MY1 MONITORING REPORT

Wits End Stream and Wetland Mitigation Site

Union County, North Carolina
Yadkin River Basin
Cataloging Unit 03040105

DMS Project No. 100164
Full Delivery Contract No. 7968
DMS RFQ No. 16-032819-YD05 (Date of Issue: May 9, 2019)
USACE Action ID No. SAW-2020-00455
DWR Project No. 20200369

Data Collection: March - November 2023
Submission: February 2024

Prepared for:

NORTH CAROLINA DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF MITIGATION SERVICES
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Response to DMS Comment – MY1 (2023)
DMS Project ID No. 100164
Full Delivery Contract No. 7968
USACE Action ID No. SAW-2020-00455
DWR Project No. 2020-0369
IFB 16-032819, RFQ 16-032819-YD05

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

General

1. Thank you for addressing the action items identified in the DMS Boundary Inspection report. Please verify that the conservation easement boundary has been inspected and no new encroachments have been identified.
   Response: The easement boundary has been inspected, and no new encroachments have been identified since the DMS boundary inspection.

2. 3.1 Stream Assessment: Please add a short discussion of the off site beaver dam and how it relates to stream stability at the downstream end of Waxhaw Branch.
   Response: The following passage has been added to Section 3.1: "Beaver activity is present downstream of the Site, across Snyder Store Road, to the point that a portion of the outfall structure was inundated at times during the year. The activity has not caused any observable stream stability or vegetation issues in the downstream portion of Waxhaw Branch. RS will continue to monitor beaver activity, but at this point, the observed activity was not a detriment to the reach.

3. 3.3 Vegetative Assessment: Please include a discussion of the invasive treatments that occurred at the site. The monitoring summary indicates that several invasive treatments occurred targeting privet, fescue, bamboo, chinaberry, multiflora rose, and tree of heaven.
   Response: The following discussion was added to Section 3.3: "Several small, scattered, and isolated populations of Chinese privet (*Ligustrum sinense*), fescue (*Festuca* sp.), bamboo (*Bambusa vulgaris*), Chinaberry (*Melia azedarach*), multiflora rose (*Rosa multiflora*), and tree of heaven (*Ailanthus altissima*) were observed throughout the Site. These were addressed with three separate treatments during MY1 (2023); February 20, June 26-27, and September 18. Invasive species will continue to be monitored but do not currently pose a threat to Site vegetative success."

4. 3.2 Vegetative Assessment: When discussing the replant effort that occurred on January 23, 2023, please reference Figure 2 in Appendix A and Table 6D in Appendix B.
   Response: References to Figure 2 (Appendix A) and Table 6D (Appendix B) were added to the discussion of the January 23, 2023, replanting effort.

5. Please include photos and updates once the Adaptive Management Plan has been implemented in the MY2 report.
   Response: The MY2 report will contain updates and a photo log of AMP activities.

6. DMS Recommends at least 2 temporary vegetation plots be conducted within the pond bottom/replant area in MY2.
   Response: At least 2 temporary plots will be measured within this area during MY2.

7. Table 7: Due to the large number of vegetation plots, DMS recommends shading the success criteria met cell either green/red based on meeting success criteria for the year.
   Response: The "Success Criteria Met?" column was color-coded; green = yes and red = no.

8. Table 11: Recommend revising table to clearly show which gauges are meeting success criteria for each year. Please see "overbank event" tab in the DMSMonReportTablesOct2020.xls for example. Currently the 2 crest gauges on Waxhaw are not accounted for in the table, nor is a bankfull event reported on Waxhaw. Revising the table will make it easier to know which gauges are meeting the four separate bankfull events, occurring in separate years, requirement.
   Response: A column was added to indicate on which reach(es) each bankfull event was documented. All references to Waxhaw Branch were mistakenly labelled UT-1. This has been corrected. Additionally, a summary table (Table 11B) was added to match the DMS template format. We feel that that current table provides valuable information on the method of documentation for each bankfull event, so adding the summary table will help tie the data to success criteria.

9. Crest Gauge Graphs: Two graphs are incorrectly labeled UT1 upstream and UT1 downstream. These should be Waxhaw
   Response: The Waxhaw Branch crest gauge graph titles have been corrected.

10. Crest Gauge Graphs: Please include bankfull elevation line for each graph. Recommend adding a legend to each graph.
    Response: A bankfull elevation line and legend were added to each crest gauge graph.

11. Table 12: Same comment as Table 7 above. Please color code cells for meeting/not meeting success.
    Response: Table 12 was color-coded to indicate meeting/not meeting success.

12. Groundwater Gauge Graphs: Recommend adding ground surface line at 0.
    Response: A ground surface line was added to each graph.

13. Flow Gauge Graphs: Please include bankfull elevation and legend.
    Response: A bankfull elevation line and legend were added to each flow gauge graph.

14. Table 14: Please include the following:
    - Stream Survey and Vegetation Survey lines for MY1 as it is shown for MY0
    - Replant that occurred on January 23, 2023
    - Invasive Treatment that occurred in Feb, June, and Sep 2023

    Response: These events were added to Table 14.

Wits End Year 1, 2023 Monitoring Summary

General Notes

- The DMS boundary inspection identified six small areas of encroachment totaling 0.296 acres were identified during MY1 (2023). Restoration Systems has communicated with the farmer that easement encroachment is not permissible, and enhanced easement visibility by adding signage and horse tape to prevent further encroachment (Appendix A and G). RS will replant these areas as needed with 3-gallon upland containerized species from the approved Mitigation Plan during the Adaptive Management Plan planting phase.
- Additional items from the DMS boundary inspection report related to marking/monumentation that was missing, damaged, or not meeting specification were addressed (Appendix A and G).
- Beaver activity is present downstream of the Site, across Snyder Store Road, to the point that a portion of the outfall structure was inundated at times during the year. RS will continue to monitor beaver activity, but at this point, the observed activity was not a detriment to the reach.

Site Maintenance Report (2023)

Invasive Species Work	Maintenance work
02/20/2023: Chinese Privet & Fescue 06/26-27/2023: Bamboo, Chinaberry, & Chinese Privet 09/18/2023: Chinaberry, Chinese Privet, Multiflora Rose, & Tree of Heaven	01/23/2023: Tree Planting (replant of 33.4-acres) 06/05/2023: Remnant Fence Removal 09/28/2023: Survey Work (replaced missing and unstamped caps) 09/23/2023: Boundary Work (add/adjusted/replace/move signage and posts)

Streams

- Streams remained stable with little or no deviations from MY0.
- All engineered structures were stable and function within design parameters: no stream areas of concern were documented.
- Four bankfull events were documented during MY1 (2023) (Table 11, Appendix D).
- Flow gauges on UT2, UT3, UT3A, UT4, and UT5 documented 113, 148, 110, 115, and 111 consecutive days of flow respectively, meeting success criteria for each tributary.

Wetlands

- Nineteen of 27 ground water gauges met success criteria for MY1 (2023). Gauges 5 and 14 each dropped below 12 inches of the surface for just 7 and 4 of the first 35 days of the growing season, respectively. Otherwise, these gauges would have met success criteria during MY1. Gauges 17, 18, 19, 20, 22, and 24, which also did not meet success criteria, are within the former pond bed along Waxhaw Branch.
- Due to insufficient planted stem survival and a lack of wetland hydrology within the former pond bed along Waxhaw Branch, Restoration Systems (RS) has implemented an Adaptive Management Plan to address the observed surface cracking in former pond sediments left behind after Site construction. The hydrology issues have been addressed by: (1) physically mixing 0.427 acres of

existing top soils that were observed to be severely cracked, then reincorporating the soil along with additional large woody debris to help reestablish healthy soil structure; and (2) installing 2 floodplain grade control (VGC) structures to eliminate subsurface groundwater flow through existing surface cracks and to encourage sediment deposition within the cracks instead of on the floodplain itself. The VGC structures were installed in areas where outer bends of Waxhaw Branch come within close proximity of the former pond boundary. These management activities are expected to improve groundwater hydrology in this area during future monitoring years. See the 2023 Adaptive Management Plan (Appendix F) for details regarding soil and hydrology improvement-related activities.

Vegetation

- Measurements of 37 vegetation plots resulted in an average of 416 stems/acre. Twenty-five of the 37 measured permanent plots met the interim stem density requirement for MY3. Additionally, measurement of the 12 temporary vegetation plots yielded an average of 492 stems/acre, with 10 of the 12 temporary plots meeting the MY3 stem density requirement. Accounting both permanent and temporary vegetation plots, the Site contained an average of 434 stems/acre. See Appendix B for MY1 vegetation data.
- Bare root planted stem mortality was exceptionally prominent within the former pond bed along Waxhaw Branch. Visible surface cracking was observed during MY1 monitoring, which resulted in the exposure of roots on bare-root trees, leading to their mortality. In many cases, the dibble bar holes themselves were observed to have contributed to surface cracking and air pruning. As such, the 2023 Adaptive Management Plan focuses on planting methods such as live-staking and seeding, that allow trees to establish roots themselves rather than attempting to transplant an existing root structure into potentially inadequate soil conditions. Target planting areas are depicted on Figure 1 (Appendix A), and details regarding the supplemental planting effort are in the 2023 Adaptive Management Plan (Appendix F). Once the planting phase of the Adaptive Management Plan is complete RS will provide an Adaptive Management Plan Implementation Memo.
- A replanting effort took place on January 23, 2023, on 33.4-acres of the Project where low survivorship was observed in MY0 (Appendix A and B).
- Invasive vegetation treatments have been effective in reducing populations and currently areas of invasive vegetation are below the mapping threshold. These areas will continue to be monitored and treated as needed.

Site Monitoring Activity and Reporting History

Project Milestones	Stream Monitoring Complete	Vegetation Monitoring Complete	Wetland Monitoring	Data Analysis Complete	Completion or Delivery
Construction Earthwork	--	--	--	--	July 22, 2022
Planting	--	--	--	--	January 23, 2023
As-Built Documentation	June 1-6, 2022	February 15, 2023	--	February 2023	April 2023
Year 1 Monitoring	April 2, 2023	October 2, 2023	Jan. – Nov. 2023	November 2023	February 2024
Adaptive Management Plan Implementation	--	--	--	--	Q1 2024

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1 PROJECT SUMMARY

Restoration Systems, LLC (RS) has established the North Carolina Division of Mitigation Services (NCDMS) Wits End Stream and Wetland Mitigation Site (Site). The Site is on five contiguous parcels in the Carolina Slate Belt portion of the Southeastern Plains ecoregion of North Carolina. Located in the Yadkin River Basin, Cataloging Unit 03040105, the Site is in the Targeted Local Watershed (TLW) 03040105081020 and North Carolina Division of Water Resources [NCDWR] subbasin number 03-07-14. The Site is not located in a Local Watershed Plan (LWP), Regional Watershed Plan (RWP), or Targeted Resource Area (TRA). Site watersheds range from approximately 0.04 of a square mile (25 acres) on UT5 to 1.09 square miles (700 acres) at the Site's outfall.

1.1 Project Background, Components, and Structure

Located approximately 5 miles south of Wingate, NC, and seven miles north of the NC/SC state line, the Site encompasses 71.7 acres. Mitigation work within the Site included 1) stream restoration, 2) stream enhancement (Level I), 3) stream enhancement (Level II), 4) wetland reestablishment, 5) wetland enhancement, 6) wetland creation, 7) wetland preservation, and 8) vegetation planting. The Site is expected to provide 11,525.946 warm water stream credits and 24.163 riparian wetland credits by closeout (Table 1, Page 2). A conservation easement was granted to the State of North Carolina and recorded in the Union County Register of Deeds on September 30, 2021.

Before construction, land use at the Site was characterized by open water and maintained fields. Site design was completed on January 27, 2022; construction started on February 1, 2022, and ended with a final walkthrough on July 22, 2022. The Site was planted between April 7, 2022 and January 23, 2023. Completed project activities, reporting history, completion dates, and project contacts are summarized in Tables 14-15 (Appendix E).

