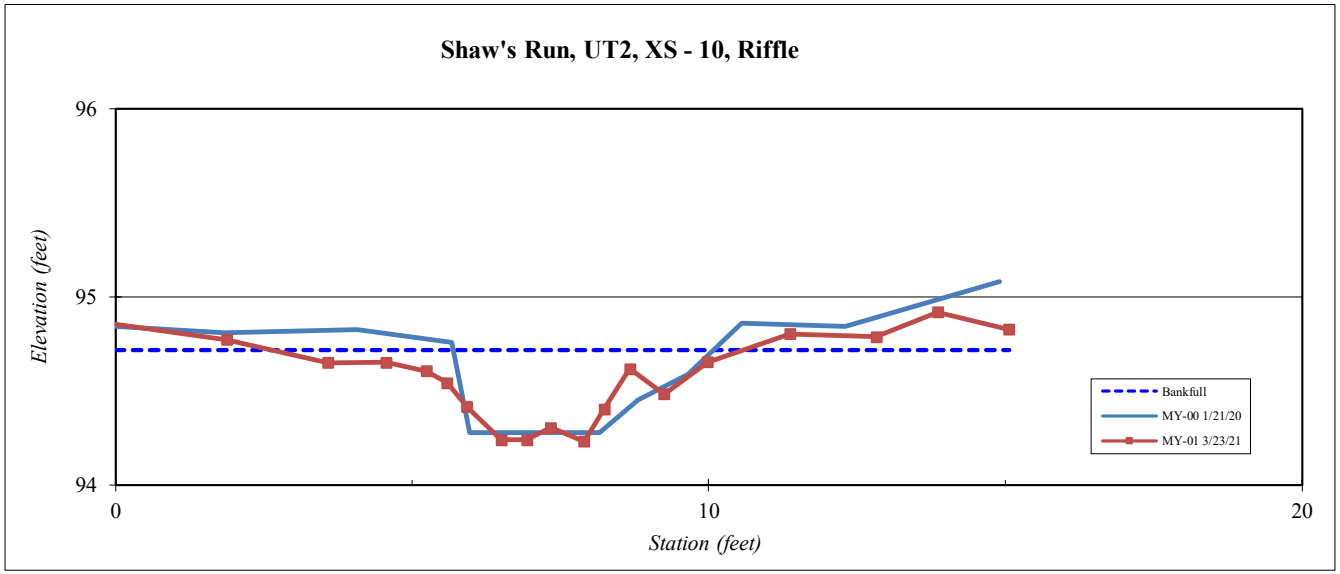


Table 10A. Baseline Stream Data Summary
Shaw's Run - UT 1

Parameter	Pre-Existing Condition (applicaple)					Design		Monitoring Baseline			Monitoring Year 1		
Riffle Only	Min	Mean	Med	Max	n	Min	Max	Min	Max	n	Min	Max	n
Bankfull Width (ft)	4.1	5.9		6.9		6.1	7	5.6	8.2	4	5.8	9.3	4
Floodprone Width (ft)	5.4	7		9.4		30	70	100	100	4	100	100	4
Bankfull Mean Depth (ft)	0.5	0.5		0.8		0.4	0.5	0.4	0.6	4	0.4	0.5	4
Bankfull Max Depth (ft)	0.6	0.8		1.2		0.6	0.8	0.7	1.0	4	0.9	1.0	4
Bankfull Cross Sectional Area (ft^2)	3.1	3.1		3.1		3.1	3.1	2.5	4.8	4	2.5	4.8	4
Width/Depth Ratio	5.3	10.9		14.9		12	16	12.7	17.7	4	13.7	18.1	4
Entrenchment Ratio	4.6	7.6		10.6		4.6	10.6	12.2	17.9	4	10.7	17.1	4
Bank Height Ratio	**2.8**	**3.4**		**4.7**		**1**	**1.2**	**1.0**	**1.0**	4	**1.0**	**1.0**	4
Max part size (mm) mobilized at bankfull													
Rosgen Classification	G 5/6					E/C 5		C 5			C 5		
Bankfull Discharge (cfs)	2.8					2.8		2.8			2.8		
Sinuosity (ft)	1					1.15		1.15			1.15		
Water Surface Slope (Channel) (ft/ft)	0.0033					0.0029		0.004			0.004		
Other													

Table 10B. Baseline Stream Data Summary
Shaw's Run - UT 2

Parameter	Pre-Existing Condition (applicaple)					Design		Monitoring Baseline			Monitoring Year 1		
Riffle Only	Min	Mean	Med	Max	n	Min	Max	Min	Max	n	Min	Max	n
Bankfull Width (ft)	5.2	7.9		8.3		3.6	4.2	4.5	4.5	1	7.9	7.9	1
Floodprone Width (ft)	7	9		12		30	70	100	100	1	100	100	1
Bankfull Mean Depth (ft)	0.1	0.1		0.2		0.3	0.3	0.4	0.4	1	0.2	0.2	1
Bankfull Max Depth (ft)	0.2	0.3		0.3		0.3	0.5	0.5	0.5	1	0.5	0.5	1
Bankfull Cross Sectional Area (ft^2)	1.1	1.1		1.1		1.1	1.1	1.8	1.8	1	1.8	1.8	1
Width/Depth Ratio	24.6	56.9		62.6		12	16	11.2	11.2	1	34.8	34.8	1
Entrenchment Ratio	1	1.2		1.6		7.6	17.8	22.0	22.0	1	12.6	12.6	1
Bank Height Ratio	**6**	**6.8**		**9.5**		**1**	**1.2**	**1.0**	**1.0**	1	**1.0**	**1.0**	1
Max part size (mm) mobilized at bankfull													
Rosgen Classification	F 5/6					E/C 5		E/C 5			E/C 5		
Bankfull Discharge (cfs)	0.9					0.9		0.9			0.9		
Sinuosity (ft)	1					1.15		1.15			1.15		
Water Surface Slope (Channel) (ft/ft)	0.01					0.0087		0.0028			0.0028		
Other													

Table 11. Monitoring Data - Cross Section Morphology Monitoring Summary

(Shaw's Run/ DMS:100055) UT 1 and UT 2

	UT 1 - Cross Section 1 (Riffle)							UT 1 - Cross Section 2 (Pool)							UT 1 - Cross Section 3 (Pool)							UT 1 - Cross Section 4 (Riffle)							UT 1 - Cross Section 5 (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+	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-Bankfull[1] Area	90.88	90.81																				92.29	92.21												
Bank Height Ratio_Based on AB Bankfull[1] Area	1.00	0.99																				1.00	0.99												
Thalweg Elevation	90.15	89.80						89.75	89.63						90.8011	90.66						91.46	91.31						92.647	92.56					
LTOB[2] Elevation	90.88	90.80						90.939	90.87			`			92.21	92.07						92.29	92.20						93.805	93.76					
LTOB[2] Max Depth (ft)	0.74	1.00						1.19	1.24						1.41	1.42						0.83	0.89						1.16	1.21					
LTOB[2] Cross Sectional Area (ft^2)	3.7	3.7						5.7	5.7						6.1	6.1						2.5	2.5						5.6	5.6					
	UT 1 - Cross Section 6 (Riffle)							UT 1 - Cross Section 7 (Pool)							UT 1 - Cross Section 8 (Riffle)							UT 2 - Cross Section 9 (Pool)							UT 2 - Cross Section 10 (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+	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-Bankfull[1] Area	94.16	94.18													95.60	95.52													94.60	94.55					
Bank Height Ratio_Based on AB Bankfull[1] Area	1.00	1.01													1.00	1.05													1.00	1.11					
Thalweg Elevation	93.11	93.25						94.258	94.09						94.79	94.57						93.4402	93.33						94.054	94.00					
LTOB[2] Elevation	94.16	94.19						95.609	95.59						95.60	95.56						94.37	94.39						94.60	94.61			`		
LTOB[2] Max Depth (ft)	1.05	0.93						1.35	1.50						0.81	1.00						0.93	1.06						0.54	0.61					
LTOB[2] Cross Sectional Area (ft^2)	4.8	4.8						5.6	5.6						3.2	3.2						2.4	2.4						1.8	1.8					

Bankfull Elevation (ft) - Based on AB-Bankfull[1] Area							
Bank Height Ratio_Based on AB Bankfull[1] Area							
Thalweg Elevation							
LTOB[2] Elevation							
LTOB[2] Max Depth (ft)							
LTOB[2] Cross Sectional Area (ft^2)							

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 bankfull 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 12. Verification of Bankfull Events
Table 13. Groundwater Hydrology Data
Groundwater Gauge Graphs
Tables 14 A-B. Channel Evidence
Surface Water Gauge Graphs
Figure D1. 30/70 Percentile Graph for Rainfall
Soil Temperature Graph
WETS Tables

Table 12. Verification of Bankfull Events

Date of Data Collection	Date of Occurrence	Method	Photo (if available)
February 18, 2021	February 18, 2021	A bankfull event was documented on UT1 by trail camera and stream gauge evidence after 3.02 inches of rain were captured at an onsite rain gauge.	1
March 1, 2021	February 18, 2021	Wrack and laid-back vegetation were observed on the TOB of UT2 after 3.02 inches of rain was documented on February 18, 2021 at an onsite rain gauge.	2

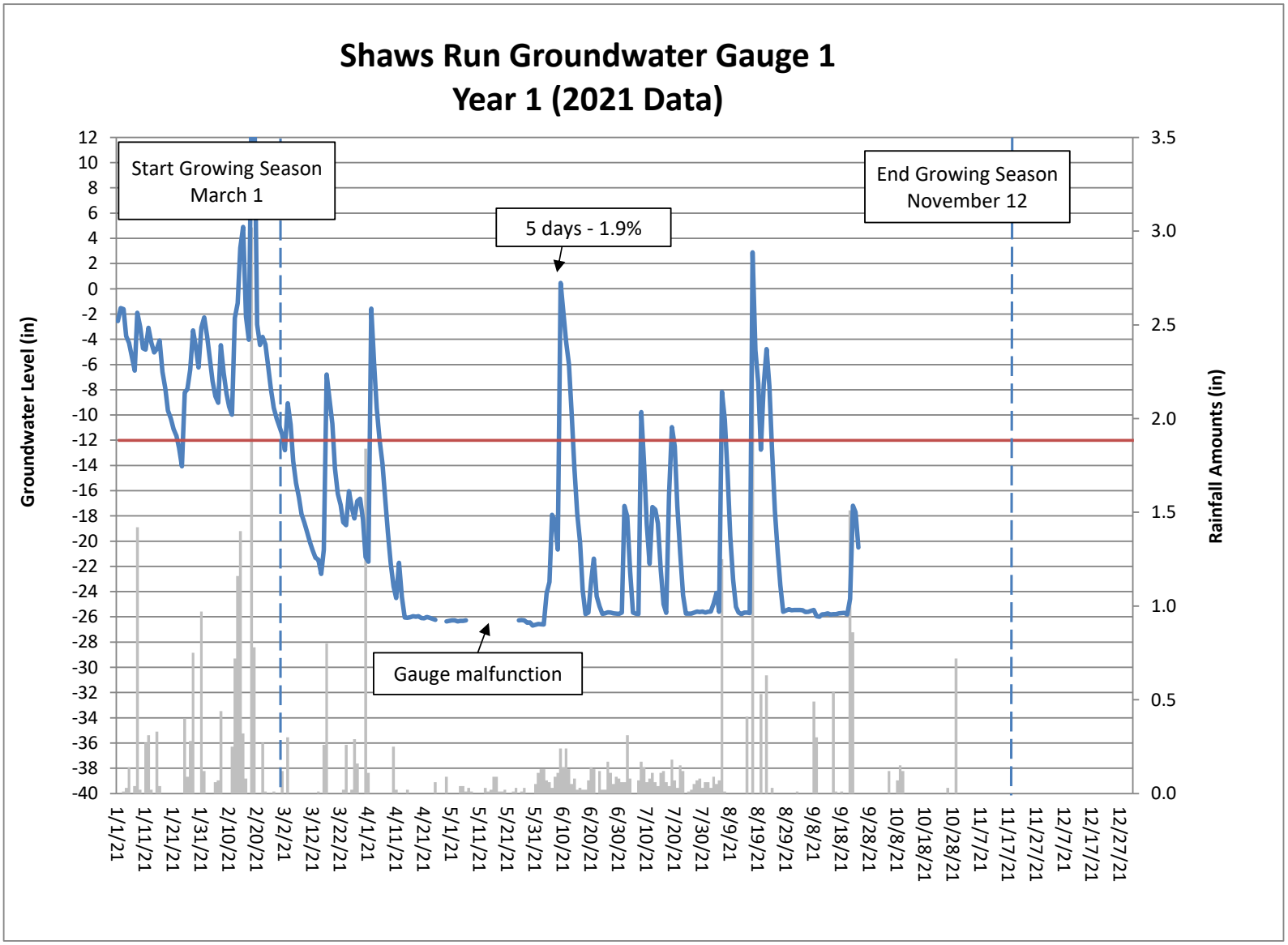
Photo 1: Bankfull event documented on UT 1 downstream after 3" of rain fell on February 18, 2021

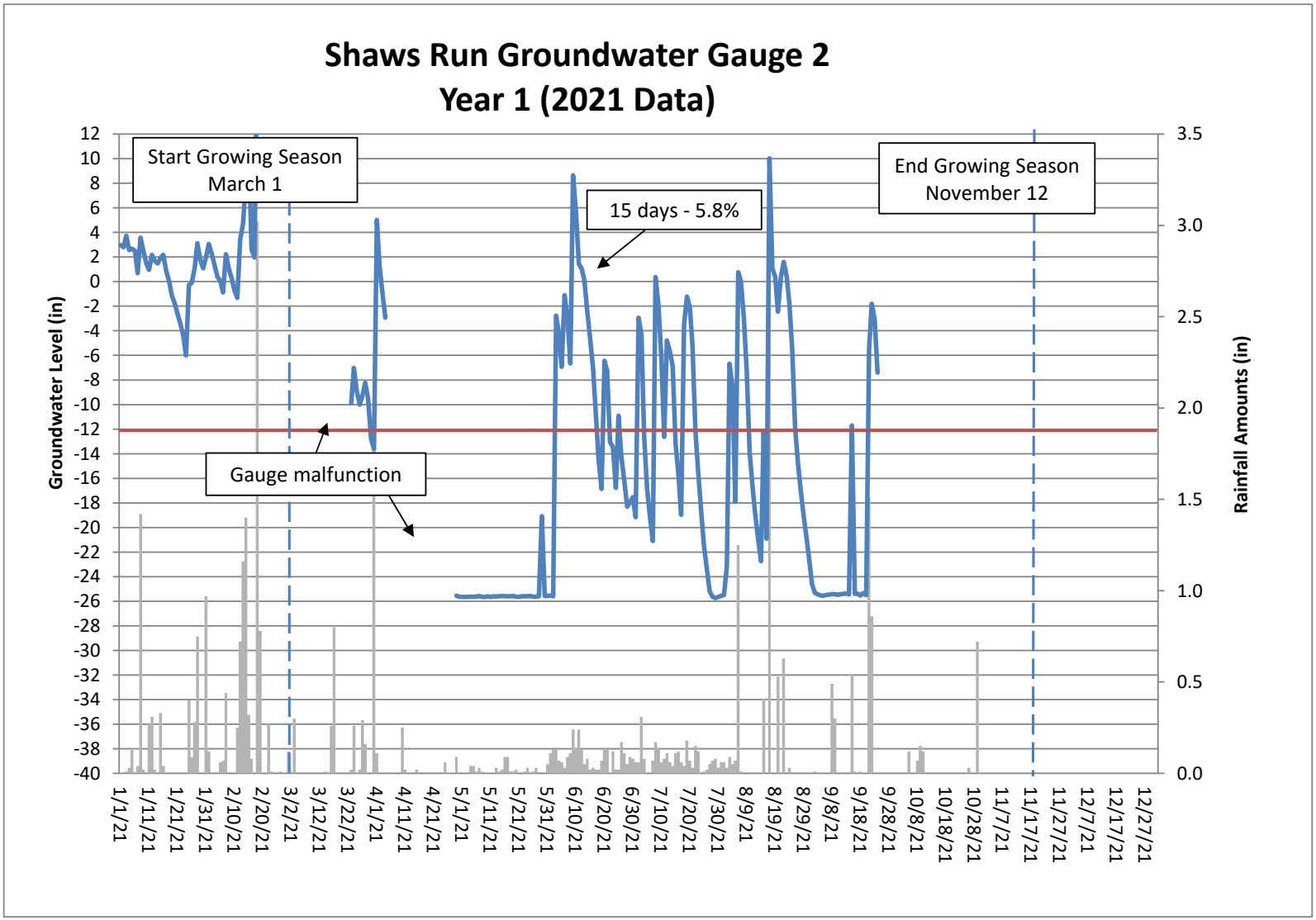
Photo 2:
Wrack and laid-back vegetation were observed on the TOB of UT2 after 3” inches of rain fell on February 18, 2021.

Table 13. Groundwater Hydrology Data
Summary of Monitoring Period/Hydrology Success Criteria by Year

Gauge	12% Hydroperiod Success Criteria Achieved/Max Consecutive Days During Growing Season (Percentage)						
	Year 1 (2021)	Year 2 (2022)	Year 3 (2023)	Year 4 (2024)	Year 5 (2025)	Year 6 (2026)	Year 7 (2027)
1*	No - 5 days (1.9%)						
2^	No - 15 days (5.8%)						
3	Yes - 44 days (17.1%)						
4	Yes - 38 days (14.8%)						
5	Yes - 34 days (13.2%)						
6	Yes - 52 days (20.2%)						
7	Yes - 36 days (14.0%)						
8	Yes - 38 days (14.8%)						
9	Yes - 37 days (14.4%)						

* Gauge 1 is not located in a credit generating area.
^ Gauge 2 likely would have met success criteria, however, logger failure occurred at the start of the growing season.


Shaws Run Groundwater Gauge 1
Year 1 (2021 Data)
Groundwater Level (in)
Rainfall Amounts (in)
Start Growing Season
March 1
End Growing Season
November 12
5 days - 1.9%
Gauge malfunction
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/21
1/11/21
1/21/21
1/31/21
2/10/21
2/20/21
3/2/21
3/12/21
3/22/21
4/1/21
4/11/21
4/21/21
5/1/21
5/11/21
5/21/21
5/31/21
6/10/21
6/20/21
6/30/21
7/10/21
7/20/21
7/30/21
8/9/21
8/19/21
8/29/21
9/8/21
9/18/21
9/28/21
10/8/21
10/18/21
10/28/21
11/7/21
11/17/21
11/27/21
12/7/21
12/17/21
12/27/21


Shaws Run Groundwater Gauge 2
Year 1 (2021 Data)
Start Growing Season
March 1
End Growing Season
November 12
15 days - 5.8%
Gauge malfunction
Groundwater Level (in)
Rainfall Amounts (in)
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/21
1/11/21
1/21/21
1/31/21
2/10/21
2/20/21
3/2/21
3/12/21
3/22/21
4/1/21
4/11/21
4/21/21
5/1/21
5/11/21
5/21/21
5/31/21
6/10/21
6/20/21
6/30/21
7/10/21
7/20/21
7/30/21
8/9/21
8/19/21
8/29/21
9/8/21
9/18/21
9/28/21
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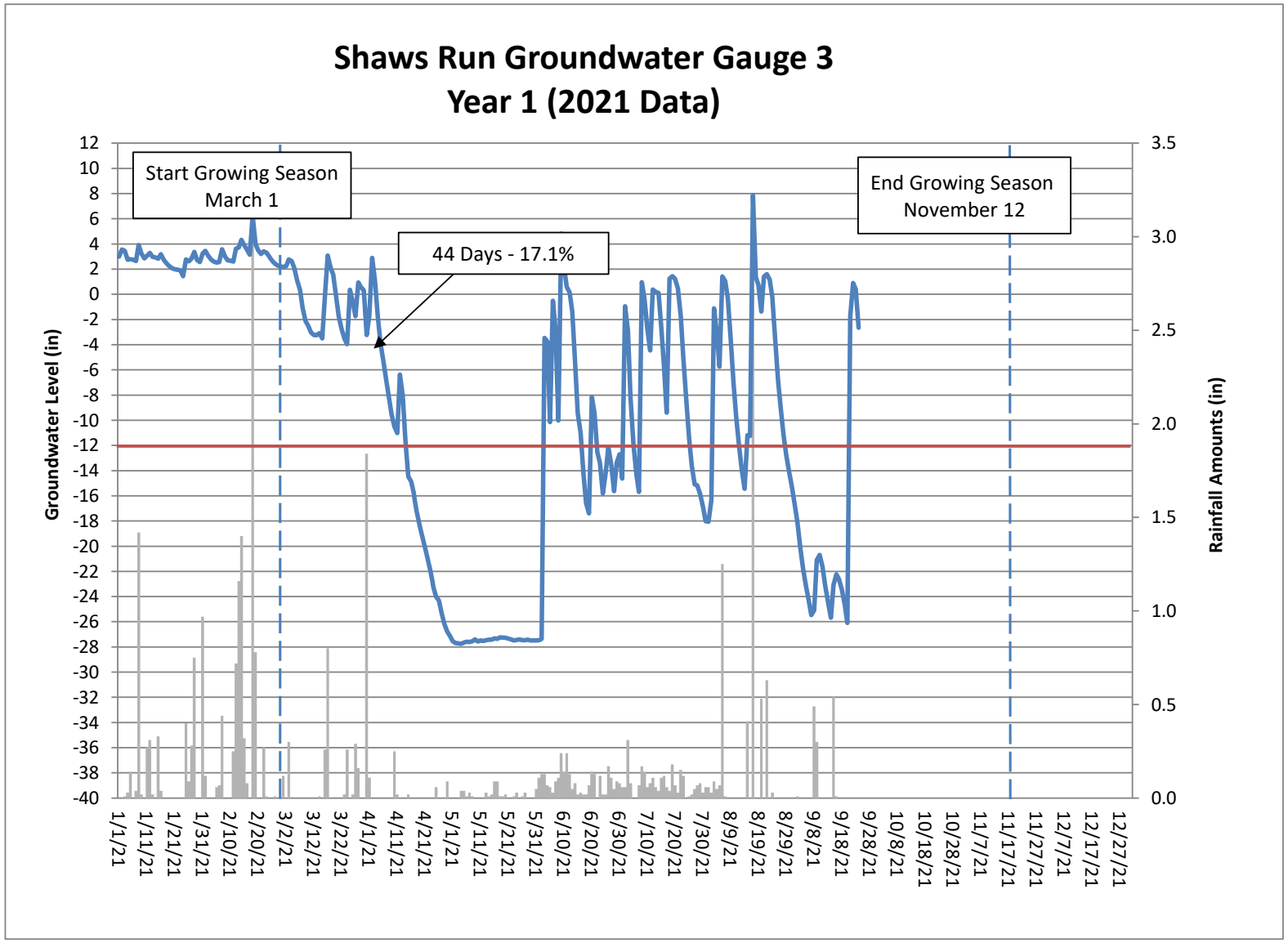
11/27/21
12/7/21
12/17/21
12/27/21


Shaws Run Groundwater Gauge 3
Year 1 (2021 Data)
Start Growing Season
March 1
End Growing Season
November 12
44 Days - 17.1%
Groundwater Level (in)
Rainfall Amounts (in)
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/21
1/11/21
1/21/21
1/31/21
2/10/21
2/20/21
3/2/21
3/12/21
3/22/21
4/1/21
4/11/21
4/21/21
5/1/21
5/11/21
5/21/21
5/31/21
6/10/21
6/20/21
6/30/21
7/10/21
7/20/21
7/30/21
8/9/21
8/19/21
8/29/21
9/8/21
9/18/21
9/28/21
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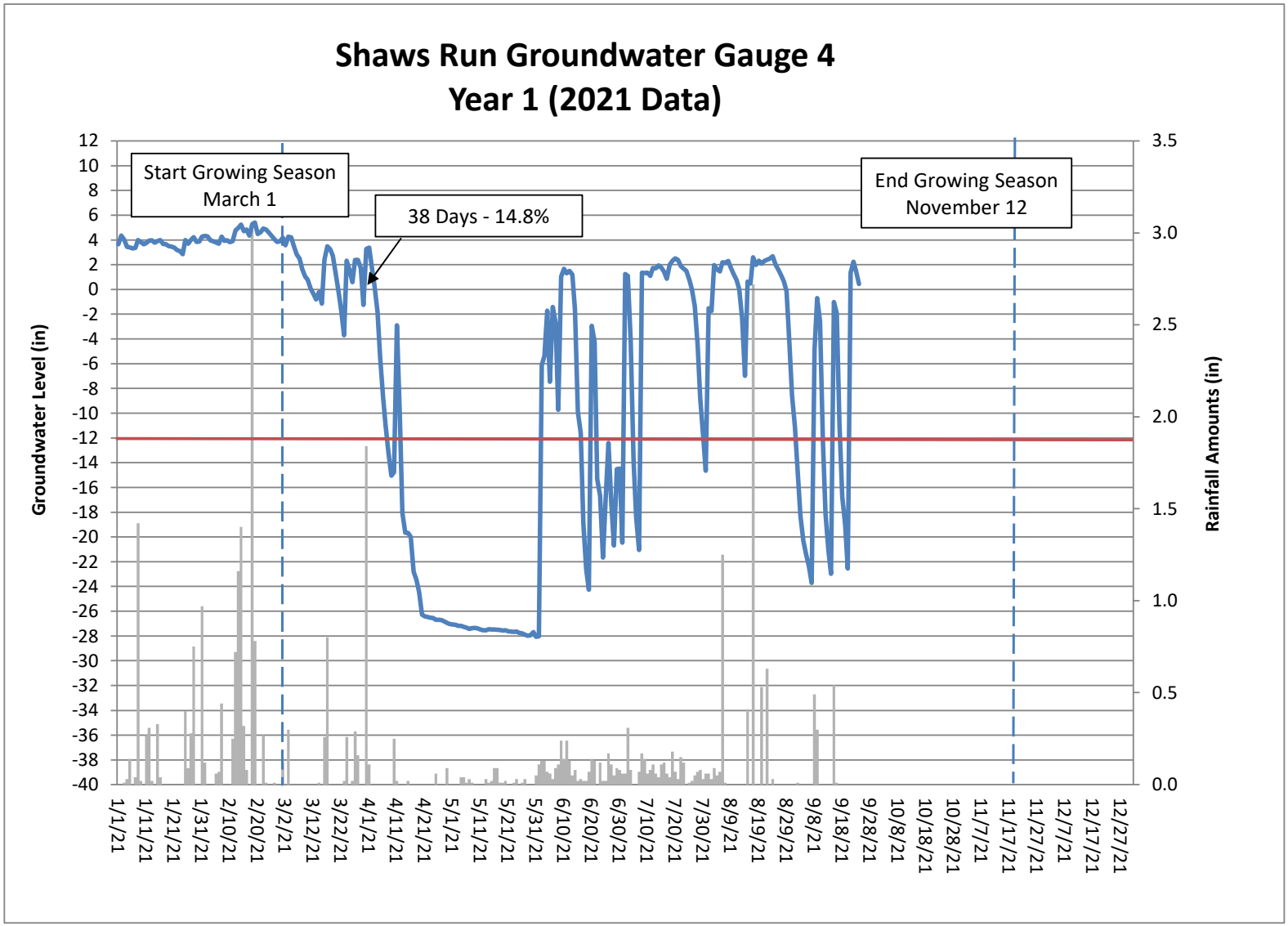
11/27/21
12/7/21
12/17/21
12/27/21