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Table 1. Wits End Mitigation Site (ID-100164) 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							
Waxhaw Br Upstream R1	330	329	Warm	EII*	5.000	66.000	
Waxhaw Br Upstream R2**	42	52	Warm	R	1.000	52.000	
Waxhaw Br Upstream R3	2547	2533	Warm	R	1.000	2,547.000	62 ft of piped crossing between R3 and R4 receives no credit
Waxhaw Br Upstream R4	1051	1042	Warm	R	1.000	1,051.000	
Waxhaw Br Downstream	1362	1368	Warm	R	1.000	1,362.000	
UT 1 R1**	2	14	Warm	EII*	5.000	2.800	
UT 1 R2	96	97	Warm	EII*	5.000	19.200	
UT 1 R3	78	77	Warm	R	1.000	78.000	
UT 2 R1	583	579	Warm	R	1.000	583.000	49 ft of forded crossing between R1 and R2 receives no credit
UT 2 R2**	36	46	Warm	R	1.000	46.000	
UT 2 R3	562	560	Warm	R	1.000	562.000	
UT 3A	780	792	Warm	R	1.000	780.000	
UT 3 Upstream R1	168	171	Warm	EII*	5.000	33.600	
UT 3 Upstream R2	232	232	Warm	EI	1.500	154.667	
UT 3 Upstream R3	770	757	Warm	R	1.000	770.000	
UT 3 Downstream R1^	1459	41	Warm	R	1.000	41.000	
UT 3 Downstream R2^	NA	292	Warm	EII*	5.000	58.400	
UT 3 Downstream R3^	NA	1109	Warm	R	1.000	1,109.000	
UT 4	1223	1215	Warm	R	1.000	1,223.000	
UT 5 R1	73	73	Warm	EII*	5.000	14.600	
UT 5 R2	119	118	Warm	R	1.000	119.000	
					Total:	**10,672.267**	
Wetland							
Wetland Reestablish[@]	22.886	22.833	NA	REE	1.000	22.833	
Wetland Enhancement	1.442	1.442	NA	E	2.000	0.721	
Wetland Creation	0.351	0.351	R	P	10.000	0.117	
Wetland Preservation	4.923	4.916	R	C	3.000	0.492	
					Total:	**24.163**	

Project Credits

	Stream			Riparian	Non-Rip	Coastal
Restoration Level	Warm	Cool	Cold	Wetland	Wetland	Marsh
Restoration	10,323.000					
Re-establishment				22.833		
Rehabilitation						
Enhancement				0.721		
Enhancement I	154.667					
Enhancement II						
Enhancement II*	194.600					
Creation				0.117		
Preservation				0.492		
Benthics	212.989					
Wider Buffer[%]	640.690					
Totals	**11,525.946**			**24.163**		

Total Stream Credit **11,525.946**
Total Wetland Credit **24.163**

* Enhancement at reduced ratio

** The ATV paths and forded crossings proposed in the Mitigation Plan were legally abandoned and were not constructed

^ UT 3 channel realigned during construction back into old channel. This reach (R2) is now Enhancement (level II) at 5:1 with 2 smaller reaches of Restoration above and below (R1 and R3).

[@] Wetland reestablishment credit reduced due to UT 3 realignment

[%] Wider buffer credit updated due to UT 3 channel realignment

Wetland Mitigation Category

CM	Coastal Marsh
R	Riparian
NR	Non-Riparian

Restoration Level

HQP	High Quality Preservation
P	Preservation
E	Wetland Enhancement - Veg and Hydro
EII	Stream Enhancement II
EI	Stream Enhancement I
C	Wetland Creation
RH	Wetland Rehabilitation - Veg and Hydro
REE	Wetland Re-establishment Veg and Hydro
R	Restoration

Table 2. Summary: Goals, Performance, and Results

Goals	Objectives	Success Criteria
(1) HYDROLOGY		
Restore proper hydrodynamics to the Site and downstream receiving waters.	• Construct new channels at historic floodplain elevation to restore overbank flows • Remove impoundment and restore valley topography • Plant woody riparian buffer 150' from stream and wetland features • 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 • < 10% change in BHR in any given year • Document four overbank events in separate monitoring years • Attain Wetland Hydrology Success Criteria • Attain Vegetation Success Criteria • Cross-section measurements indicate a stable channel with the appropriate substrate • Visual documentation of stable channels and structures
(1) WATER QUALITY		
Remove direct nutrient and pollutant inputs from the Site and reduce contributions to downstream waters.	• Plant a woody riparian buffer 150 feet off 90% of the Site's streams and wetlands and a 100-foot buffer on the Site's ephemeral streams. • Re-establish and enhance jurisdictional wetlands • Provide surface roughness and reduce compaction through deep ripping/plowing. • Restore overbank flooding by constructing channels at historic floodplain elevation. • Enhance existing wetlands by removing stressors and returning existing wetlands back to appropriate hydroperiods.	• Attain Wetland Hydrology Success Criteria • Attain Vegetation Success Criteria
(1) HABITAT		
Improve instream and stream-side habitat.	• Construct stable channels with the appropriate substrate and at historic floodplain elevations to restore overbank flows. • Remove impoundment & restore the Waxhaw Branch FEMA floodplain to historic conditions. • Plant woody riparian buffer to provide organic matter and shade • Re-establish and enhance existing jurisdictional wetlands • Provide large-woody debris in floodplain wetlands and project buffers to historic conditions. • Re-establish and enhance existing jurisdictional wetlands	• Cross-section measurement indicates a stable channel with the appropriate substrate • Visual documentation of stable channels and in-stream structures • Attain Wetland Hydrology Success Criteria • Attain Vegetation Success Criteria

Table 3. Project Attribute Table									
Project Name	Wits End Site								
County	Union County, North Carolina								
Project Area (acres)	71.7								
Project Coordinates (latitude and longitude decimal degrees)	34.913353, -80.442090								
Project Watershed Summary Information									
Physiographic Province	Carolina Slate Belt								
River Basin	Yadkin								
USGS Hydrologic Unit 8-digit	03040105								
DWR Sub-basin	03-07-14								
Project Drainage Area (acres)	700								
Project Drainage Area Percentage of Impervious Area	<2%								
Land Use Classification	Managed Herbaceous Cover								
Reach Summary Information									
Parameters	**Waxhaw Br**	**UT1**	**UT2**	**UT3**	**UT3A**	**UT4**	**UT5**		
Pre-project length (feet)	3047	133	696	2371	734	818	161		
Post-project (feet)	5386	188	1234	2602	792	1215	191		
Valley confinement (Confined, moderately confined,	Moderate	Confined	Confined	Confined	Confined	Confined	Confined		
Drainage area (acres)	700	32	59	161	61	66	25		
Perennial, Intermittent, Ephemeral	Per	Int	Int	Per/Int	Int	Int	Int		
NCDWR Water Quality Classification	WS-V								
Dominant Stream Classification (existing)	Eg 4/5	Eg 4	E 6	G 4/5	G 4	Cg & D 4/5	Eg 4		
Dominant Stream Classification (proposed)	Ce 3/4	Ce 3/4	Ce 3/4	Ce 3/4	Ce 3/4	Ce 3/4	Ce 3/4		
Dominant Evolutionary class (Simon) if applicable	III	III	III	III/IV	III/IV	V	III		
Wetland Summary Information									
Parameters	**Wetlands**								
Pre-project (acres)	25.4 acre drained & 6.38 acre degraded								
Post-project (acres)	29.602 (Total)								
Wetland Type (non-riparian, riparian)	Riparian								
Mapped Soil Series	Cid channery silt loam and Goldston-Badin complex, and field verified Secrest-Cid complex Variant								
Soil Hydric Status	Nonhydric and Nonhydric-Nonhydric								
Regulatory Considerations									
Parameters	**Applicable?**		**Resolved?**			**Supporting Docs?**			
Water of the United States - Section 404	Yes		Yes			Section 404 Permit			
Water of the United States - Section 401	Yes		Yes			Section 401			
Endangered Species Act	Yes		Yes			CE Document			
Historic Preservation Act	Yes		Yes			CE Document			
Coastal Zone Management Act (CZMA or CAMA)	No		N/A			N/A			
Essential Fisheries Habitat	No		N/A			N/A			

1.2 Project Success Criteria

Monitoring and success criteria for stream restoration should relate to project goals and objectives identified from on-site NC SAM and NC WAM data collection. From a mitigation perspective, several 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. Table A summarizes Site success criteria.

Table A. Project Success Criteria

Streams
• All streams must maintain an Ordinary High-Water Mark (OHWM), per RGL 05-05. • Continuous surface flow in each intermittent tributary should occur each year for at least 30 consecutive days. • Bank height ratio (BHR) cannot exceed 1.2 at any measured cross-section over the monitoring period. • BHR at any measure riffle cross-section should not change by more than 10% from baseline condition during any single monitoring year. • 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 & Soils
• During average climatic conditions, saturation or inundation within the upper 12 inches of the soil surface for 8 percent of the growing season*. • Soil profile descriptions must meet one of the hydric soil indicators identified in the Field Indicators of Hydric Soils in the United States, Version 8.2 (USDA 2018) in monitoring years 4 and 7.
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 at year 7. • 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. • Any single species can only account for up to 50% of the required number of stems within any vegetation plot.

* The growing season is defined as March 1 to November 14, with the March 1 start date to be confirmed by documentation of soil temperature greater than 41°F at 12 inches below the surface and bud burst of two or more different non-evergreen vascular plant species (Section 8.1, Mitigation Plan).

2 PROJECT MONITORING – 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 31 of each monitoring year data is collected. The monitoring schedule is summarized in Table B.

Table B. 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

Table C. 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 28 cross-sections on restored channels	Graphic and tabular data.
Channel Stability	Visual Assessments	Yearly	All restored stream channels	Areas of concern depicted on the 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 the monitoring period	5 surface water gauges on UT 2, 3A, 3, 4, and 5	Surface water data for each monitoring period
Bankfull Events	Continuous monitoring surface water gauges and/or trail camera	Continuous recording through the monitoring period	3 crest gauges (pressure transducers on Waxhaw Br up-and downstream, and UT 3	Surface water data for each monitoring period
	Visual/Physical Evidence	Continuous through the monitoring period	Visual monitoring and photographic evidence as needed	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)	Pre-construction, Years 3, 5, and 7 during the "index period" referenced in *Small Streams Biocriteria Development* (NCDWQ 2009)	2 stations (on Waxhaw Br upstream and UT 3 downstream); however, the exact locations will be determined at the time pre-construction benthics are collected	Results will be presented on a site-by-site basis. They will include a list of taxa collected, an enumeration of *Ephemeroptera, Plecoptera, Tricopetera* taxa, and Biotic Index values. *
Wetland Parameters				
Parameter	**Method**	**Schedule/Frequency**	**Number/Extent**	**Data Collected/Reported**
Wetland Restoration	Groundwater gauges	Years 1, 2, 3, 4, 5, 6, and 7 throughout the year, with the modified growing season** as defined in the approved Site mitigation plan	27 gauges spread throughout restored wetlands	Soil temperature and bud burst of two woody species at the beginning of each monitoring period to verify the start of the modified growing season, groundwater and rain data for each monitoring period
	Soil profile descriptions	As-built and Years 3, 5, and 7	27 soil profile descriptions, one at each groundwater gauge	Soil profile descriptions completed to assess the development of hydric soil morphologic features
Vegetation Parameters				
Parameter	**Method**	**Schedule/Frequency**	**Number/Extent**	**Data Collected/Reported**
Vegetation establishment and vigor	Permanent vegetation plots 0.0247 acres (100 square meters) in size	As-built, Years 1, 2, 3, 5, and 7	37 plots spread across the Site	Species, height, planted vs. volunteer, stems/acre
	Annual random vegetation plots, 0.0247 acres (100 square meters) in size	As-built, Years 1, 2, 3, 5, and 7	12 plots randomly selected each year	Species and height

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

** The growing season is as defined March 1 to November 14, with the March 1 start date to be confirmed by documentation of soil temperature greater than 41°F at 12 inches below the surface and bud burst of two or more different non-evergreen vascular plant species (Section 8.1, Mitigation Plan).