Shaws Run Groundwater Gauge 4
Year 1 (2021 Data)
Start Growing Season
March 1
38 Days - 14.8%
End Growing Season
November 12
Groundwater Level (in)
Rainfall Amounts (in)
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/21
1/11/21
1/21/21
1/31/21
2/10/21
2/20/21
3/2/21
3/12/21
3/22/21
4/1/21
4/11/21
4/21/21
5/1/21
5/11/21
5/21/21
5/31/21
6/10/21
6/20/21
6/30/21
7/10/21
7/20/21
7/30/21
8/9/21
8/19/21
8/29/21
9/8/21
9/18/21
9/28/21
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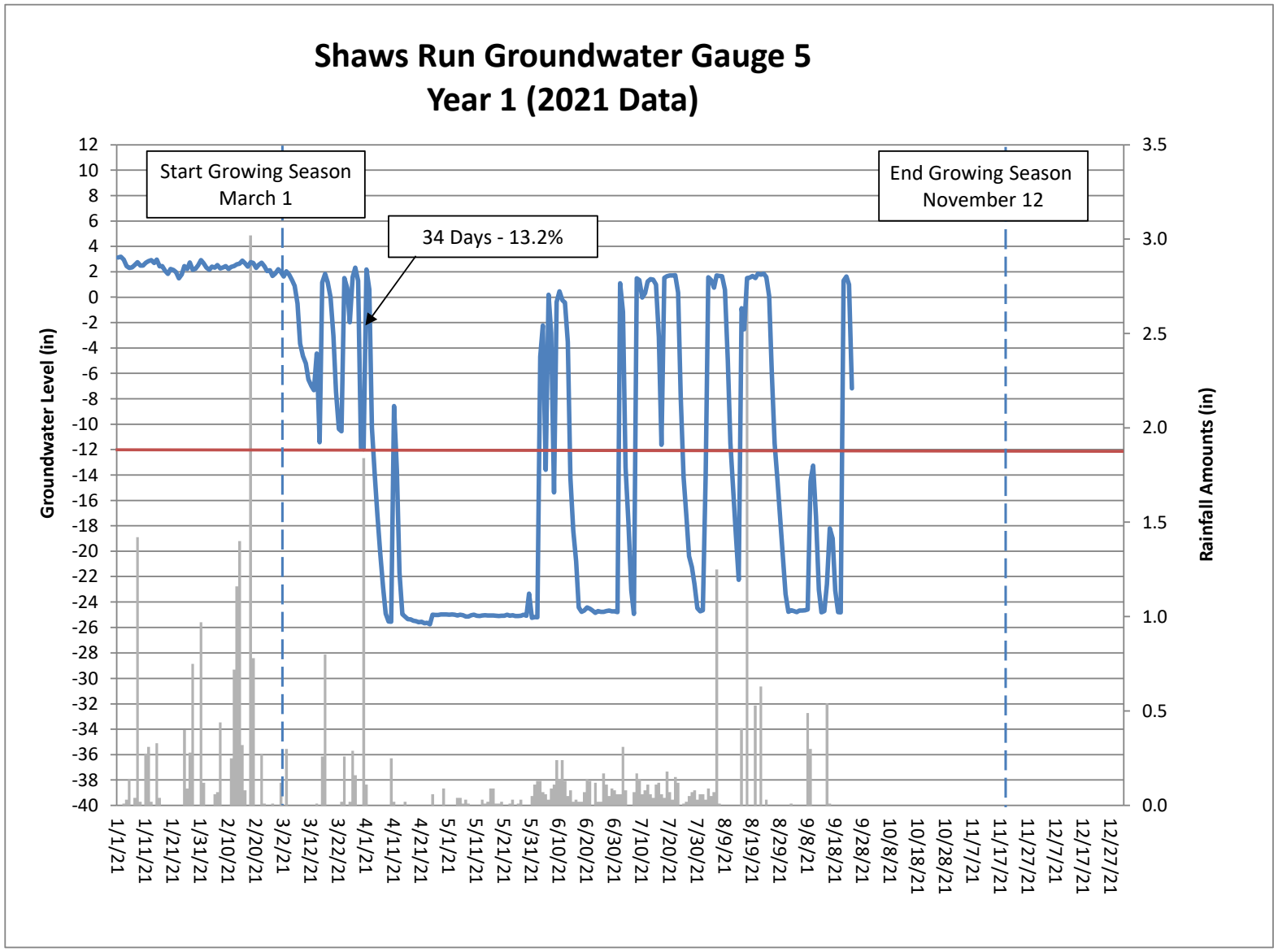
11/27/21
12/7/21
12/17/21
12/27/21


Shaws Run Groundwater Gauge 5
Year 1 (2021 Data)
Start Growing Season
March 1
End Growing Season
November 12
34 Days - 13.2%
Groundwater Level (in)
Rainfall Amounts (in)
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/21
1/11/21
1/21/21
1/31/21
2/10/21
2/20/21
3/2/21
3/12/21
3/22/21
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4/11/21
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5/11/21
5/21/21
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6/20/21
6/30/21
7/10/21
7/20/21
7/30/21
8/9/21
8/19/21
8/29/21
9/8/21
9/18/21
9/28/21
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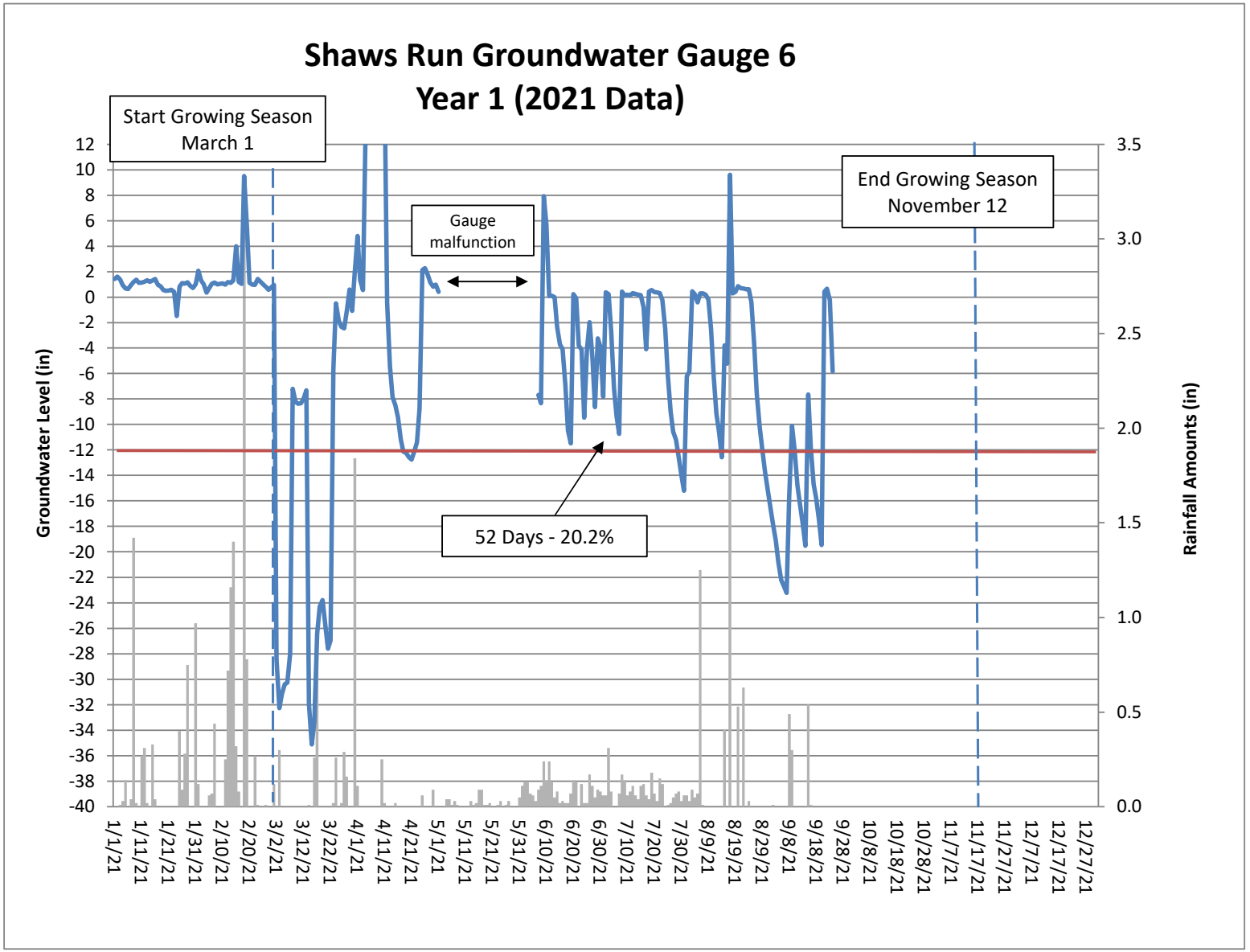
12/7/21
12/17/21
12/27/21


Shaws Run Groundwater Gauge 6
Year 1 (2021 Data)
Start Growing Season
March 1
End Growing Season
November 12
Gauge
malfunction
52 Days - 20.2%
Groundwater Level (in)
Rainfall Amounts (in)
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/21
1/11/21
1/21/21
1/31/21
2/10/21
2/20/21
3/2/21
3/12/21
3/22/21
4/1/21
4/11/21
4/21/21
5/1/21
5/11/21
5/21/21
5/31/21
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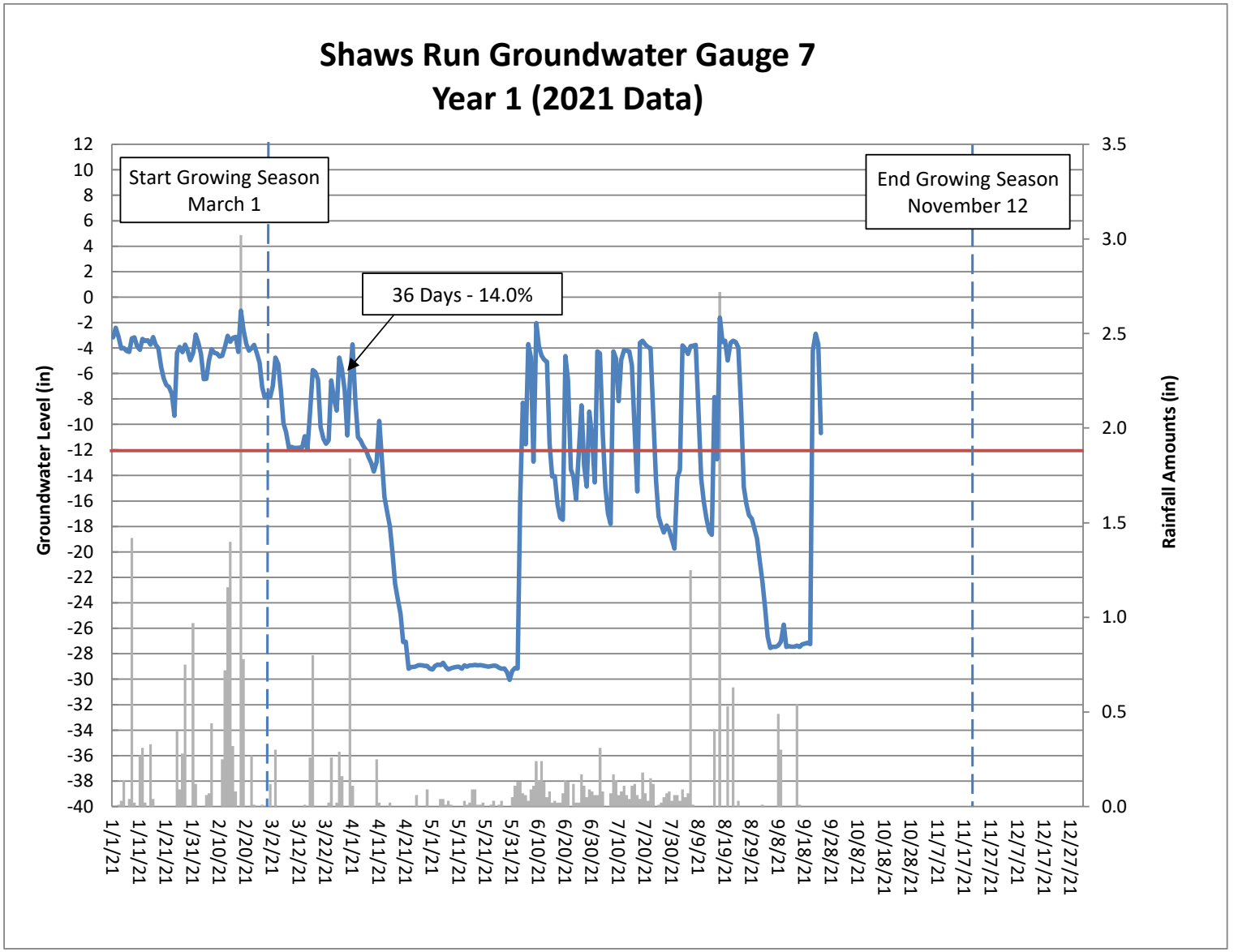
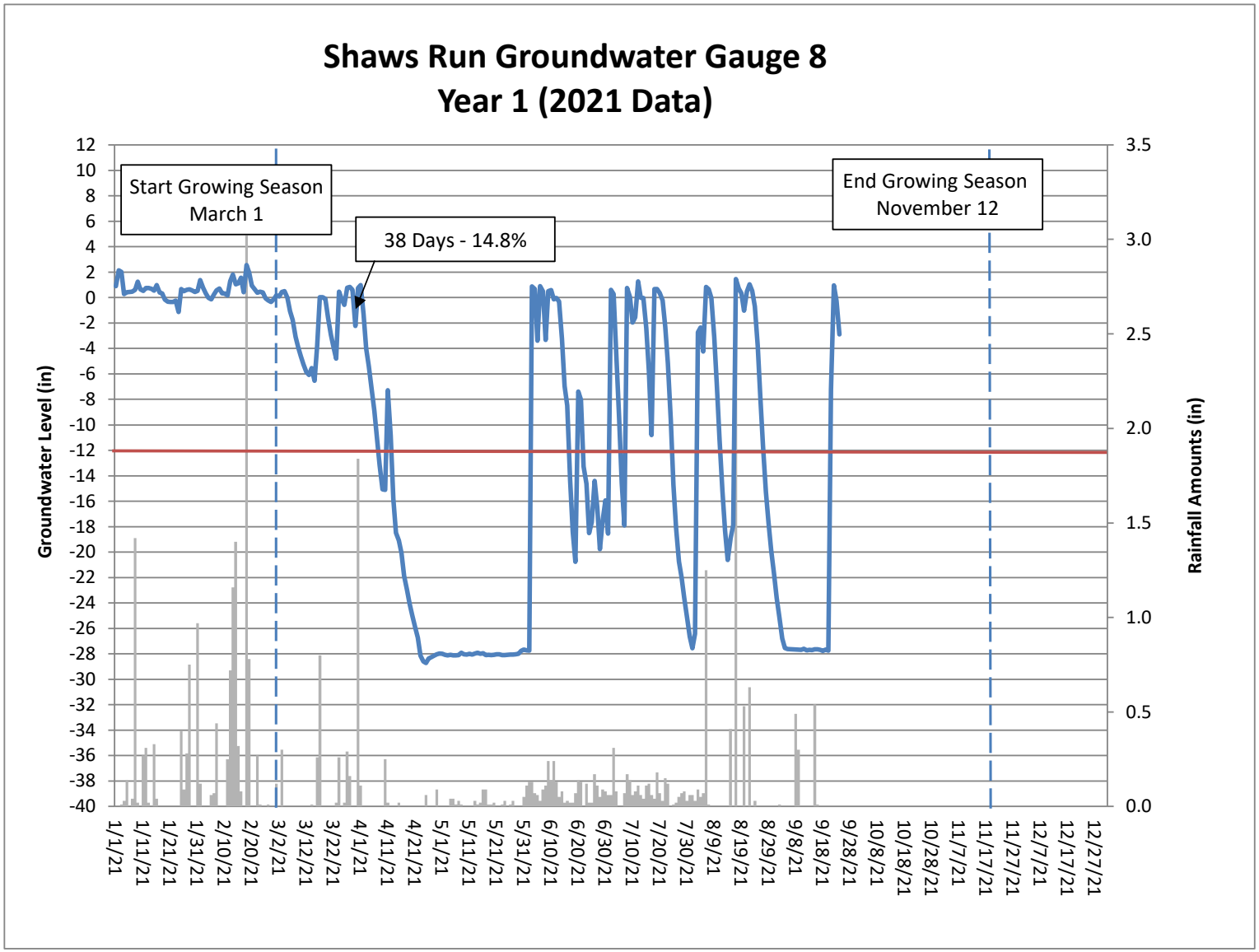
12/27/21


Shaws Run Groundwater Gauge 7
Year 1 (2021 Data)
Start Growing Season
March 1
End Growing Season
November 12
36 Days - 14.0%
Groundwater Level (in)
Rainfall Amounts (in)
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/21
1/11/21
1/21/21
1/31/21
2/10/21
2/20/21
3/2/21
3/12/21
3/22/21
4/1/21
4/11/21
4/21/21
5/1/21
5/11/21
5/21/21
5/31/21
6/10/21
6/20/21
6/30/21
7/10/21
7/20/21
7/30/21
8/9/21
8/19/21
8/29/21
9/8/21
9/18/21
9/28/21
10/8/21
10/18/21
10/28/21
11/7/21
11/17/21
11/27/21
12/7/21
12/17/21
12/27/21


Shaws Run Groundwater Gauge 8
Year 1 (2021 Data)
Start Growing Season
March 1
38 Days - 14.8%
End Growing Season
November 12
Groundwater Level (in)
Rainfall Amounts (in)
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/21
1/11/21
1/21/21
1/31/21
2/10/21
2/20/21
3/2/21
3/12/21
3/22/21
4/1/21
4/11/21
4/21/21
5/1/21
5/11/21
5/21/21
5/31/21
6/10/21
6/20/21
6/30/21
7/10/21
7/20/21
7/30/21
8/9/21
8/19/21
8/29/21
9/8/21
9/18/21
9/28/21
10/8/21
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10/28/21
11/7/21
11/17/21
11/27/21
12/7/21
12/17/21
12/27/21

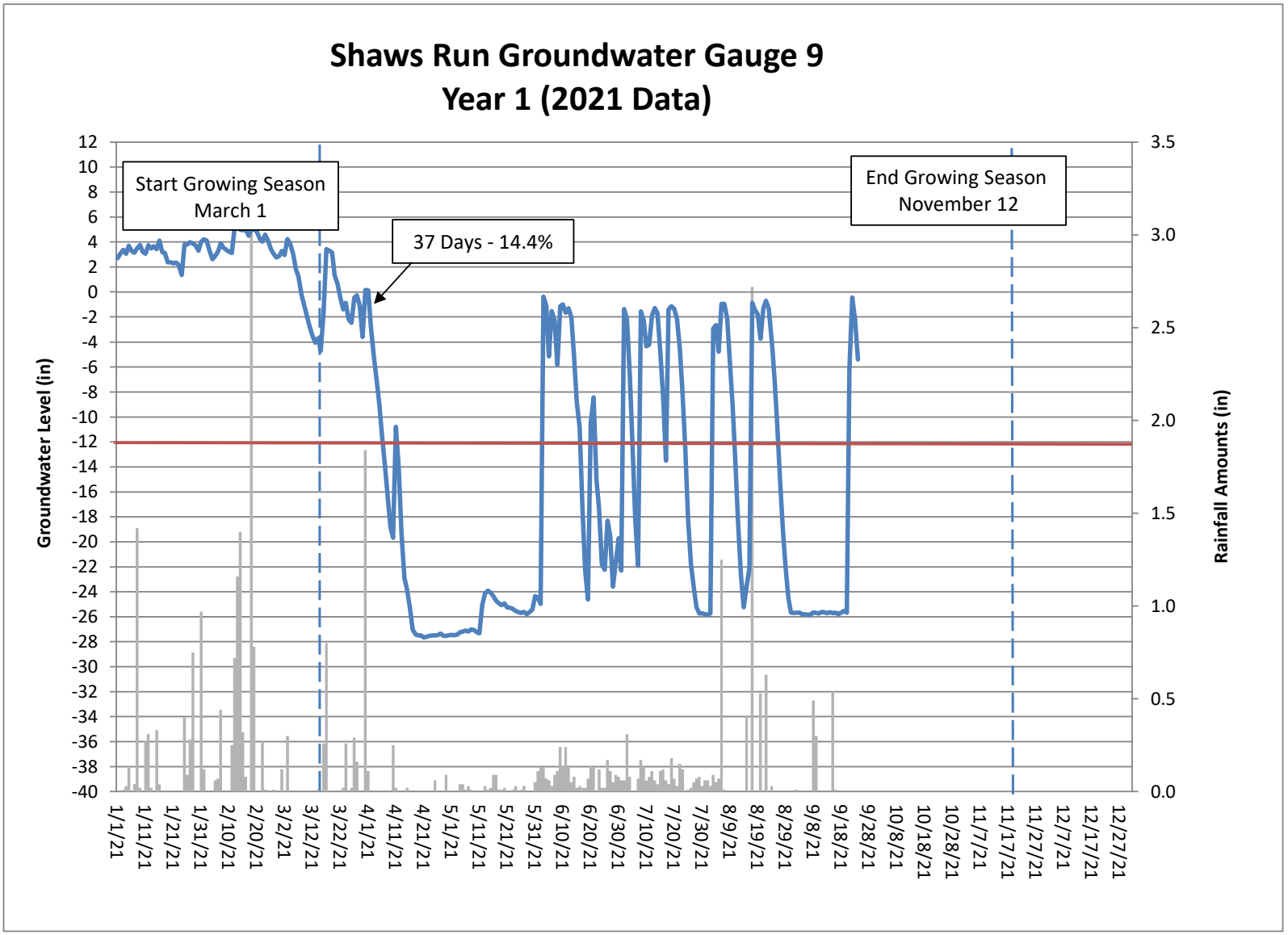

Shaws Run Groundwater Gauge 9
Year 1 (2021 Data)
Start Growing Season
March 1
37 Days - 14.4%
End Growing Season
November 12
Groundwater Level (in)
Rainfall Amounts (in)
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/21
1/11/21
1/21/21
1/31/21
2/10/21
2/20/21
3/2/21
3/12/21
3/22/21
4/1/21
4/11/21
4/21/21
5/1/21
5/11/21
5/21/21
5/31/21
6/10/21
6/20/21
6/30/21
7/10/21
7/20/21
7/30/21
8/9/21
8/19/21
8/29/21
9/8/21
9/18/21
9/28/21
10/8/21
10/18/21
10/28/21
11/7/21
11/17/21
11/27/21
12/7/21
12/17/21
12/27/21

Table 14A UT-1 Upstream Channel Evidence

UT-1 Upstream Channel Evidence	Year 1 (2021)
Max consecutive days channel flow	107
Presence of litter and debris (wracking)	Yes
Leaf litter disturbed or washed away	Yes
Matted, bent, or absence of vegetation (herbaceous or otherwise)	Yes
Sediment deposition and/or scour indicating sediment transport	Yes
Water staining due to continual presence of water	Yes
Formation of channel bed and banks	Yes
Sediment sorting within the primary path of flow	Yes
Sediment shelving or a natural line impressed on the banks	Yes
Change in plant community (absence or destruction of terrestrial vegetation and/or transition to species adapted for flow or inundation for a long duration, including hydrophytes)	Yes
Development of channel pattern (meander bends and/or channel braiding) at natural topographic breaks, woody debris piles, or plant root systems	Yes
Exposure of woody plant roots within the primary path of flow	No
Other:	