3 MONITORING YEAR 1 – DATA ASSESSMENT

Annual monitoring and site visits were conducted between March 2023 and November 2023 to assess the condition of the project. Stream, wetland, and vegetation criteria for the Site follow the approved success criteria presented in the Mitigation Plan and summarized in Section 1.2; monitoring methods are detailed in Section 3.0.

3.1 Stream Assessment

Morphological surveys for MY1 were conducted on April 2, 2023. All streams within the Site are stable and functioning as designed. Refer to Appendix A for the Visual Stream Morphology Stability Assessment Table and Stream Photographs. Refer to Appendix C for Stream Geomorphology Data. No stream areas of concern were identified during MY1.

Flow gauges on UT2, UT3, UT3A, UT4, and UT5 documented 113, 148, 110, 115, and 111 consecutive days of flow respectively, meeting success criteria for each tributary. Refer to Appendix D for flow gauge data.

Four bankfull events were documented during MY1 (2023) (Table 11, Appendix D).

Beaver activity is present downstream of the Site, across Snyder Store Road, to the point that a portion of the outfall structure was inundated at times during the year. The activity has not caused any observable stream stability or vegetation issues in the downstream portion of Waxhaw Branch. RS will continue to monitor beaver activity, but at this point, the observed activity was not a detriment to the reach.

3.2 Hydrology Assessment

Nineteen of 27 ground water gauges met success criteria for MY1 (2023). Gauges 5 and 14 each dropped below 12 inches of the surface for just 7 and 4 of the first 35 days of the growing season, respectively. Otherwise, these gauges would have met success criteria during MY1. Gauges 17, 18, 19, 20, 22, and 24, which also did not meet success criteria, are within the former pond bed along Waxhaw Branch.

Due to insufficient planted stem survival and a lack of wetland hydrology within the former pond bed along Waxhaw Branch, RS has implemented an Adaptive Management Plan to address the observed surface cracking in former pod sediments left behind after Site construction. The hydrology issues have been addressed by: (1) physically mixing 0.427 acres of existing top soils that were observed to be severely cracked, then reincorporating the soil along with additional large woody debris to help reestablish healthy soil structure; and (2) installing 2 floodplain grade control (VGC) structures to eliminate subsurface groundwater flow through existing surface cracks and to encourage sediment deposition within the cracks instead of on the floodplain itself. The VGC structures were installed in areas where outer bends of Waxhaw Branch come within close proximity of the former pond boundary. These management activities are expected to improve groundwater hydrology in this area during future monitoring years. Soil mixing areas and locations of the VGC structures are depicted on Figure 1 (Appendix A). Details regarding soil and hydrology improvement-related activities are in the 2023 Adaptive Management Plan (Appendix F).

3.3 Vegetative Assessment

The MY1 vegetative survey was completed on October 2, 2023. Measurements of 37 vegetation plots resulted in an average of 416 stems/acre. Twenty-five of the 37 measured permanent plots met the interim stem density requirement for MY3. Additionally, measurement of the 12 temporary vegetation plots yielded an average of 492 stems/acre, with 10 of the 12 temporary plots meeting the MY3 stem density requirement. Accounting both permanent and temporary vegetation plots, the Site contained an average of 434 stems/acre. See Appendix B for MY1 vegetation data.

A replanting effort occurred on January 23, 2023, of 22,800 stems over 33.4-acres of the Project where low survivorship was observed in MY0 (Figure 2, Appendix A and Table 6D, Appendix B). Planted stem mortality was exceptionally prominent within the former pond bed along Waxhaw Branch. Visible surface cracking was observed during MY1 monitoring, which resulted in the exposure of roots on bare-root trees, leading to their mortality. In many cases, the dibble bar holes themselves were observed to have contributed to surface cracking and air pruning. As such, RS has implemented an Adaptive Management Plan that focuses on planting methods such as live-staking and seeding, that will allow trees to establish roots themselves rather than attempting to transplant an existing root structure into potentially inadequate soil conditions. Target planting areas are depicted on Figure 1 (Appendix A), and details regarding the supplemental planting effort are in the 2023 Adaptive Management Plan (Appendix F). Once the planting phase of the Adaptive Management Plan is complete RS will provide an Adaptive Management Plan Implementation Memo.

Several small, scattered, and isolated populations of Chinese privet (*Ligustrum sinense*), fescue (*Festuca* sp.), bamboo (*Bambusa vulgaris*), Chinaberry (*Melia azedarach*), multiflora rose (*Rosa multiflora*), and tree of heaven (*Ailanthus altissima*) were observed throughout the Site. These were addressed with three separate treatments during MY1 (2023); February 20, June 26-27, and September 18. Invasive species will continue to be monitored but do not currently pose a threat to Site vegetative success.

Six small areas (totaling 0.296 acres) of easement encroachment were observed during MY1 (2023) around the boundary of UT-2 and UT3A. RS has communicated with the farmer that easement encroachment is not permissible, and enhanced easement visibility by adding signage and horse tape to prevent further encroachment (Appendix A and G). RS will replant these areas as needed with 3-gallon upland containerized species from the approved Mitigation Plan during the Adaptive Management Plan planting phase.

3.4 Monitoring Year 1 Summary

Overall, the Site looks good, and with the implementation of the 2023 Adaptive Management Plan (Appendix F), it is on track to meet success criteria. Site vegetation is trending toward exceeding the MY3 interim requirement of 320 planted stems per acre, most ground water gauges are meeting success criteria, and all streams within the Site are stable and are meeting project goals.

4 REFERENCES

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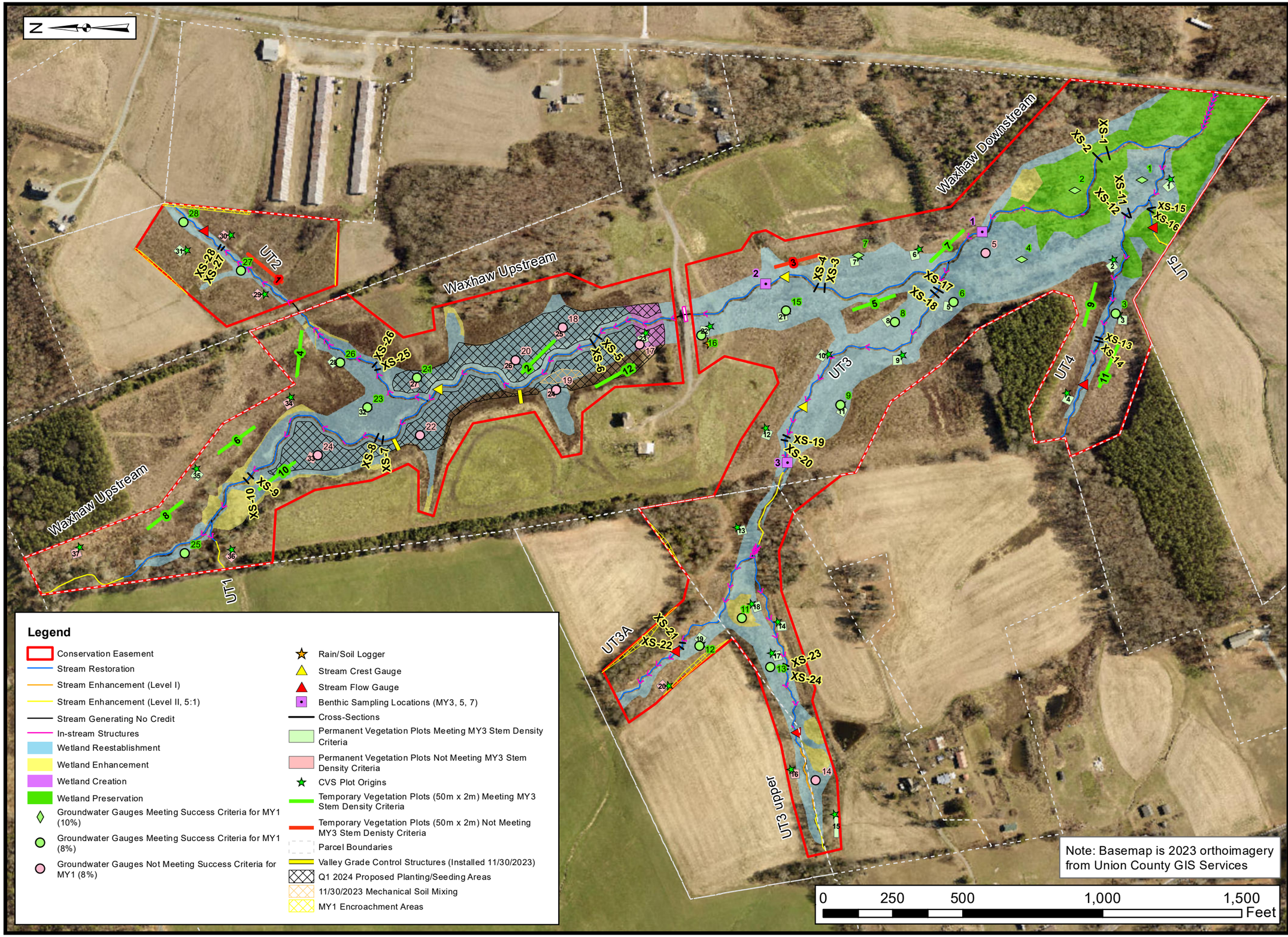
Appendix A: Visual Assessment Data

Figure 1. Current Conditions Plan View
Figure 2. 2023 Replant Map
Tables 4A-H. Stream Visual Stability Assessment
Table 5. Visual Vegetation Assessment
Vegetation Plot Photographs
Site Photo Log



Axiom Environmental, Inc.

Prepared for:

RESTORATION SYSTEMS | LLC

Project:

WITS END

Union County, NC

Title:

CURRENT CONDITIONS PLAN VIEW

Drawn by: KRJ

Date: Dec 2023

Scale: 1:3900

Project No.: 20-011

FIGURE

1

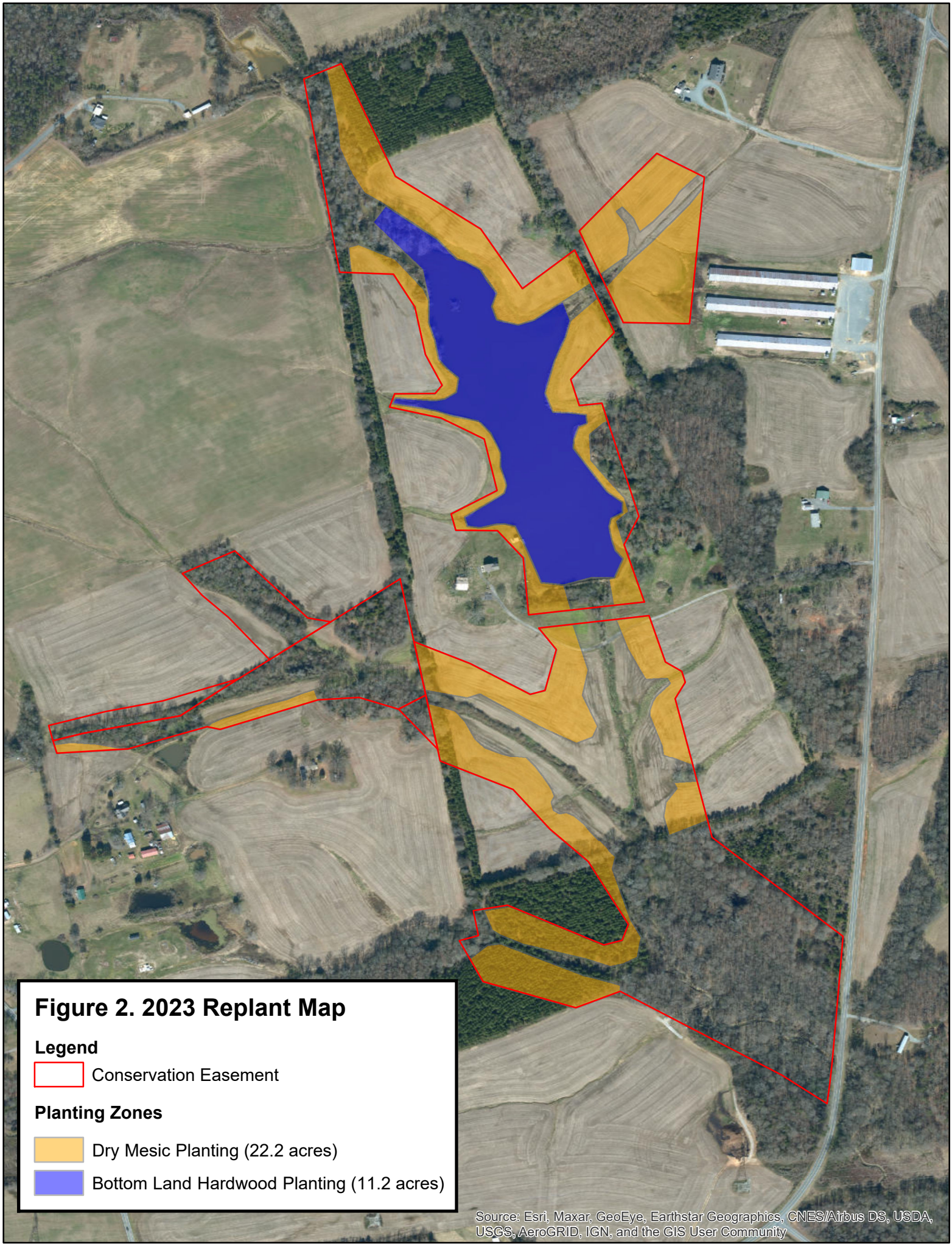


Figure 2. 2023 Replant Map
Legend
Conservation Easement
Planting Zones
Dry Mesic Planting (22.2 acres)
Bottom Land Hardwood Planting (11.2 acres)
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Table 4A. Visual Stream Stability Assessment

Reach: Waxhaw Branch
Assessed Stream Length: 5386
Assessed Bank Length: 10772
Survey Date: April 2, 2023

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.	26	26		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)	26	26		100%

Table 4B. Visual Stream Stability Assessment

Reach UT 1

Assessed Stream Length 188 Survey Date: April 2, 2023

Assessed Bank Length 376

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.	1	1		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)	1	1		100%

Table 4C. Visual Stream Stability Assessment

Reach UT 2

Assessed Stream Length 1234 Survey Date: April 2, 2023

Assessed Bank Length 2468

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.	12	12		100%
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in DMS monitoring guidance document)	12	12		100%

Table 4D. Visual Stream Stability Assessment

Reach UT 3 Lower

Assessed Stream Length 1442 Survey Date: April 2, 2023

Assessed Bank Length 2884

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.	11	11		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)	11	11		100%

Table 4E. Visual Stream Stability Assessment

Reach UT 3 Upper

Assessed Stream Length 1160 Survey Date: April 2, 2023

Assessed Bank Length 2320

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.	7	7		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)	7	7		100%

Table 4F. Visual Stream Stability Assessment

Reach UT 3A

Assessed Stream Length 792 Survey Date: April 2, 2023

Assessed Bank Length 1584

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 4G. Visual Stream Stability Assessment

Reach UT 4

Assessed Stream Length 1215 Survey Date: April 2, 2023

Assessed Bank Length 2430

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.	8	8		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)	8	8		100%

Table 4H. Visual Stream Stability Assessment

Reach UT 5

Assessed Stream Length 191 Survey Date: April 2, 2023

Assessed Bank Length 382

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.	0	0		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)	0	0		100%

Visual Vegetation Assessment

Planted acreage **58**

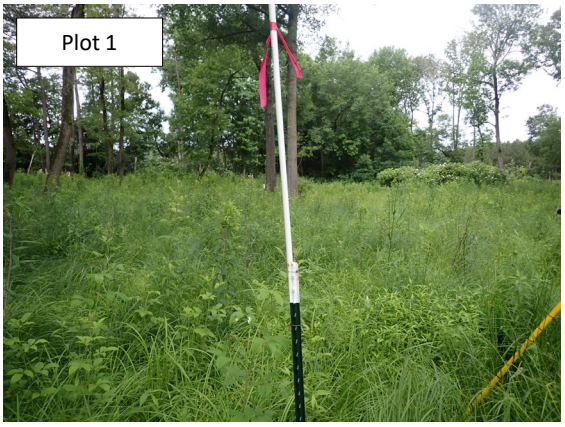
Vegetation Category	Definitions	Mapping Threshold	Combined Acreage	% of Planted Acreage
Bare Areas	Very limited cover of both woody and herbaceous material. Visible surface cracking. Repaired by physically mixing soils on 11/30/2023.	0.10 acres	0.10	0.2%
Low Stem Density Areas	Woody stem densities clearly below target levels based on current MY stem count criteria. Area proposed for planting detailed in 2023 AMP in Q1 2024.	0.10acres	5.06	8.7%
		Total	5.16	8.9%
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	5.16	8.9%

Easement Acreage **71.7**

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.	0.10 acres	0.00	0.0%
Easement Encroachment Areas	DMS boundary inspection report noted several areas of row crop encroachment along UT2 and UT3A.	none	6 encroachments noted (0.30 acres total)	

Whits End Mitigation Site
MY1 (2023) Vegetation Monitoring Photographs

Plot 1



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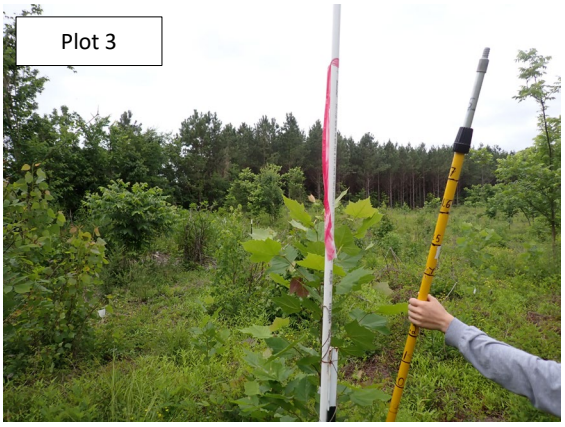
Plot 3



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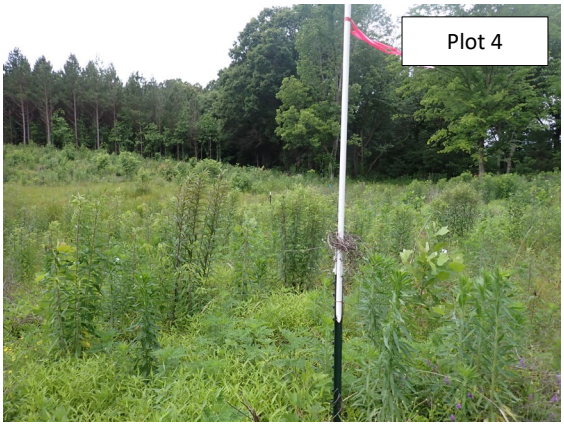

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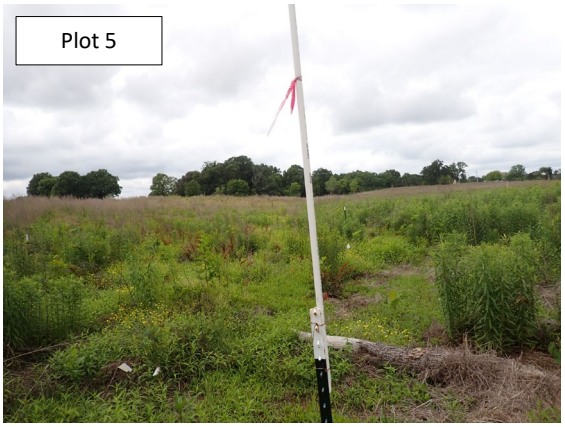

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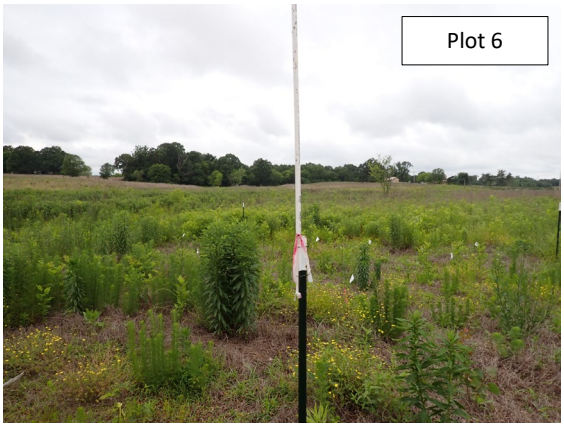

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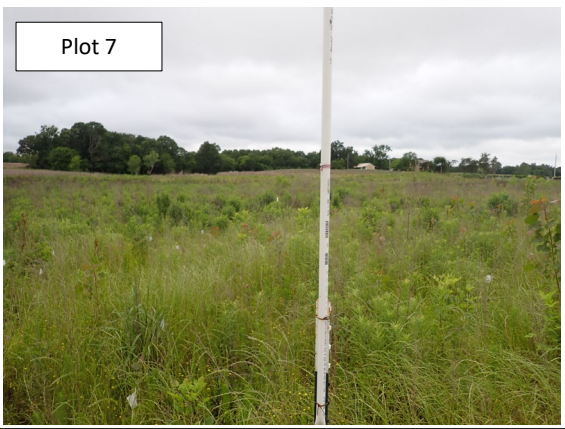

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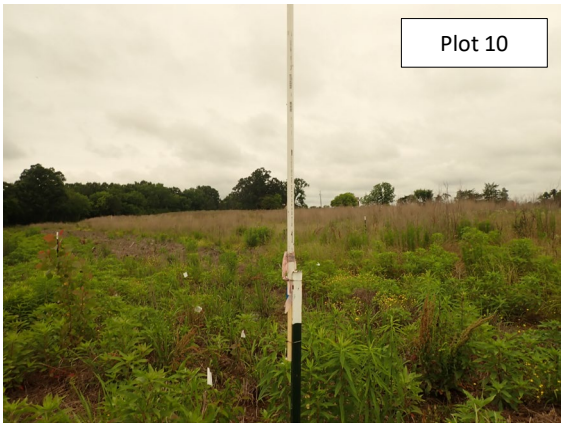
Whits End Mitigation Site
MY1 (2023) Vegetation Monitoring Photographs

Plot 9

Plot 10



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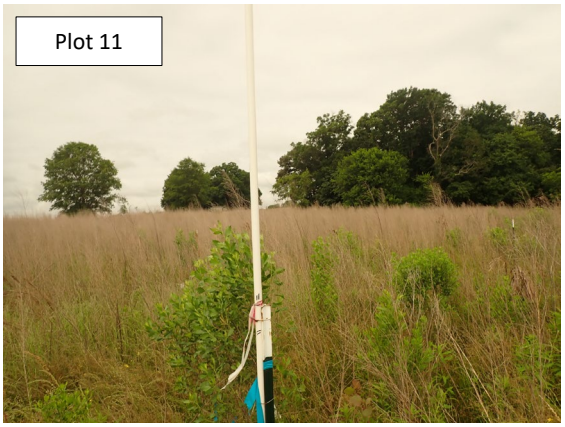

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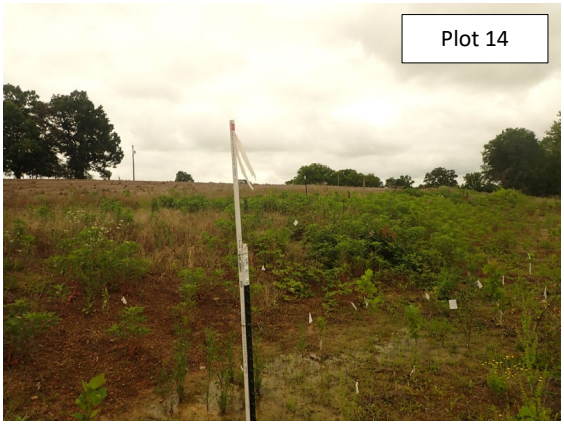
Plot 13