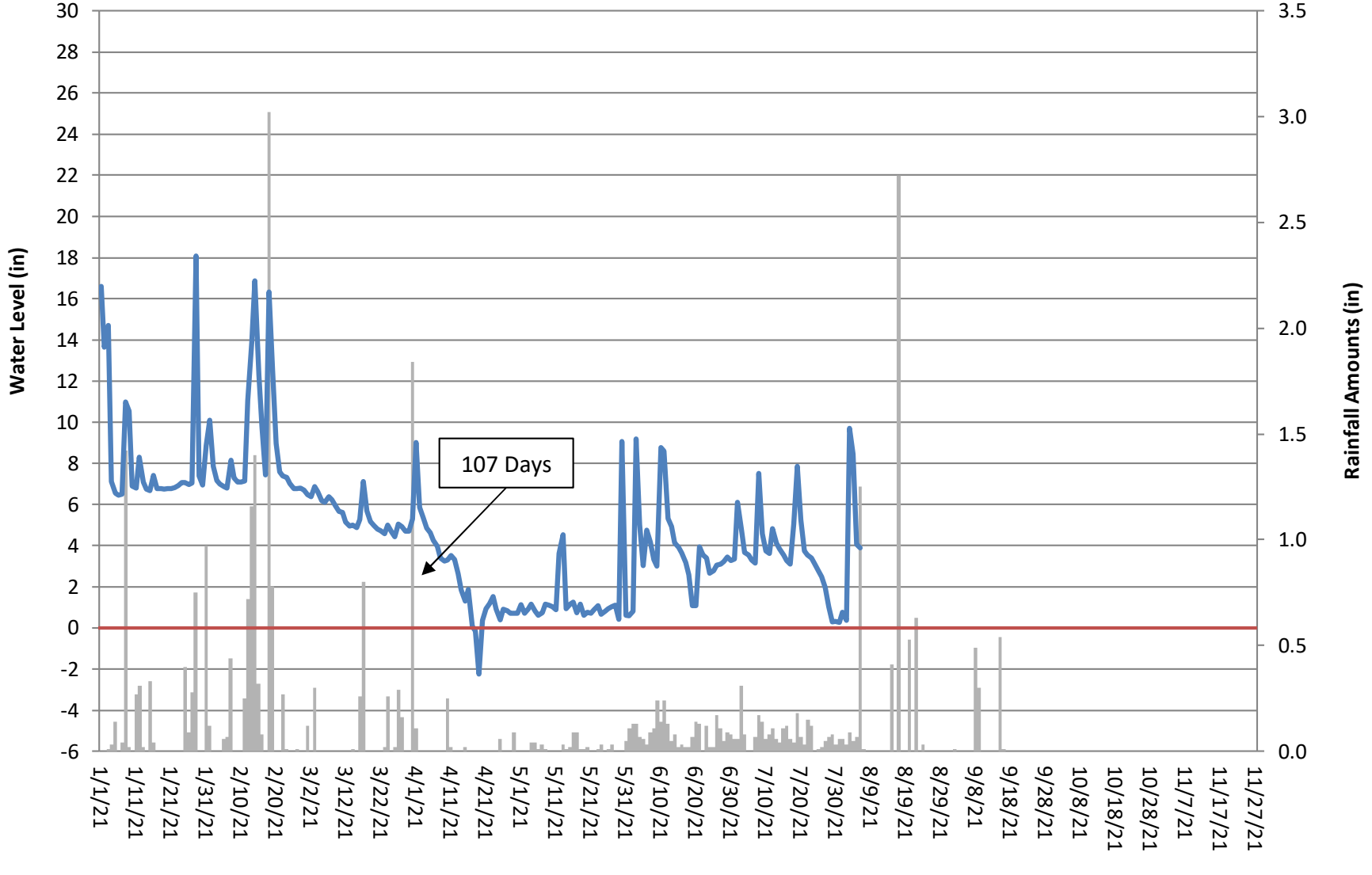
Table 14B UT-1 Downstream Channel Evidence

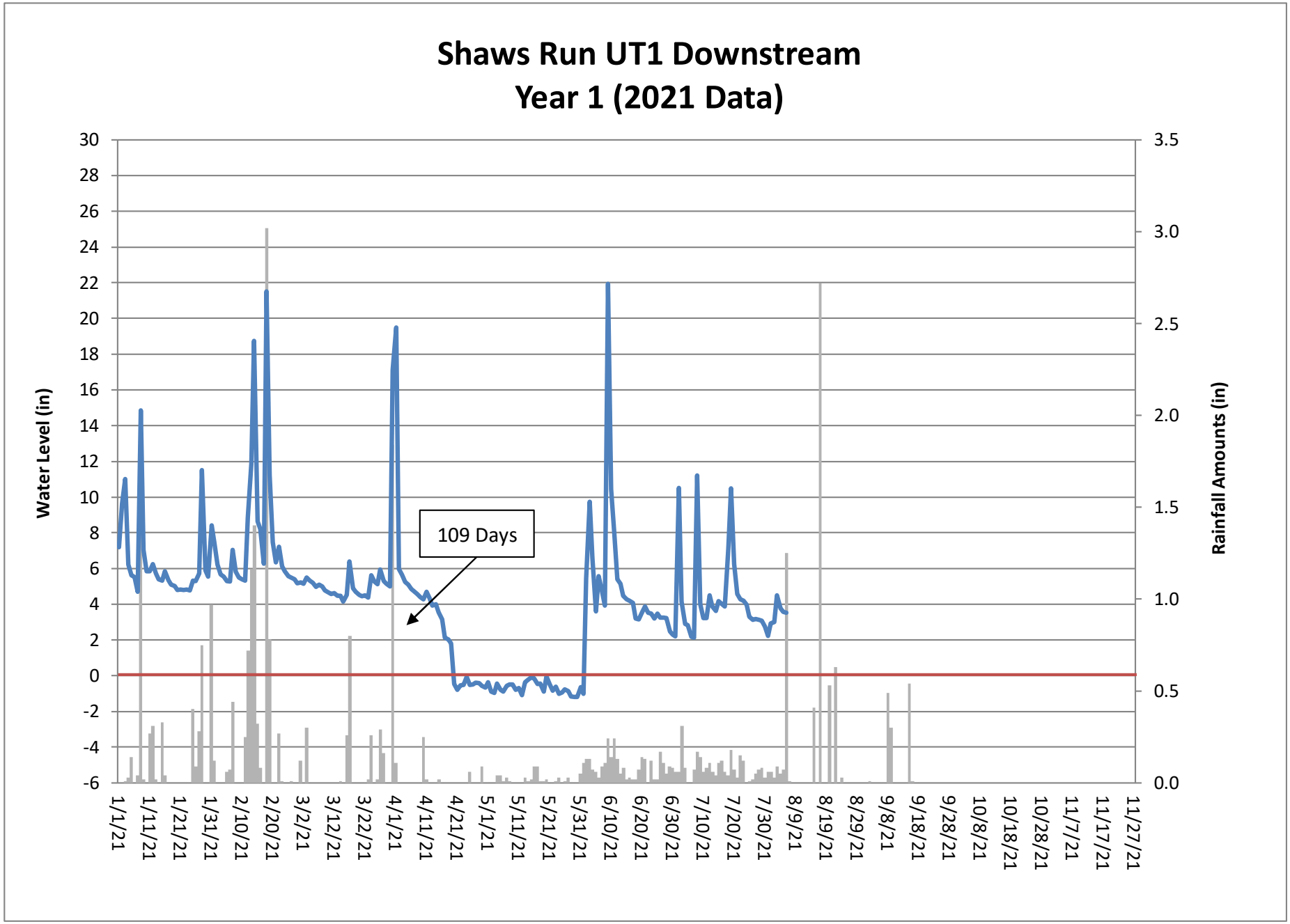
UT-2 Channel Evidence	Year 1 (2021)
Max consecutive days channel flow	109
Presence of litter and debris (wracking)	Yes
Leaf litter disturbed or washed away	Yes
Matted, bent, or absence of vegetation (herbaceous or otherwise)	Yes
Sediment deposition and/or scour indicating sediment transport	Yes
Water staining due to continual presence of water	Yes
Formation of channel bed and banks	Yes
Sediment sorting within the primary path of flow	Yes
Sediment shelving or a natural line impressed on the banks	Yes
Change in plant community (absence or destruction of terrestrial vegetation and/or transition to species adapted for flow or inundation for a long duration, including hydrophytes)	Yes
Development of channel pattern (meander bends and/or channel braiding) at natural topographic breaks, woody debris piles, or plant root systems	Yes
Exposure of woody plant roots within the primary path of flow	No
Other:	

Table 14C UT-2 Channel Evidence

UT-2 Channel Evidence	Year 1 (2021)
Max consecutive days channel flow	70
Presence of litter and debris (wracking)	Yes
Leaf litter disturbed or washed away	Yes
Matted, bent, or absence of vegetation (herbaceous or otherwise)	Yes
Sediment deposition and/or scour indicating sediment transport	Yes
Water staining due to continual presence of water	Yes
Formation of channel bed and banks	Yes
Sediment sorting within the primary path of flow	Yes
Sediment shelving or a natural line impressed on the banks	Yes
Change in plant community (absence or destruction of terrestrial vegetation and/or transition to species adapted for flow or inundation for a long duration, including hydrophytes)	Yes
Development of channel pattern (meander bends and/or channel braiding) at natural topographic breaks, woody debris piles, or plant root systems	Yes
Exposure of woody plant roots within the primary path of flow	No
Other:	

Shaws Run UT1 Upstream
Year 1 (2021 Data)




Shaws Run UT1 Downstream
Year 1 (2021 Data)
Water Level (in)
Rainfall Amounts (in)
109 Days
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/21
1/11/21
1/21/21
1/31/21
2/10/21
2/20/21
3/2/21
3/12/21
3/22/21
4/1/21
4/11/21
4/21/21
5/1/21
5/11/21
5/21/21
5/31/21
6/10/21
6/20/21
6/30/21
7/10/21
7/20/21
7/30/21
8/9/21
8/19/21
8/29/21
9/8/21
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10/8/21
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10/28/21
11/7/21
11/17/21
11/27/21