Plot 14



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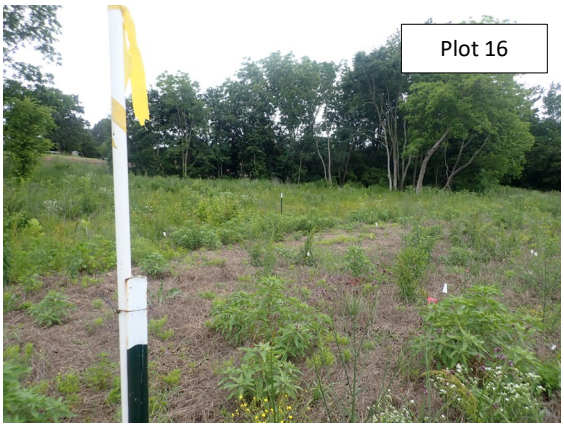
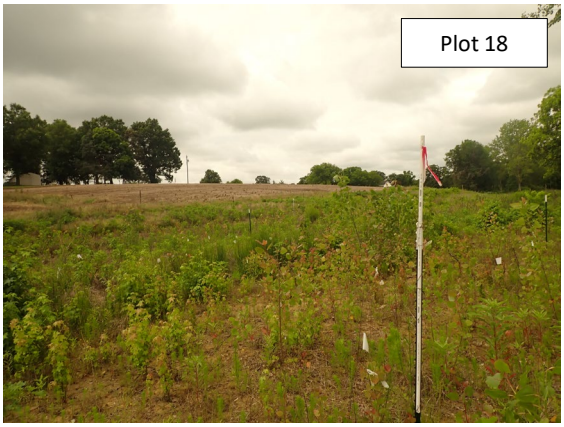


Whits End Mitigation Site
MY1 (2023) Vegetation Monitoring Photographs

Plot 17

Plot 18



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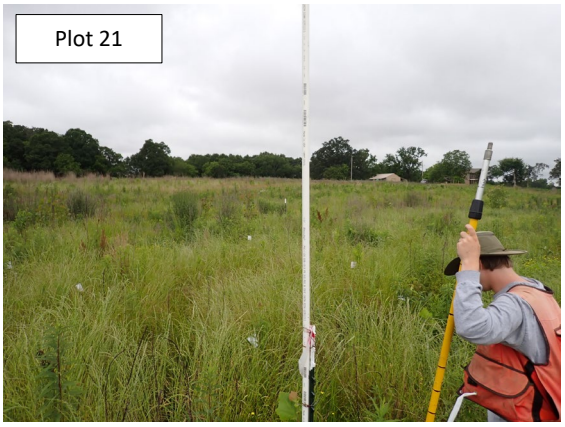
Plot 20

Plot 21



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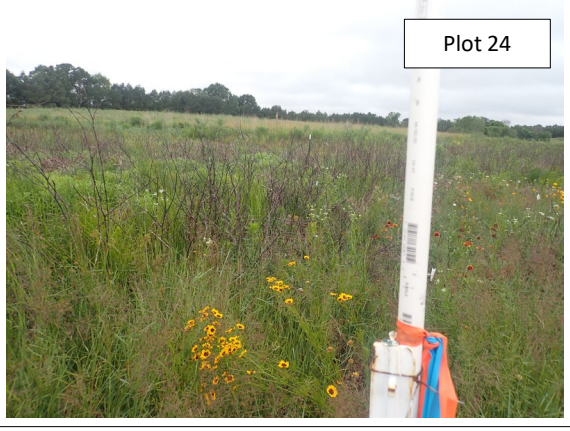
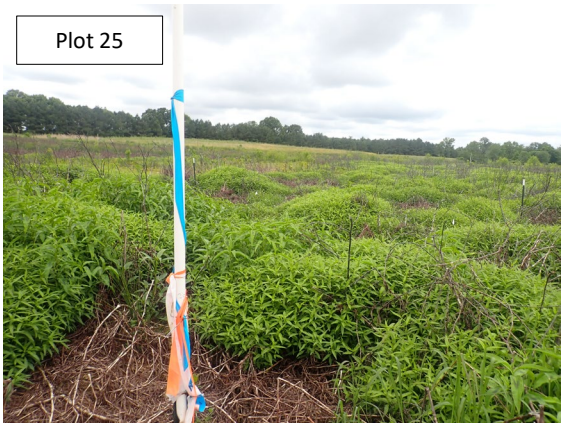
Plot 23

Plot 24



Whits End Mitigation Site
MY1 (2023) Vegetation Monitoring Photographs

Plot 25



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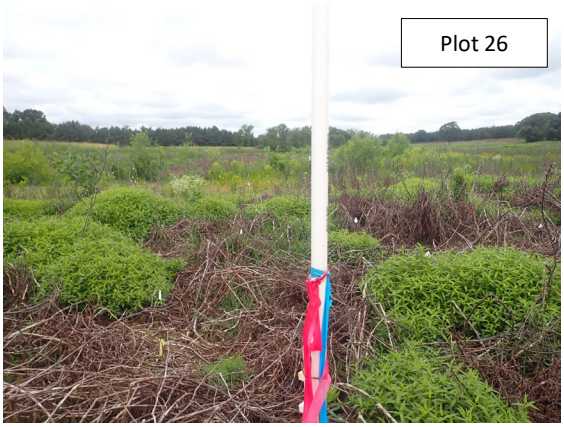

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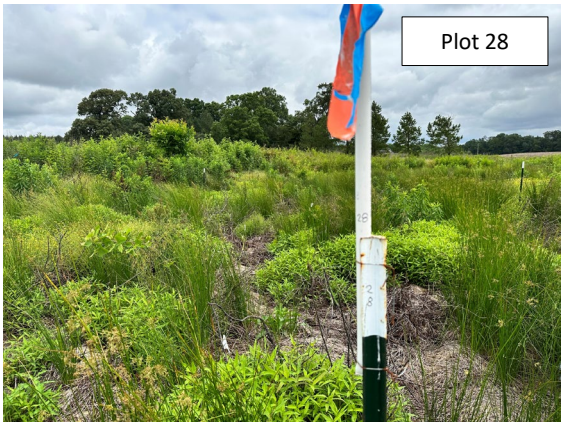

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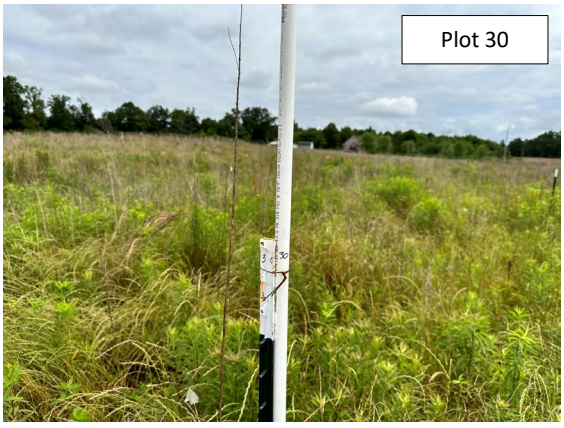

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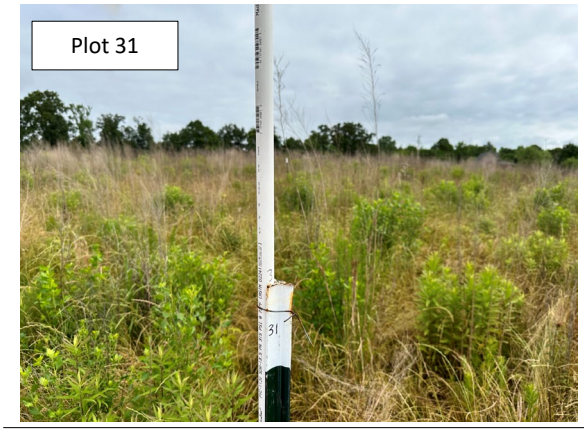

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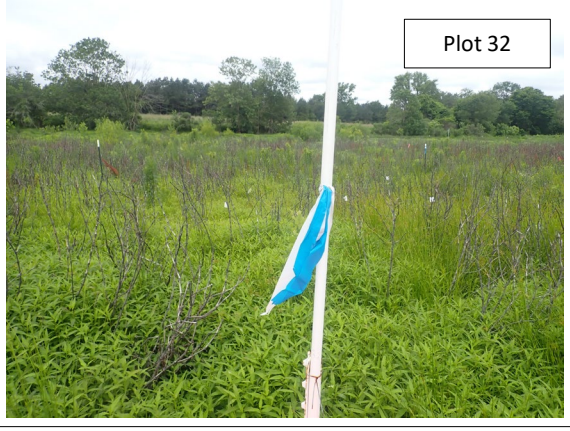
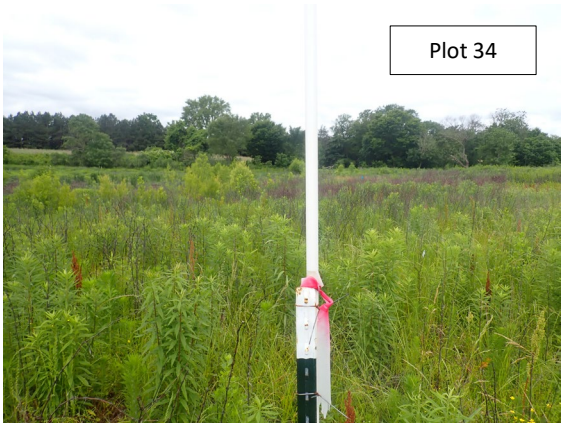


Whits End Mitigation Site
MY1 (2023) Vegetation Monitoring Photographs

Plot 33

Plot 34



Plot 35

Plot 36

Plot 37

Whits End Mitigation Site
MY1 (2023) Vegetation Monitoring Photographs

Transect 1

Transect 2

Transect 3

Transect 4

Transect 5

Transect 6

Transect 7

Transect 8

Whits End Mitigation Site
MY1 (2023) Vegetation Monitoring Photographs

Transect 9

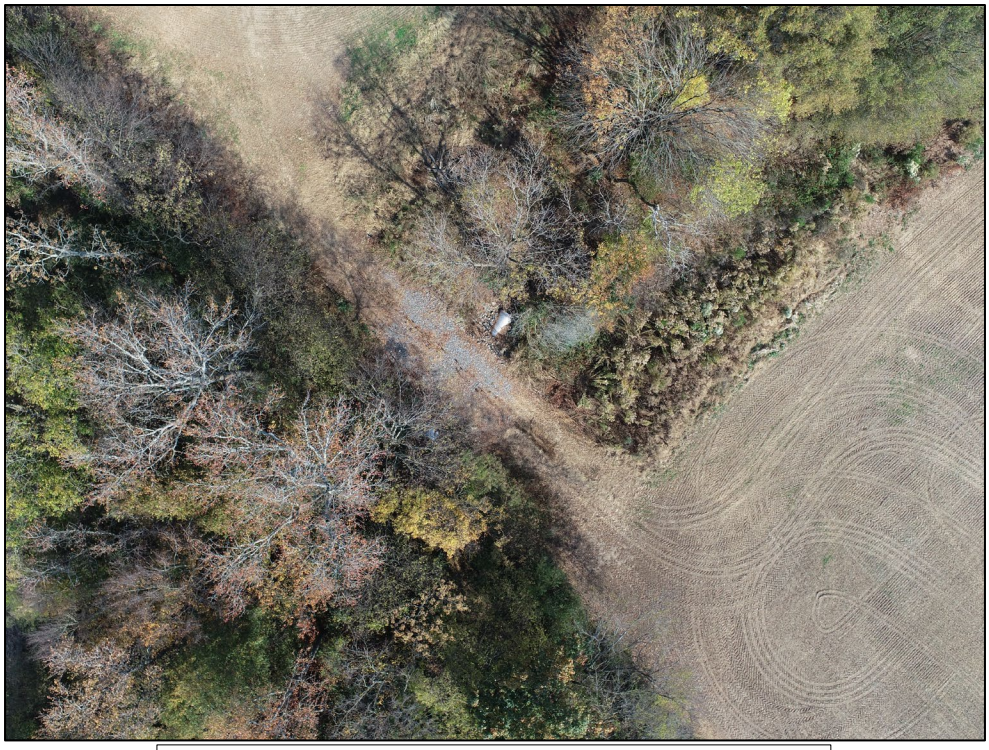
Transect 10

Transect 11

Transect 12

Wits End Stream and Wetland Mitigation Site
Photo Log

Bridge Crossing on Waxhaw Branch, taken November 8, 2023



Forded Crossing UT 2, taken May November 8, 2023

Easement Boundary Signage, taken February 6, 2023

Site Outfall and Drop Structure, taken November 8, 2023

Wits End Stream and Wetland Mitigation Site
Photo Log (continued)