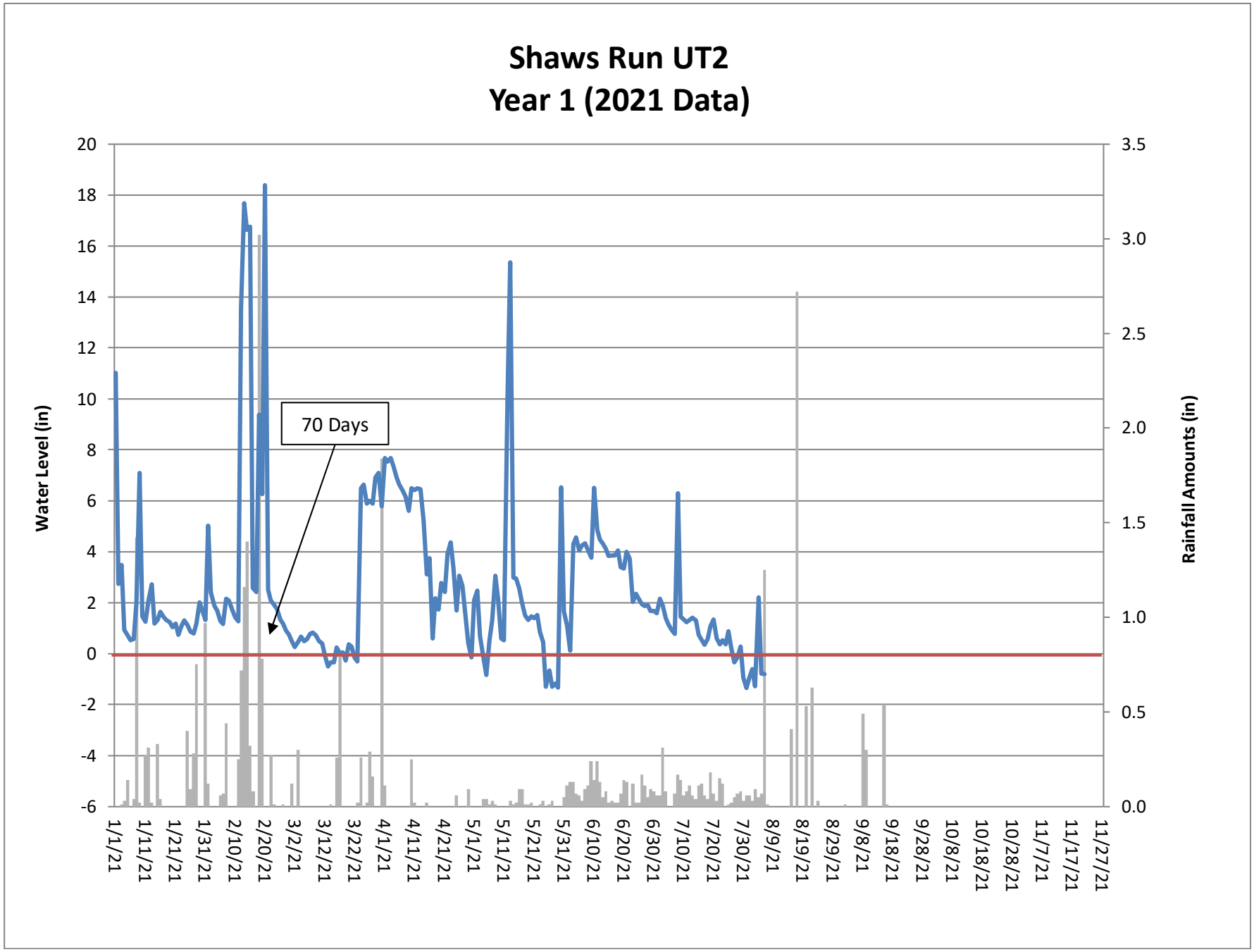
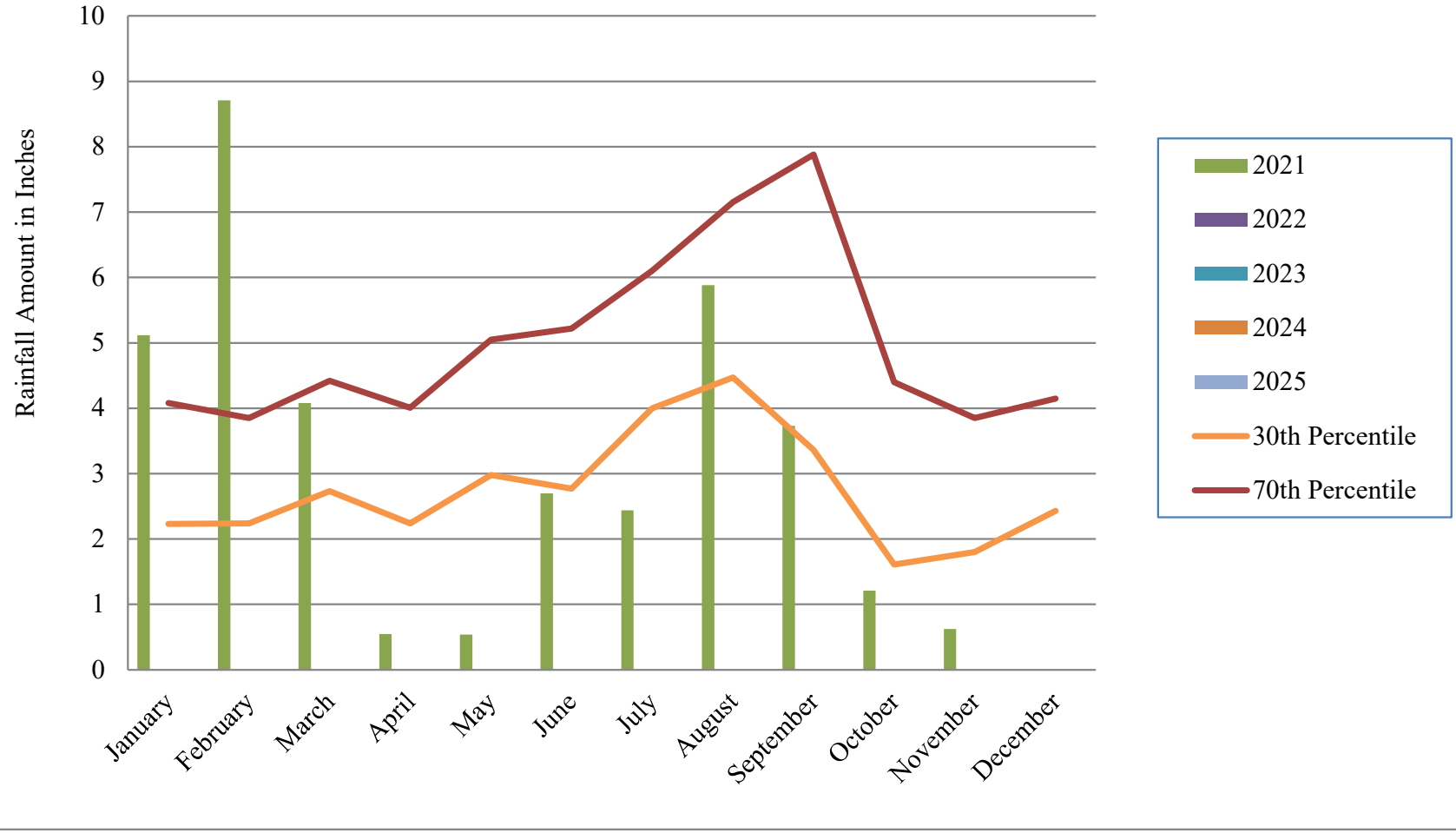
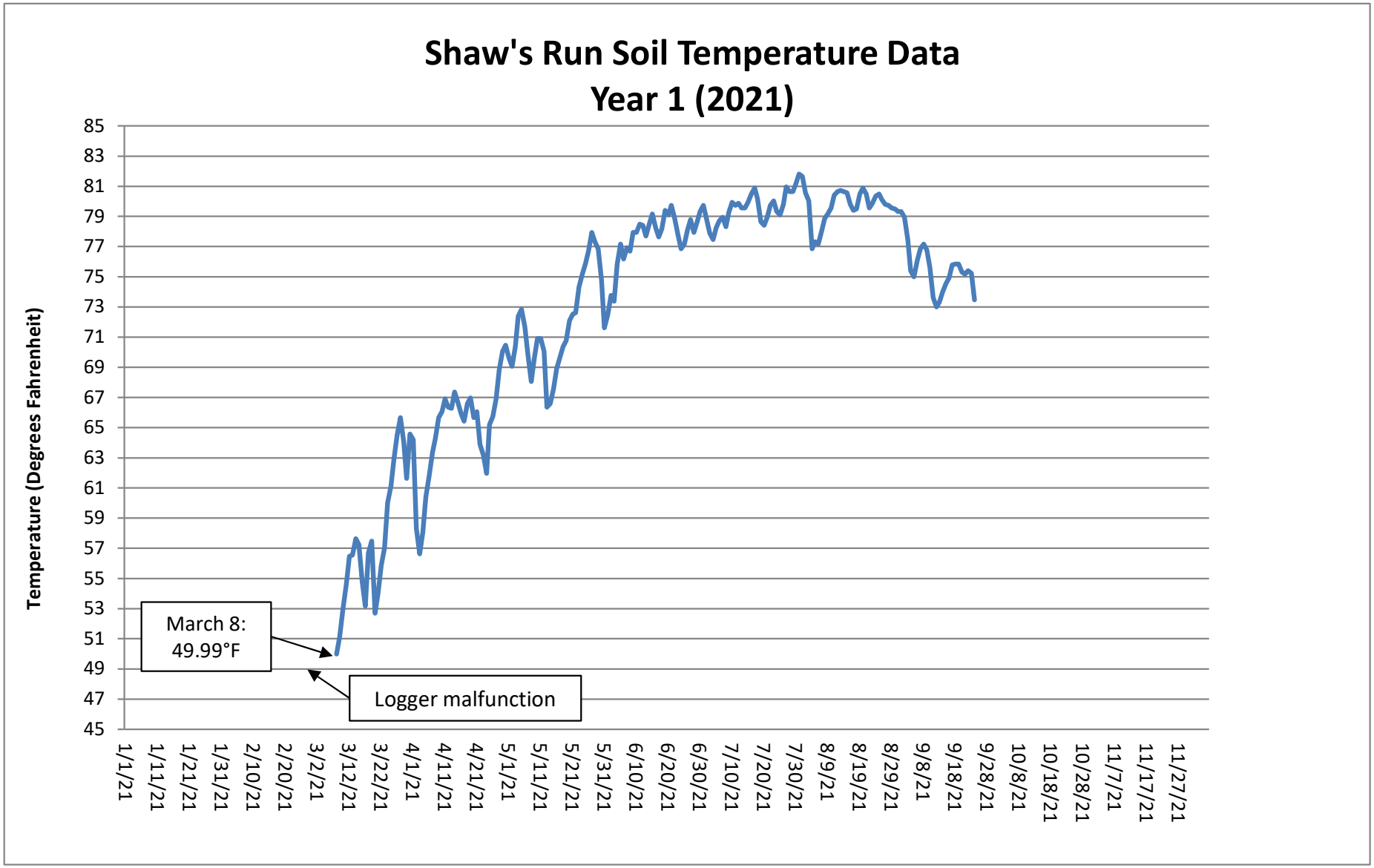

Shaws Run UT2
Year 1 (2021 Data)
Water Level (in)
Rainfall Amounts (in)
70 Days
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/21
1/11/21
1/21/21
1/31/21
2/10/21
2/20/21
3/2/21
3/12/21
3/22/21
4/1/21
4/11/21
4/21/21
5/1/21
5/11/21
5/21/21
5/31/21
6/10/21
6/20/21
6/30/21
7/10/21
7/20/21
7/30/21
8/9/21
8/19/21
8/29/21
9/8/21
9/18/21
9/28/21
10/8/21
10/18/21
10/28/21
11/7/21
11/17/21
11/27/21

Figure D1: Shaw's Run
30-70 Percentile Graph for Rainfall
Current year data from onsite rain gauge
30-70th percentile data from WETS Station: Whiteville, NC




Shaw's Run Soil Temperature Data
Year 1 (2021)
Temperature (Degrees Fahrenheit)
85
83
81
79
77
75
73
71
69
67
65
63
61
59
57
55
53
51
49
47
45
1/1/21
1/11/21
1/21/21
1/31/21
2/10/21
2/20/21
3/2/21
3/12/21
3/22/21
4/1/21
4/11/21
4/21/21
5/1/21
5/11/21
5/21/21
5/31/21
6/10/21
6/20/21
6/30/21
7/10/21
7/20/21
7/30/21
8/9/21
8/19/21
8/29/21
9/8/21
9/18/21
9/28/21
10/8/21
10/18/21
10/28/21
11/7/21
11/17/21
11/27/21
March 8:
49.99°F
Logger malfunction

WETS Table

WETS Station: WHITEVILLE 7 NW, NC								
Requested years: 1990 - 2020								
Month	Avg Max Temp	Avg Min Temp	Avg Mean Temp	Avg Precip	30% chance precip less than	30% chance precip more than	Avg number days precip 0.10 or more	Avg Snowfall
Jan	56.1	32.9	44.5	3.40	2.23	4.08	7	0.8
Feb	59.5	34.9	47.2	3.23	2.24	3.85	6	0.2
Mar	66.7	40.6	53.7	3.76	2.73	4.42	6	0.0
Apr	75.2	48.7	61.9	3.35	2.24	4.01	5	0.0
May	82.1	58.1	70.1	4.25	2.98	5.05	6	0.0
Jun	88.1	66.2	77.2	4.33	2.77	5.22	7	0.0
Jul	91.1	70.0	80.5	5.24	4.00	6.10	8	0.0
Aug	89.4	68.6	79.0	6.09	4.47	7.15	9	0.0
Sep	84.5	62.9	73.7	6.45	3.36	7.88	6	0.0
Oct	76.1	51.2	63.6	3.61	1.61	4.40	5	0.0
Nov	66.8	40.7	53.8	3.16	1.80	3.85	5	0.0
Dec	58.9	35.4	47.2	3.49	2.43	4.15	6	0.3
Annual:					44.30	54.05		
Average	74.6	50.9	62.7	-	-	-	-	-
Total	-	-	-	50.36			77	1.4

GROWING SEASON DATES			
Years with missing data:	24 deg = 2	28 deg = 1	32 deg = 1
Years with no occurrence:	24 deg = 0	28 deg = 0	32 deg = 0
Data years used:	24 deg = 29	28 deg = 30	32 deg = 30
Probability	24 F or higher	28 F or higher	32 F or higher
50 percent *	2/23 to 12/13: 293 days	3/9 to 11/19: 255 days	3/27 to 11/7: 225 days
70 percent *	2/17 to 12/20: 306 days	3/3 to 11/25: 267 days	3/23 to 11/11: 233 days
* Percent chance of the growing season occurring between the Beginning and Ending dates.			

STATS TABLE - total precipitation (inches)													
Yr	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annl
1954					2.30	2.13	5.75	5.21	1.78	5.20	1.54	2.34	26.25
1955	4.08	1.56	2.82	4.21	2.68	5.50	2.46	8.90	12.77	4.35	2.44	1.08	52.85
1956	1.77	5.03	3.57	2.81	4.68	8.40	0.82	3.98	5.17	3.03	0.94	1.37	41.57
1957	2.48	3.36	4.73	0.58	5.72	5.63	1.78	3.12	5.48	0.98	5.54	4.15	43.55
1958	5.22	3.33	M4.78	4.34	2.40	9.86	4.21	9.01	2.95	5.56	1.51	3.27	56.44
1959	1.61	5.59	7.17	5.22	4.43	2.44	10.52	5.22	5.78	7.25	1.29	4.24	60.76
1960	4.53	5.28	3.63	1.37	2.90	4.85	10.86	3.83	6.28	3.08	1.58	1.60	49.79
1961	M1.53	2.75	5.37	6.13	3.93	10.77	10.22	4.34	4.32	1.16	2.17	1.02	53.71

1962	4.92	3.77	4.66	5.55	2.13	8.84	6.52	3.10	5.49	0.55	7.07	2.37	54.97
1963	6.21	3.09	1.29	1.77	6.47	4.60	5.66	2.13	6.49	0.94	6.55	1.88	47.08
1964	5.88	6.78	2.71	3.77	3.49	5.55	6.34	4.56	4.95	8.85	1.56	3.71	58.15
1965	1.13	6.20	6.76	3.89	4.30	6.72	6.94	4.51	5.17	2.15	1.15	0.55	49.47
1966	5.69	4.91	3.45	2.84	4.62	4.79	7.40	5.97	3.52	0.86	1.43	4.75	50.23
1967	3.80	3.60	1.95	2.35	3.83	5.17	6.29	4.24	5.87	1.20	3.20	4.45	45.95
1968	3.90	1.13	3.27	3.40	2.57	2.24	5.47	0.92	0.89	4.25	3.80	2.07	33.91
1969	2.45	2.95	4.57	4.15	5.37	9.56	5.37	5.83	2.15	3.23	3.67	3.36	52.66
1970	2.25	5.15	6.64	1.11	2.39	1.79	7.54	6.40	5.42	4.03	2.77	2.14	47.63
1971	4.64	3.52	7.73	3.23	5.71	2.72	7.33	8.34	3.42	7.44	1.58	1.33	56.99
1972	4.76	5.12	3.53	1.34	4.39	4.16	4.01	3.97	2.67	1.45	5.57	3.29	44.26
1973	4.35	7.36	5.28	6.95	4.09	5.56	3.24	3.54	3.06	1.74	0.65	6.39	52.21
1974	5.01	4.77	3.87	2.69	7.53	5.25	4.72	11.68	6.82	1.06	1.92	5.30	60.62
1975	3.95	4.51	4.70	5.19	6.04	2.90	6.46	1.20	4.78	1.71	1.75	4.45	47.64
1976	3.71	1.33	3.26	0.13	4.17	5.70	3.84	3.59	3.78	3.12	3.46	4.56	40.65
1977	2.20	2.13	6.12	0.99	4.90	4.32	4.19	6.68	2.08	3.93	5.50	5.82	48.86
1978	5.63	1.08	3.83	4.08	6.16	5.50	5.53	6.26	3.28	1.09	4.10	2.24	48.78
1979	3.64	4.67	5.82	1.95	9.04	8.64	4.56	1.92	11.87	0.59	3.76	2.28	58.74
1980	4.63	1.48	8.62	1.68	4.89	2.56	5.39	1.10	3.83	3.05	1.62	3.32	42.17
1981	1.12	2.38	2.93	0.78	6.71	9.76	10.19	9.39	2.17	1.62	0.51	5.22	52.78
1982	6.95	5.35	1.43	4.16	2.03	4.78	5.02	2.89	3.80	5.23	2.05	4.13	47.82
1983	3.67	6.38	8.81	5.88	2.98	6.01	3.95	1.30	2.77	2.69	3.37	4.81	52.62
1984	2.81	6.13	6.09	3.32	M3.84	1.61	12.70	2.96	8.02	0.34	1.04	0.45	49.31
1985	3.46	5.29	1.13	1.24	2.40	3.41	5.86	3.57	6.98	M4.16	4.16	1.58	43.24
1986	1.25	1.65	2.52	0.30	5.15	5.62	6.93	5.28	0.47	2.80	3.66	3.76	39.39
1987	6.83	3.85	4.18	2.56	0.53	6.26	5.22	M7.49	7.68	1.29	3.64	2.36	51.89
1988	3.68	0.91	2.58	3.20	4.99	2.62	6.32	7.69	4.27	1.06	1.07	0.33	38.72
1989	2.42	2.46	5.75	5.01	5.68	4.54	5.26	7.25		2.92	2.35	4.07	47.71
1990	1.70	2.12	3.38	1.35	6.59	0.46	3.63	7.37	0.15	7.25	1.81	2.75	38.56
1991	6.88	1.96	6.03	2.27	2.67	3.45	9.72	6.48	5.89	1.93	2.24	1.90	51.42
1992	4.23	1.94	2.76	2.31	4.21	4.32	4.06	13.45	4.54	3.61	6.07	3.64	55.14
1993	6.18	2.11	3.90	5.45	1.38	3.28	4.15	5.31	7.18	4.12	0.91	2.39	46.36
1994	5.36	1.82	4.26	2.31	4.59	5.56	6.20	6.93	4.82	5.34	2.35	3.26	52.80
1995	6.08	4.73	3.25	0.72	5.08	6.48	5.58	3.17	4.29	4.89	3.79	1.97	50.03

1996	3.02	M2.57	5.26	4.70	3.69	4.72	6.88	7.42	16.11	5.06	2.51	3.08	65.02
1997	3.78	3.17	M1.92	3.78	1.26	2.39	4.57	1.88	5.19	2.54	M5.56	4.57	40.61
1998	6.68	7.98	M7.38	3.79	6.85	7.08	4.52	7.26	3.59	0.36	2.17	4.90	62.56
1999	8.04	2.35	2.88	4.29	5.59	2.39	3.26	5.39	18.05	7.35	0.98	1.75	62.32
2000	5.37	1.14	5.49	2.56	3.08	8.69	5.92	8.53	5.61	0.02	3.53	2.28	52.22
2001	0.88	2.63	5.41	M0.69	4.65	3.87	3.56	7.34	M2.20	0.46	1.34	1.08	34.11
2002	4.23	2.04	3.63	1.10	2.86	3.54	4.27	4.77	3.13	3.77	3.33	3.03	39.70
2003	1.51	4.40	5.06	5.54	7.16	2.76	10.35	3.62	7.47	4.55	0.99	3.54	56.95
2004	1.66	5.92	0.70	4.25	4.28	2.94	4.13	9.02	3.18	0.86	4.74	2.04	43.72
2005	1.71	3.37	2.73	1.46	4.05	5.08	3.96	4.28	3.83	6.29	3.22	3.19	43.17
2006	3.12	3.16	1.09	4.68	3.66	9.31	4.09	4.29	7.10	3.55	7.58	3.45	55.08
2007	3.00	2.26	1.53	3.90	1.81	3.51	1.98	1.83	1.27	3.79	0.20	3.69	28.77
2008	2.19	4.24	4.83	4.33	4.60	2.82	5.59	5.39	7.76	0.99	3.25	2.43	48.42
2009	1.76	M1.77	4.23	3.66	7.83	3.36	5.04	6.30	2.52	3.23	6.47	7.91	54.08
2010	4.30	3.50	3.26	0.74	4.35	4.26	2.28	2.61	10.69	1.48	1.72	1.67	40.86
2011	1.37	3.99	3.78	3.81	2.18	1.20	5.59	10.49	3.80	1.76	3.99	0.67	42.63
2012	1.80	2.35	4.85	2.89	9.11	2.59	6.30	7.68	3.16	2.92	1.58	4.40	49.63
2013	1.13	4.37	2.66	4.19	2.21	13.28	8.59	5.10	1.55	0.91	3.55	5.52	53.06
2014	3.35	2.97	4.64	3.13	5.34	2.10	7.77	9.81	8.70	1.31	3.67	2.96	55.75
2015	2.36	4.62	4.58	3.29	2.09	3.69	2.31	2.68	3.93	11.18	5.55	6.25	52.53
2016	3.19	8.61	M1.81	4.40	5.65	7.37	10.21	M4.55	M11.34	10.60	0.85	4.28	72.86
2017	2.25	2.01	3.17	4.58	4.77	3.48	4.33	M6.68	6.14	3.06	0.90	4.27	45.64
2018	2.71	M0.93	3.62	4.82	4.69	M3.68	4.15	M6.07	23.31	M2.74	M3.57	7.47	67.76
2019	2.06	M1.94	2.62	5.54	1.35	2.29	4.66	5.80	5.40	3.38	M3.29		38.33
2020							4.87	7.19	8.14	2.48	6.45	4.34	33.47
2021	6.28	8.50	1.62										16.40

Notes: Data missing in any month have an "M" flag. A "T" indicates a trace of precipitation.

Data missing for all days in a month or year is blank.

Creation date: 2021-12-07

Appendix E
Project Timeline and Contact Info

Table 15. Project Timeline
Table 16. Project Contacts

Table 15. Project Timeline
Shaw's Run Stream and Wetland Mitigation Site/100055

Activity or Deliverable	Data Collection Complete	Task Completion or Deliverable Submission
Project Instituted	NA	20-Apr-18
Mitigation Plan Approved	NA	02-Dec-19
Construction (Grading) Completed	NA	25-Jun-20
Planting Completed	NA	20-Dec-20
As-built Survey Completed	Jan-21	Jan-21
MY-0 Baseline Report	Jan-21	Mar-21
MY-1 Monitoring Report	Oct-21	Dec-21

Table 16. Project Contacts
Shaw's Run Stream and Wetland Mitigation Site/100055

Provider Mitigation Provider POC	Restoration Systems 1101 Haynes Street, #211 Raleigh, NC 27604 Raymond Holz 919-755-9490
Designer Primary project design POC	Axiom Environmental 218 Snow Ave Raleigh, NC 27603 Grant Lewis 919-215-1693
Construction Contractor	Land Mechanics 126 Circle G Lane Willow Spring, NC 27592 Loyde Glover 919-639-6132

Appendix F
Other Data

Preconstruction Benthic Results
Preconstruction Benthic Habitat Assessment Data Forms

PAI ID NO			53928	53929
STATION			UT-1	UT-2
DATE			6/9/2020	6/9/2020
SPECIES	Tolerance Value	Functional Feeding Group		
ARTHROPODA				
Crustacea				
Isopoda				
Asellidae		SH		
Caecidotea sp.	8.4	CG		4
Amphipoda		CG		
Crangonyctidae				
Crangonyx sp.	7.2	CG		1
Insecta				
Hemiptera				
Corixidae		PI	1	
Coleoptera				
Dytiscidae		P		
Copelatus sp.			2	3
Neoporus sp.	5			1
Thermonectus sp.		P	2	
Uvarus sp.				1
Hydrophilidae		P		
Enochrus sp.	8.5	CG	1	1
Tropisternus sp.	9.3	P	4	9
Diptera				
Chironomidae				
Chironomus sp.	9.3	CG	10	40
Goeldichironomus sp.			46	4
Psectrotanypus sp.				1
Psychodidae		CG		
Pericoma sp.		CG		1
Sciomyzidae				2
TOTAL NO. OF ORGANISMS			66	68
TOTAL NO. OF TAXA			7	12
EPT TAXA			0	0
BIOTIC INDEX ASSIGNED VALUES			9.24	8.78

SR UT1

3/06 Revision 7

Habitat Assessment Field Data Sheet
Coastal Plain Streams

TOTAL SCORE 33

Biological Assessment Unit, DWQ

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

Stream Shaws Run UT-1 Location/road: Cudbow (Road Name Braswell) County Columbus

Date 200609 **CC#** 03040203 Basin Lumber Subbasin 03-07-50

Observer(s) K.J Type of Study: ☐ Fish ☑ Benthos ☐ Basinwide ☐ Special Study (Describe) _____

Latitude 34.31735 Longitude -78.86707 Ecoregion: ☐ CA ☐ SWP ☐ Sandhills ☐ CB

Water Quality: Temperature _____ °C DO _____ mg/l Conductivity (corr.) _____ µS/cm pH _____

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

Visible Land Use: 5 %Forest 10 %Residential _____ %Active Pasture 85 % Active Crops
_____ %Fallow Fields _____ % Commercial _____ %Industrial _____ %Other - Describe: _____

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

Width: (meters) Stream 1 Channel (at top of bank) 1.2 **Stream Depth:** (m) Avg .2 Max .5
☐ **Width variable** ☐ **Braided channel** ☐ **Large river >25m wide**
Bank Height (from deepest part of channel to top of bank): (m) 1-2

Flow conditions : ☐ High ☑ Normal ☐ Low

Channel Flow Status

Useful especially under abnormal or low flow conditions.