UT 4, taken April 8, 2023

UT3 taken November 8, 2023

Upper UT 3, taken February 6, 2023

UT 3, taken May 31, 2023

Waxhaw Branch in Old Pond Bed, taken February 6, 2023

Lower Waxhaw Branch, taken November 8, 2023

Bud burst of *Liquidambar styraciflua*, taken February 21, 2023

Bud burst of *Ulmus alata*, taken February 21, 2023

Horse tape installed to prevent easement encroachment, taken December 21, 2023

Upgraded fastener on wooden posts, taken December 21, 2023

Missing caps and unmarked caps addressed, taken December 21, 2023

Upgraded fastener and blazing of trees, taken December 21, 2023

Appendix B: Vegetation Data

Table 6A. Planted Woody Vegetation
Table 6B. Permanent Seed Mix – Sitewide
Table 6C. Permanent Seed Mix – Marsh Treatments, Pools, Seeps
Table 6D. Replant of Woody Vegetation
Table 7. Vegetation Plot Counts and Densities
Table 8. Vegetation Plot Data Table from Vegetation Data Entry Tool

Table 6A. Planted Woody Vegetation
Wits End Stream and Wetland Mitigation Site

Bare-Root Planting		
Species	**Total**	**Percent**
Acres	**58**	**%**
American Elm (*Ulmus americana*)	3,000	4.0
American Holly (*Ilex opaca*)	2,220	2.9
Birch River (*Betula nigra*)	6,300	8.3
Black Gum (*Nyssa sylvatica*)	5,049	6.7
Hackberry (*Celtis occidentalis*)	2,900	3.8
Hickory Mockernut (*Carya tomentosa*)	1,500	2.0
Hickory Shagbark (*Carya ovata*)	3,500	4.6
Oak Red (*Quercus rubra*)	4,000	5.3
Oak Swamp Chestnut (*Quercus michauxii*)	1,700	2.2
Oak Water (*Quercus nigra*)	12,200	16.1
Oak White (*Quercus alba*)	4,850	6.4
Oak Willow (*Quercus phellos*)	1,400	1.8
Persimmon (*Diospyros virginiana*)	4,250	5.6
Red Bud (*Cercis canadensis*)	1,900	2.5
Silky Dogwood (*Cornus amomum*)	7,550	10.0
Sycamore (*Platanus occidentalis*)	7,900	10.4
Tulip Poplar (*Liriodendron tulipifera*)	5,050	6.7
Tupelo Gum (*Nyssa aquatica*)	500	0.7
TOTALS	**75,769**	**100**
Average Stems/Acre	**1306**	
1-Gallon Containerized Planting		
Species	**Total**	**Percent**
Acres	**1.5**	**%**
American Elm (*Ulmus americana*)	40	7.7
Birch River (*Betula nigra*)	40	7.7
Black Gum (*Nyssa sylvatica*)	70	13.5
Oak Red (*Quercus rubra*)	60	11.5
Oak Water (*Quercus nigra*)	90	17.3
Oak White (*Quercus alba*)	90	17.3
Red Bud (*Cercis canadensis*)	60	11.5
Sycamore (*Platanus occidentalis*)	30	5.8
Tulip Poplar (*Liriodendron tulipifera*)	40	7.7
TOTALS	**520**	**100**
Average Stems/Acre	**347**	

Table 6B. Permanent Seed Mix - Sitewide
Wits End Stream and Wetland Mitigation Site

Species*	%	Species*	%
Common Yarrow (*Achillea millefolium*)	0.98	Boneset (*Eupatorium perfoliatum*)	0.25
Redtop (*Agrostis gigantea*)	14.98	Perennial Gaillardia (Blanketflower) (*Gaillardia perennial*)	0.49
Winter Bentgrass (*Agrostis hyemalis*)	4.90	Narrowleaf Sunflower (*Helianthus angustifolius*)	0.50
Autumn Bentgrass (*Agrostis perennans*)	4.97	Oxeye Sunflower (*Heliopsis helianthoides*)	0.50
Creeping Bentgrass (*Agrostis stolonifera*)	4.98	Crimsoneyed Rosemallow (*Hibiscus moscheutos*)	0.50
Blue False Indigo (*Baptisia australis*)	2.00	Path Rush (*Juncus tenuis*)	0.45
Fox Sedge (*Carex vulpinoidea*)	0.94	Roundhead Lespedeza (*Lespedeza capitata*)	0.50
Partridge Pea (*Chamaecrista fasciculata*)	1.00	Marsh Blazing Star (*Liatris spicata*)	0.49
Sensitive Pea (*Chamaecrista nictitans*)	1.00	Wild Bergamot (*Monarda fistulosa*)	0.50
Oxeye Daisy (*Leucanthemum vulgare*)	4.98	Beaked Panicgrass (*Panicum anceps*)	0.46
Shasta Daisy (*Leucanthemum superbum*)	2.99	Deertongue, Tioga (*Dichanthelium clandestinum*)	4.95
Lanceleaf Coreopsis (*Coreopsis lanceolata*)	3.96	Tall White Beardtongue (*Penstemon digitalis*)	0.99
Plains Coreopsis (*Coreopsis tinctoria*)	3.95	Clasping Coneflower (*Dracopis amplexicaulis*)	1.00
Cosmos (*Cosmos bipinnatus*)	1.00	Blackeyed Susan (*Rudbeckia hirta*)	2.99
Rocket Larkspur (*Consolida ajacis*)	1.99	Wild Senna (*Senna hebecarpa*)	0.50
Showy Ticktrefoil (*Desmodium canadense*)	0.98	Purpletop (*Tridens flavus*)	16.76
Purple Coneflower (*Echinacea purpurea*)	4.75	Blue Vervain (*Verbena hastata*)	1.00
Virginia Wildrye (*Elymus virginicus*)	4.06		
			Total = 100%

* This seed mix was applied at 2 lbs per acre sitewide.

Table 6C. Permanent Seed Mix – Marsh Treatments, Pools, Seeps
Wits End Stream and Wetland Mitigation Site

Species*	%	Species*	%
Switchgrass (*Panicum rigidulum*)	36	Virginia Wildrye (*Elymus virginicus*)	6
Bearded Beggarticks (*Bidens aristosa*)	20	Soft Rush (*Juncus effusus*)	5
Narrowleaf Sunflower (*Helianthus angustifolius*)	18	Common Hop Sedge (*Carex lupulina*)	5
Greenwhite sedge (*Carex albolutescens*)	8	Fox Sedge (*Carex vulpinoidea*)	2
			Total = 100%

* This seed mix was applied at 5 lbs per acre in marsh treatment areas, pools, and seeps.

Table 6D. Replant of Woody Vegetation
Wits End Stream and Wetland Mitigation Site

January 23, 2023 Targeted Replant		
Species	**Total**	**Percent**
Acres	**33.4**	**%**
American Elm (*Ulmus americana*)	1,500	6.5
Birch River (*Betula nigra*)	1,000	4.4
Black Gum (*Nyssa sylvatica*)	2,700	11.8
Hackberry (*Celtis occidentalis*)	600	2.6
Hickory Shagbark (*Carya ovata*)	2,000	8.8
Oak Red (*Quercus rubra*)	2,500	11.0
Oak Swamp Chestnut (*Quercus michauxii*)	1,700	7.5
Oak Water (*Quercus nigra*)	3,600	15.8
Oak Willow (*Quercus phellos*)	1,400	6.1
Persimmon (*Diospyros virginiana*)	2,000	8.8
Silky Dogwood (*Cornus amomum*)	1,200	5.3
Sycamore (*Platanus occidentalis*)	600	2.6
Tulip Poplar (*Liriodendron tulipifera*)	2,000	8.8
TOTALS	**22,800**	**100**
Average Stems/Acre	**683**	

Table 7. Planted Vegetation Totals
Wits End Stream and Wetland Mitigation Site

Plot #	Planted Stems/Acre	Success Criteria Met?
1	405	Yes
2	445	Yes
3	405	Yes
4	445	Yes
5	324	Yes
6	405	Yes
7	729	Yes
8	486	Yes
9	445	Yes
10	607	Yes
11	324	Yes
12	364	Yes
13	607	Yes
14	810	Yes
15	486	Yes
16	283	No
17	567	Yes
18	607	Yes
19	526	Yes
20	243	No
21	931	Yes
22	405	Yes
23	607	Yes
24	202	No
25	121	No
26	283	No
27	202	No
28	445	Yes
29	243	No
30	283	No
31	405	Yes
32	526	Yes
33	202	No
34	243	No
35	445	Yes
36	81	No
37	243	No
Average Planted Stems/Acre	**416**	**Yes**

Table 7. Planted Vegetation Totals (Continued)
Wits End Stream and Wetland Mitigation Site

Plot #	Planted Stems/Acre	Success Criteria Met?
T-1	162	No
T-2	486	Yes
T-3	243	No
T-4	405	Yes
T-5	445	Yes
T-6	769	Yes
T-7	567	Yes
T-8	445	Yes
T-9	607	Yes
T-10	688	Yes
T-11	729	Yes
T-12	324	Yes
Average Planted Stems/Acre	**492**	**Yes**

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

Planted Acreage	58
Date of Initial Plant	2022-04-07
Date(s) of Supplemental Plant(s)	2023-01-23
Date(s) Mowing	NA
Date of Current Survey	2023-10-02
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		Veg Plot 8 F	
					Planted	Total	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	5	5	2	2					1	1	3	3	2	2		
	Carya ovata	shagbark hickory	Tree	FACU																
	Carya sp.																			
	Carya tomentosa	mockernut hickory	Tree						1	1										
	Celtis occidentalis	common hackberry	Tree	FACU																
	Cercis canadensis	eastern redbud	Tree	FACU																
	Cornus amomum	silky dogwood	Shrub	FACW			1	1			2	2	2	2						
	Diospyros virginiana	common persimmon	Tree	FAC			2	2												
	Liriodendron tulipifera	tuliptree	Tree	FACU	1	1			1	1	1	1								
	Nyssa aquatica	water tupelo	Tree	OBL																
	Nyssa sylvatica	blackgum	Tree	FAC																
	Platanus occidentalis	American sycamore	Tree	FACW			1	8		3	5	8	3	3	1	1	2	2	6	6
	Quercus alba	white oak	Tree	FACU																
	Quercus michauxii	swamp chestnut oak	Tree	FACW											4	4	2	2	4	4
	Quercus nigra	water oak	Tree	FAC	3	3					1	1					3	3	1	1
	Quercus phellos	willow oak	Tree	FAC					4	4	1	1			2	2	5	5		
	Quercus rubra	northern red oak	Tree	FACU	1	1			1	1										
	Quercus sp.																			
	Ulmus americana	American elm	Tree	FACW									2	2			4	4	1	1
Sum	Performance Standard				10	10	6	13	7	10	10	13	8	8	10	10	18	18	12	12
Post Mitigation Plan Species	*Fraxinus pennsylvanica*	*green ash*	*Tree*	*FACW*																
	Populus deltoides	eastern cottonwood	Tree	FAC																
Sum	Proposed Standard				10	10	6	13	7	10	10	13	8	8	10	10	18	18	12	12
Mitigation Plan Performance Standard	Current Year Stem Count					10		13		10		13		8		10		18		12
	Stems/Acre					405		445		405		445		324		405		729		486
	Species Count					4		4		5		5		4		4		6		4
	Dominant Species Composition (%)					50		62		40		62		38		40		28		50
	Average Plot Height (ft.)					3		4		3		3		2		2		2		2
	% Invasives					0		0		0		0		0		0		0		0
Post Mitigation Plan Performance Standard	Current Year Stem Count					10		13		10		13		8		10		18		12
	Stems/Acre					405		445		405		445		324		405		729		486
	Species Count					4		4		5		5		4		4		6		4
	Dominant Species Composition (%)					50		62		40		62		38		40		28		50
	Average Plot Height (ft.)					3		4		3		3		2		2		2		2
	% Invasives					0		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 8. Vegetation Plot Data Table from Vegetation Data Entry Tool

Planted Acreage	58
Date of Initial Plant	2022-04-07
Date(s) of Supplemental Plant(s)	2023-01-23
Date(s) Mowing	NA
Date of Current Survey	2023-10-02
Plot size (ACRES)	0.0247

	Scientific Name	Common Name	Tree/Shrub	Indicator Status	Veg Plot 9 F		Veg Plot 10 F		Veg Plot 11 F		Veg Plot 12 F		Veg Plot 13 F		Veg Plot 14 F		Veg Plot 15 F		Veg Plot 16 F	
					Planted	Total	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	1	1					1	1	2	2	1	1		
	Carya ovata	shagbark hickory	Tree	FACU															2	2
	Carya sp.																			
	Carya tomentosa	mockernut hickory	Tree																	
	Celtis occidentalis	common hackberry	Tree	FACU	1	1							1	1						
	Cercis canadensis	eastern redbud	Tree	FACU									2	2			2	2		
	Cornus amomum	silky dogwood	Shrub	FACW	2	2	7	7			2	2			3	3				
	Diospyros virginiana	common persimmon	Tree	FAC									2	2						
	Liriodendron tulipifera	tuliptree	Tree	FACU							2	2								
	Nyssa aquatica	water tupelo	Tree	OBL																
	Nyssa sylvatica	blackgum	Tree	FAC	1	1									1	1				
	Platanus occidentalis	American sycamore	Tree	FACW											6	6	1	1		
	Quercus alba	white oak	Tree	FACU									2	2						
	Quercus michauxii	swamp chestnut oak	Tree	FACW	2	2	5	5	4	4	1	1	1	1						
	Quercus nigra	water oak	Tree	FAC	3	3	2	2					3	3	2	2	4	4	2	2
	Quercus phellos	willow oak	Tree	FAC	1	1			1	1	1	1			1	1	1	1	1	1
	Quercus rubra	northern red oak	Tree	FACU					3	3			1	1			2	2	1	1
	Quercus sp.										1	1	2	2	3	3				
	Ulmus americana	American elm	Tree	FACW							2	2			2	2	1	1	1	1
Sum	Performance Standard				11	11	15	15	8	8	9	9	15	15	20	20	12	12	7	7
Post Mitigation Plan Species	*Fraxinus pennsylvanica*	*green ash*	*Tree*	*FACW*																
	Populus deltoides	eastern cottonwood	Tree	FAC																
Sum	Proposed Standard				11	11	15	15	8	8	9	9	15	15	20	20	12	12	7	7
Mitigation Plan Performance Standard	Current Year Stem Count					11		15		8		9		15		20		12		7
	Stems/Acre					445		607		324		364		607		810		486		283
	Species Count					7		4		3		6		9		8		7		5
	Dominant Species Composition (%)					27		47		50		22		20		30		33		29
	Average Plot Height (ft.)					2		2		1		1		2		2		2		1
	% Invasives					0		0		0		0		0		0		0		0
Post Mitigation Plan Performance Standard	Current Year Stem Count					11		15		8		9		15		20		12		7
	Stems/Acre					445		607		324		364		607		810		486		283
	Species Count					7		4		3		6		9		8		7		5
	Dominant Species Composition (%)					27		47		50		22		20		30		33		29
	Average Plot Height (ft.)					2		2		1		1		2		2		2		1
	% Invasives					0		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 8. Vegetation Plot Data Table from Vegetation Data Entry Tool

Planted Acreage	58
Date of Initial Plant	2022-04-07
Date(s) of Supplemental Plant(s)	2023-01-23
Date(s) Mowing	NA
Date of Current Survey	2023-10-02
Plot size (ACRES)	0.0247

	Scientific Name	Common Name	Tree/Shrub	Indicator Status	Veg Plot 17 F		Veg Plot 18 F		Veg Plot 19 F		Veg Plot 20 F		Veg Plot 21 F		Veg Plot 22 F		Veg Plot 23 F		Veg Plot 24 F	
					Planted	Total	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	2	2	4	4	1	1			8	8			3	3	1	1
	Carya ovata	shagbark hickory	Tree	FACU											1	1				
	Carya sp.																			
	Carya tomentosa	mockernut hickory	Tree				1	1												
	Celtis occidentalis	common hackberry	Tree	FACU													1	1		
	Cercis canadensis	eastern redbud	Tree	FACU			2	2	3	3	1	1								
	Cornus amomum	silky dogwood	Shrub	FACW	1	1	2	2	4	4					1	1				
	Diospyros virginiana	common persimmon	Tree	FAC											1	1				
	Liriodendron tulipifera	tuliptree	Tree	FACU																
	Nyssa aquatica	water tupelo	Tree	OBL													3	3	1	1
	Nyssa sylvatica	blackgum	Tree	FAC	1	1	4	4			1	1	1	1			1	1	2	2
	Platanus occidentalis	American sycamore	Tree	FACW	10	10							10	10						
	Quercus alba	white oak	Tree	FACU													3	3		
	Quercus michauxii	swamp chestnut oak	Tree	FACW					2	2			4	4	4	4	2	2	1	1
	Quercus nigra	water oak	Tree	FAC	1	1	1	1			1	1			1	1	1	1		
	Quercus phellos	willow oak	Tree	FAC	1	1					1	1			1	1				
	Quercus rubra	northern red oak	Tree	FACU					1	1					1	1	1	1		
	Quercus sp.								1	1										
	Ulmus americana	American elm	Tree	FACW			1	1			2	2								
Sum	Performance Standard				16	16	15	15	13	13	6	6	23	23	10	10	15	15	5	5
Post Mitigation Plan Species	*Fraxinus pennsylvanica*	*green ash*	*Tree*	*FACW*																
	Populus deltoides	eastern cottonwood	Tree	FAC						1										
Sum	Proposed Standard				16	16	15	15	12	13	6	6	23	23	10	10	15	15	5	5
Mitigation Plan Performance Standard	Current Year Stem Count					16		15		12		6		23		10		15		5
	Stems/Acre					567		607		486		243		931		405		607		202
	Species Count					6		7		6		5		4		7		8		4
	Dominant Species Composition (%)					62		27		31		33		43		40		20		40
	Average Plot Height (ft.)					2		2		1		2		3		2		2		2
	% Invasives					0		0		0		0		0		0		0		0
Post Mitigation Plan Performance Standard	Current Year Stem Count					16		15		13		6		23		10		15		5
	Stems/Acre					567		607		526		243		931		405		607		202
	Species Count					6		7		7		5		4		7		8		4
	Dominant Species Composition (%)					62		27		31		33		43		40		20		40
	Average Plot Height (ft.)					2		2		2		2		3		2		2		2
	% Invasives					0		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 8. Vegetation Plot Data Table from Vegetation Data Entry Tool

Planted Acreage	58
Date of Initial Plant	2022-04-07
Date(s) of Supplemental Plant(s)	2023-01-23
Date(s) Mowing	NA
Date of Current Survey	2023-10-02
Plot size (ACRES)	0.0247

	Scientific Name	Common Name	Tree/Shrub	Indicator Status	Veg Plot 25 F		Veg Plot 26 F		Veg Plot 27 F		Veg Plot 28 F		Veg Plot 29 F		Veg Plot 30 F		Veg Plot 31 F		Veg Plot 32 F	
					Planted	Total	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	7	7	1	1			1	1							1	1
	Carya ovata	shagbark hickory	Tree	FACU							3	3			1	1				
	Carya sp.																			
	Carya tomentosa	mockernut hickory	Tree												1	1				
	Celtis occidentalis	common hackberry	Tree	FACU							1	1								
	Cercis canadensis	eastern redbud	Tree	FACU									2	2			1	1		
	Cornus amomum	silky dogwood	Shrub	FACW			3	3	1	1	4	4							4	4
	Diospyros virginiana	common persimmon	Tree	FAC											1	1	2	2		
	Liriodendron tulipifera	tuliptree	Tree	FACU											2	2				
	Nyssa aquatica	water tupelo	Tree	OBL																
	Nyssa sylvatica	blackgum	Tree	FAC							1	1	1	1						
	Platanus occidentalis	American sycamore	Tree	FACW					8	8	1	1							1	1
	Quercus alba	white oak	Tree	FACU									1	1	1	1	1	1	1	1
	Quercus michauxii	swamp chestnut oak	Tree	FACW											1	1	4	4	3	3
	Quercus nigra	water oak	Tree	FAC			3	3					1	1			2	2		
	Quercus phellos	willow oak	Tree	FAC									1	1					1	1
	Quercus rubra	northern red oak	Tree	FACU															2	2
	Quercus sp.																			
	Ulmus americana	American elm	Tree	FACW																
Sum	Performance Standard				7	7	7	7	9	9	11	11	6	6	7	7	10	10	13	13
Post Mitigation Plan Species	*Fraxinus pennsylvanica*	*green ash*	*Tree*	*FACW*																
	Populus deltoides	eastern cottonwood	Tree	FAC																
Sum	Proposed Standard				7	7	7	7	9	9	11	11	6	6	7	7	10	10	13	13
Mitigation Plan Performance Standard	Current Year Stem Count					7		7		9		11		6		7		10		13
	Stems/Acre					121		283		202		445		243		283		405		526
	Species Count					1		3		2		6		5		6		5		7
	Dominant Species Composition (%)					100		43		89		36		33		29		40		31
	Average Plot Height (ft.)					2		2		4		2		1		1		2		2
	% Invasives					0		0		0		0		0		0		0		0
Post Mitigation Plan Performance Standard	Current Year Stem Count					7		7		9		11		6		7		10		13
	Stems/Acre					121		283		202		445		243		283		405		526
	Species Count					1		3		2		6		5		6		5		7
	Dominant Species Composition (%)					100		43		89		36		33		29		40		31
	Average Plot Height (ft.)					2		2		4		2		1		1		2		2
	% Invasives					0		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 8. Vegetation Plot Data Table from Vegetation Data Entry Tool

Planted Acreage	58
Date of Initial Plant	2022-04-07
Date(s) of Supplemental Plant(s)	2023-01-23
Date(s) Mowing	NA
Date of Current Survey	2023-10-02
Plot size (ACRES)	0.0247