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

Turbidity: ☐ Clear ☒ Slightly Turbid ☐ Turbid ☐ Tannic ☐ Milky ☐ Colored (from dyes) ☐ Green tinge
Good potential for Wetlands Restoration Project?? ☑ **YES** ☐ **NO**
Details proposed stream and wetland project

☐ Channelized ditch
☒ Deeply incised-steep, straight banks ☐ Both banks undercut at bend ☐ Channel filled in with sediment
☐ Recent overbank deposits ☐ Bar development ☐ Sewage smell
☐ Excessive periphyton growth ☐ Heavy filamentous algae growth

Manmade Stabilization: ☒ N ☐ Y: ☐ Rip-rap, cement, gabions ☐ Sediment/grade-control structure ☐ Berm/levee
Weather Conditions: Clear - cool **Photos:** ☐ N ☐ Y ☐ Digital ☐ 35mm

Remarks: - above Goshen marker

TYPICAL STREAM CROSS SECTION DIAGRAM ON BACK

I. Channel Modification

	Score
A. Natural channel-minimal dredging.....	15
B. Some channelization near bridge, or historic (>20 year old), and/or bends beginning to reappear..	10
C. Extensive channelization, straight as far as can see, channelized ditch.....	(5)
D. Banks shored with hard structure, >80% of reach disrupted, instream habitat gone.....	0

Remarks _____ Subtotal 5

II. Instream Habitat: Consider the percentage of the reach that is favorable for benthos colonization or fish cover. If >50% of the reach is snags, and 1 type is present, circle the score of 16. Definition: leafpacks consist of older leaves that are packed together and have begun to decay (not piles of leaves in pool areas). Mark as Rare, Common, or Abundant.

__/__ **Sticks** ____ **Snags/logs** ____ **Undercut banks or root mats** ____ **Macrophytes** __X__ **Leafpacks**

AMOUNT OF REACH FAVORABLE FOR COLONIZATION OR COVER

	>50% Score	30-50% Score	10-30% Score	<10% Score
4 or 5 types present.....	20	15	10	5
3 types present.....	18	13	8	4
2 types present.....	17	12	(7)	3
1 type present.....	16	11	6	2
No substrate for benthos colonization and no fish cover.....0				

☐ No woody vegetation in riparian zone Remarks _____ Subtotal 7

III. Bottom Substrate (silt, clay, sand, detritus, gravel) look at entire reach for substrate scoring.

	Score
A. Substrate types mixed	
1. gravel dominant.....	15
2. sand dominant.....	13
3. detritus dominant.....	7
4. silt/clay/muck dominant.....	4
B. Substrate homogeneous	
1. nearly all gravel.....	12
2. nearly all sand	(7)
3. nearly all detritus.....	4
4. nearly all silt/clay/muck.....	1

Remarks _____ Subtotal 7

IV. Pool Variety Pools are areas of deeper than average maximum depths with little or no surface turbulence. Water velocities associated with pools are always slow.

	Score
A. Pools present	
1. Pools Frequent (>30% of 100m length surveyed)	
a. variety of pool sizes.....	10
b. pools about the same size (indicates pools filling in).....	8
2. Pools Infrequent (<30% of the 100m length surveyed)	
a. variety of pool sizes.....	(6)
b. pools about the same size.....	4
B. Pools absent	
1. Deep water/run habitat present.....	4
2. Deep water/run habitat absent.....	0

Subtotal 6

Remarks _____ Page Total 25

V. Bank Stability and Vegetation

	Score	Score
A. Banks stable or no banks, just flood plain		
1. little or no evidence of erosion or bank failure, little potential for erosion	10	10
B. Erosion areas present		
1. diverse trees, shrubs, grass; plants healthy with good root systems.....	9	9
2. few trees or small trees and shrubs; vegetation appears generally healthy.....	7	7
3. sparse vegetation; plant types and conditions suggest poorer soil binding.....	4	4
4. mostly grasses, few if any trees and shrubs, high erosion and failure potential at high flow	(2)	0
5. little or no bank vegetation, mass erosion and bank failure evident.....0	0	

Total 4

Remarks _____

VI. Light Penetration (Canopy is defined as tree or vegetative cover directly above the stream's surface. Canopy would block out sunlight when the sun is directly overhead).

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

Subtotal 2

Remarks _____

VII. Riparian Vegetative Zone Width

Definition: A break in the riparian zone is any area which allows sediment to enter the stream. Breaks refer to the near-stream portion of the riparian zone (banks); places where pollutants can directly enter the stream.

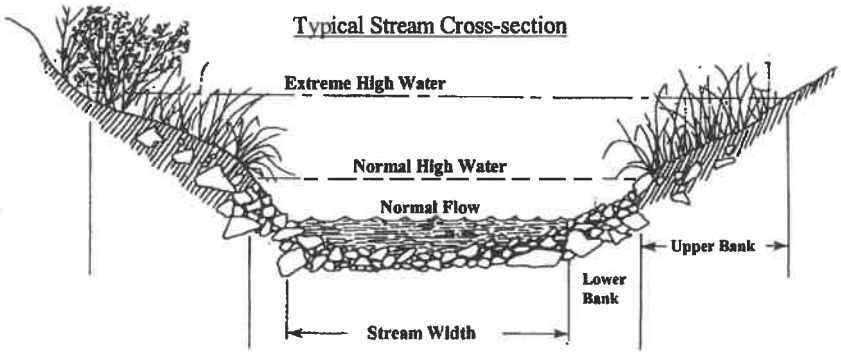
	Lft. Bank Score	Rt. Bank Score
A. Riparian zone **intact** (no breaks)		
1. zone width > 18 meters.....	5	5
2. zone width 12-18 meters.....	4	4
3. zone width 6-12 meters.....	3	3
4. zone width < 6 meters.....	2	2
B. Riparian zone **not intact** (breaks)		
1. breaks rare		
a. zone width > 18 meters.....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

Total 2

Remarks _____

Page Total 8

TOTAL SCORE 33



This side is 45° bank angle.

SR 4T-2

3/06 Revision 7

Habitat Assessment Field Data Sheet
Coastal Plain Streams

TOTAL SCORE 48

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

Stream Shawnee Run 4T-2 Location/road: (Muddy Quarter (Road Name Braswell) County Columbus

Date 200609 **CC#** 03040203 Basin Lumber Subbasin 03-07-50

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

Latitude 34.319608 Longitude -78.866604 Ecoregion: ☐ CA ☐ SWP ☐ Sandhills ☐ CB ?
Carolina Flatwoods

Water Quality: Temperature ~ °C DO — mg/l Conductivity (corr.) ~ µS/cm pH ~

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

Visible Land Use: 5 %Forest 10 %Residential _____%Active Pasture 85 % Active Crops
_____%Fallow Fields _____% Commercial _____%Industrial _____%Other - Describe:_____

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

Width: (meters) Stream 2 Channel (at top of bank) 1-2 **Stream Depth:** (m) Avg 1 Max 1.5
☒**Width variable** ☐**Braided channel** ☐**Large river >25m wide**
Bank Height (from deepest part of channel to top of bank): (m) 1-2

Flow conditions : ☐High ☒Normal ☐Low
Channel Flow Status
Useful especially under abnormal or low flow conditions.

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

Turbidity: ☐Clear ☒Slightly Turbid ☐Turbid ☐Tannic ☐Milky ☐Colored (from dyes) ☐Green tinge
Good potential for Wetlands Restoration Project?? ☒**YES** ☐**NO**
Details proposed stream and wetland restoration site

☐Channelized ditch
☒Deeply incised-steep, straight banks ☐Both banks undercut at bend ☐Channel filled in with sediment
☐Recent overbank deposits ☐Bar development ☐Sewage smell
☐Excessive periphyton growth ☐Heavy filamentous algae growth

Manmade Stabilization: ☒N ☐Y: ☐Rip-rap, cement, gabions ☐ Sediment/grade-control structure ☐Berm/levee
Weather Conditions: Clear - hot **Photos:** ☒N ☐Y ☐Digital ☐35mm

Remarks:
TYPICAL STREAM CROSS SECTION DIAGRAM ON BACK

SR UT2

I. Channel Modification

	Score
A. Natural channel-minimal dredging	15
B. Some channelization near bridge, or historic (>20 year old), and/or bends beginning to reappear..	10
C. Extensive channelization, straight as far as can see, channelized ditch	(5)
D. Banks shored with hard structure, >80% of reach disrupted, instream habitat gone	0

Remarks _____ Subtotal 5

II. Instream Habitat: Consider the percentage of the reach that is favorable for benthos colonization or fish cover. If >50% of the reach is snags, and 1 type is present, circle the score of 16. Definition: leafpacks consist of older leaves that are packed together and have begun to decay (not piles of leaves in pool areas). Mark as Rare, Common, or Abundant.

X **Sticks** ___ **Snags/logs** ___ **Undercut banks or root mats** ___ **Macrophytes** X **Leafpacks**

AMOUNT OF REACH FAVORABLE FOR COLONIZATION OR COVER

	>50% Score	30-50% Score	10-30% Score	<10% Score
4 or 5 types present	20	15	10	5
3 types present	18	13	8	4
2 types present	17	(12)	7	3
1 type present	16	11	6	2

No substrate for benthos colonization and no fish cover.....0

☐ No woody vegetation in riparian zone Remarks _____ Subtotal 12

III. Bottom Substrate (silt, clay, sand, detritus, gravel) look at entire reach for substrate scoring.

	Score
A. Substrate types mixed	
1. gravel dominant	15
2. sand dominant	(13)
3. detritus dominant	7
4. silt/clay/muck dominant	4
B. Substrate homogeneous	
1. nearly all gravel	12
2. nearly all sand	7
3. nearly all detritus	4
4. nearly all silt/clay/muck	1

Remarks _____ Subtotal 13

IV. Pool Variety Pools are areas of deeper than average maximum depths with little or no surface turbulence. Water velocities associated with pools are always slow.

	Score
A. Pools present	
1. Pools Frequent (>30% of 100m length surveyed)	
a. variety of pool sizes	10
b. pools about the same size (indicates pools filling in)	8
2. Pools Infrequent (<30% of the 100m length surveyed)	
a. variety of pool sizes	(6)
b. pools about the same size	4
B. Pools absent	
1. Deep water/run habitat present	4
2. Deep water/run habitat absent	0

Subtotal 6

Remarks _____ Page Total 36

V. Bank Stability and Vegetation

	Score	Score
A. Banks stable or no banks, just flood plain		
1. little or no evidence of erosion or bank failure, little potential for erosion	10	10
B. Erosion areas present		
1. diverse trees, shrubs, grass; plants healthy with good root systems.....	9	9
2. few trees or small trees and shrubs; vegetation appears generally healthy.....	7	7
3. sparse vegetation; plant types and conditions suggest poorer soil binding.....	(4)	(4)
4. mostly grasses, few if any trees and shrubs, high erosion and failure potential at high flow	2	2
5. little or no bank vegetation, mass erosion and bank failure evident.....0	0	

Total 8

Remarks – Row crops cutting stream

VI. Light Penetration (Canopy is defined as tree or vegetative cover directly above the stream's surface. Canopy would block out sunlight when the sun is directly overhead).

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

Subtotal 2

Remarks

VII. Riparian Vegetative Zone Width

Definition: A break in the riparian zone is any area which allows sediment to enter the stream. Breaks refer to the near-stream portion of the riparian zone (banks); places where pollutants can directly enter the stream.

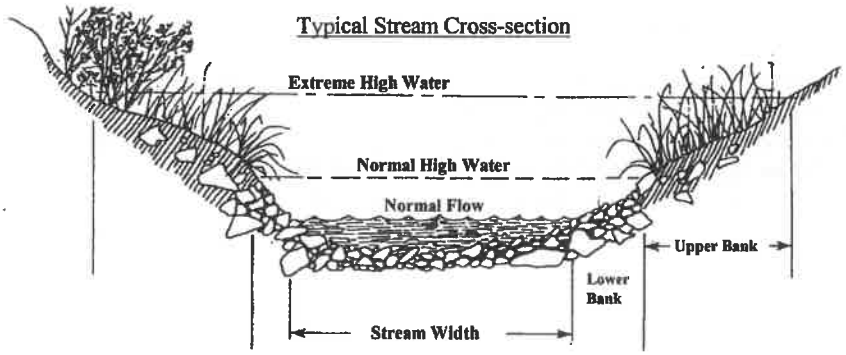
	Lft. Bank Score	Rt. Bank Score
A. Riparian zone **intact** (no breaks)		
1. zone width > 18 meters.....	5	5
2. zone width 12-18 meters.....	4	4
3. zone width 6-12 meters.....	3	3
4. zone width < 6 meters.....	2	2
B. Riparian zone **not intact** (breaks)		
1. breaks rare		
a. zone width > 18 meters.....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

Total 2

Remarks Farmed by row crops, very little forested (on) in watershed

Page Total 12

TOTAL SCORE 48



This side is 45° bank angle.