	Scientific Name	Common Name	Tree/Shrub	Indicator Status	Veg Plot 33 F		Veg Plot 34 F		Veg Plot 35 F		Veg Plot 36 F		Veg Plot 37 F		Veg Plot 1 R	Veg Plot 2 R	Veg Plot 3 R	Veg Plot 4 R	Veg Plot 5 R	Veg Plot 6 R
					Planted	Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total	Total	Total	Total	Total	Total	Total
Species Included in Approved Mitigation Plan	Betula nigra	river birch	Tree	FACW							2	2								8
	Carya ovata	shagbark hickory	Tree	FACU					1	1										
	Carya sp.																	1		
	Carya tomentosa	mockernut hickory	Tree																	
	Celtis occidentalis	common hackberry	Tree	FACU														2		
	Cercis canadensis	eastern redbud	Tree	FACU												3	1			
	Cornus amomum	silky dogwood	Shrub	FACW	1	1			1	1					1			3	2	
	Diospyros virginiana	common persimmon	Tree	FAC									2	2		2		1		2
	Liriodendron tulipifera	tuliptree	Tree	FACU																
	Nyssa aquatica	water tupelo	Tree	OBL																
	Nyssa sylvatica	blackgum	Tree	FAC					1	1							1			
	Platanus occidentalis	American sycamore	Tree	FACW														2	4	9
	Quercus alba	white oak	Tree	FACU					1	1									1	
	Quercus michauxii	swamp chestnut oak	Tree	FACW			1	1							1				3	
	Quercus nigra	water oak	Tree	FAC	7	7			1	1			1	1	2					
	Quercus phellos	willow oak	Tree	FAC			2	2					2	2		2			1	
	Quercus rubra	northern red oak	Tree	FACU			3	3	2	2			1	1						
	Quercus sp.															1				
	Ulmus americana	American elm	Tree	FACW					4	4	1	1				4	4	1		
Sum	Performance Standard				8	8	6	6	11	11	3	3	6	6	4	12	6	10	11	19
Post Mitigation Plan Species	*Fraxinus pennsylvanica*	*green ash*	*Tree*	*FACW*													*8*			
	Populus deltoides	eastern cottonwood	Tree	FAC																
Sum	Proposed Standard				8	8	6	6	11	11	3	3	6	6	4	12	6	10	11	19
Mitigation Plan Performance Standard	Current Year Stem Count					8		6		11		3		6	4	12	6	10	11	19
	Stems/Acre					202		243		445		81		243	162	486	243	405	445	769
	Species Count					2		3		7		2		4	3	5	3	6	5	3
	Dominant Species Composition (%)					88		50		36		67		33	50	33	57	30	36	47
	Average Plot Height (ft.)					2		2		1		2		2	2	2	1	2	2	3
	% Invasives					0		0		0		0		0	0	0	0	0	0	0
Post Mitigation Plan Performance Standard	Current Year Stem Count					8		6		11		3		6	4	12	6	10	11	19
	Stems/Acre					202		243		445		81		243	162	486	243	405	445	769
	Species Count					2		3		7		2		4	3	5	3	6	5	3
	Dominant Species Composition (%)					88		50		36		67		33	50	33	57	30	36	47
	Average Plot Height (ft.)					2		2		1		2		2	2	2	1	2	2	3
	% Invasives					0		0		0		0		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 8. Vegetation Plot Data Table from Vegetation Data Entry Tool

Planted Acreage	58
Date of Initial Plant	2022-04-07
Date(s) of Supplemental Plant(s)	2023-01-23
Date(s) Mowing	NA
Date of Current Survey	2023-10-02
Plot size (ACRES)	0.0247

	Scientific Name	Common Name	Tree/Shrub	Indicator Status	Veg Plot 7 R Total	Veg Plot 8 R Total	Veg Plot 9 R Total	Veg Plot 10 R Total	Veg Plot 11 R Total	Veg Plot 12 R Total
Species Included in Approved Mitigation Plan	Betula nigra	river birch	Tree	FACW	3			1	3	1
	Carya ovata	shagbark hickory	Tree	FACU						
	Carya sp.									
	Carya tomentosa	mockernut hickory	Tree							1
	Celtis occidentalis	common hackberry	Tree	FACU						2
	Cercis canadensis	eastern redbud	Tree	FACU		2				
	Cornus amomum	silky dogwood	Shrub	FACW			1			
	Diospyros virginiana	common persimmon	Tree	FAC	4	1	1		9	
	Liriodendron tulipifera	tuliptree	Tree	FACU	1					1
	Nyssa aquatica	water tupelo	Tree	OBL						
	Nyssa sylvatica	blackgum	Tree	FAC						
	Platanus occidentalis	American sycamore	Tree	FACW	1	1	9	4	5	
	Quercus alba	white oak	Tree	FACU	2	1		7		1
	Quercus michauxii	swamp chestnut oak	Tree	FACW			1	1		
	Quercus nigra	water oak	Tree	FAC	1					
	Quercus phellos	willow oak	Tree	FAC	1		2		1	
	Quercus rubra	northern red oak	Tree	FACU			2			2
	Quercus sp.									
	Ulmus americana	American elm	Tree	FACW	1	7		4		1
Sum	Performance Standard				14	12	16	17	18	9
Post Mitigation Plan Species	*Fraxinus pennsylvanica*	*green ash*	*Tree*	*FACW*						
	Populus deltoides	eastern cottonwood	Tree	FAC						
Sum	Proposed Standard				14	12	16	17	18	9
Mitigation Plan Performance Standard	Current Year Stem Count				14	12	16	17	18	9
	Stems/Acre				567	445	607	688	729	364
	Species Count				8	5	6	5	4	7
	Dominant Species Composition (%)				29	58	56	41	50	22
	Average Plot Height (ft.)				2	2	3	2	3	2
	% Invasives				0	0	0	0	0	0
Post Mitigation Plan Performance Standard	Current Year Stem Count				14	12	16	17	18	9
	Stems/Acre				567	445	607	688	729	364
	Species Count				8	5	6	5	4	7
	Dominant Species Composition (%)				29	58	56	41	50	22
	Average Plot Height (ft.)				2	2	3	2	3	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.

Appendix C: Stream Geomorphology Data

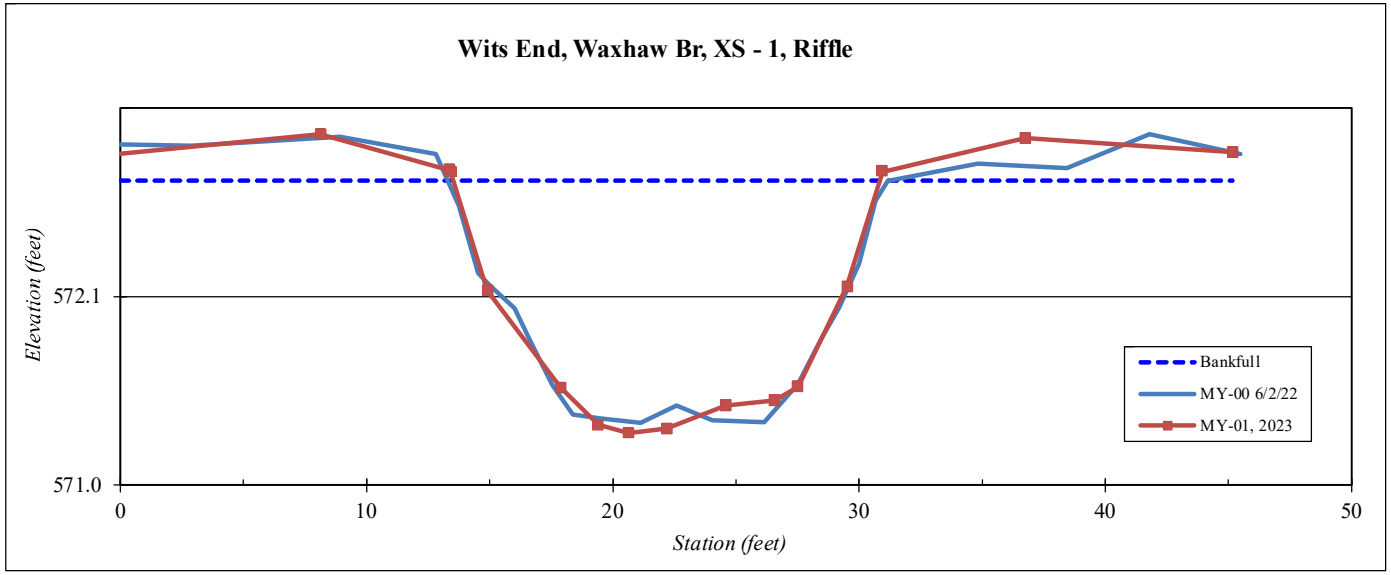
Cross-Sections with Annual Overlays
Table 9A-I. Baseline Stream Data Summary Tables
Table 10A-F. Cross-Section Morphology Monitoring Summary

Site	Wits End Site
Watershed:	Yadkin River Basin, 03040105
XS ID	Waxhaw Br, XS -1
Feature	Riffle
Date:	4/2/2023
Field Crew:	Adams, Fleming, Perkinson, Smith

Station	Elevation
-0.4	572.9
8.1	573.1
13.3	572.8
13.4	572.8
14.9	572.1
17.9	571.5
19.4	571.3
20.6	571.3
22.2	571.3
24.6	571.4
26.6	571.5
27.5	571.5
29.5	572.1
30.9	572.8
36.7	573.0
45.2	572.9

SUMMARY DATA	
Bankfull Elevation:	572.78
Bank Hieght Ratio:	1.04
Thalweg Elevation:	571.27
LTOB Elevation:	572.83
LTOB Max Depth:	1.57
LTOB Cross Sectional Area:	20.0

Stream Type	E/C

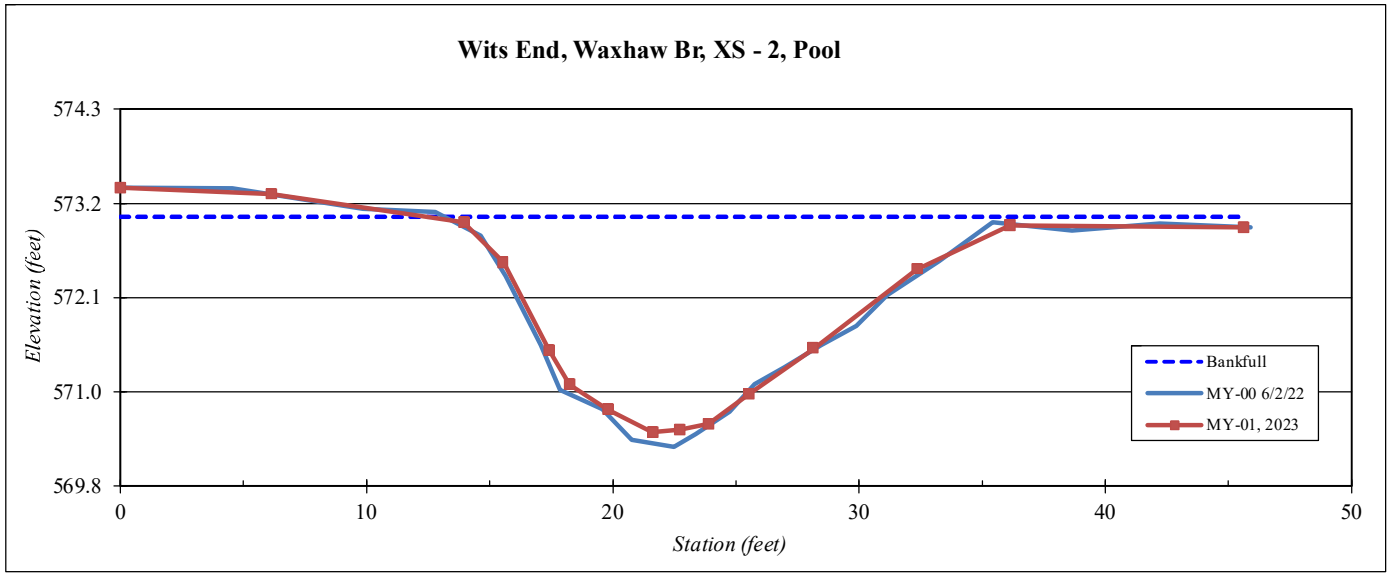


Site	Wits End Site
Watershed:	Yadkin River Basin, 03040105
XS ID	Waxhaw Br, XS -2
Feature	Pool
Date:	4/2/2023
Field Crew:	Adams, Fleming, Perkinson, Smith

Station	Elevation
0.0	573.4
6.1	573.3
13.9	573.0
15.6	572.5
17.4	571.5
18.2	571.0
19.8	570.7
21.6	570.5
22.7	570.5
23.9	570.6
25.5	570.9
28.1	571.5
32.3	572.4
36.1	572.9
45.6	572.9

SUMMARY DATA	
Bankfull Elevation:	573.05
Bank Hieght Ratio:	0.96
Thalweg Elevation:	570.47
LTOB Elevation:	572.95
LTOB Max Depth:	2.48
LTOB Cross Sectional Area:	29.9

Stream Type	E/C

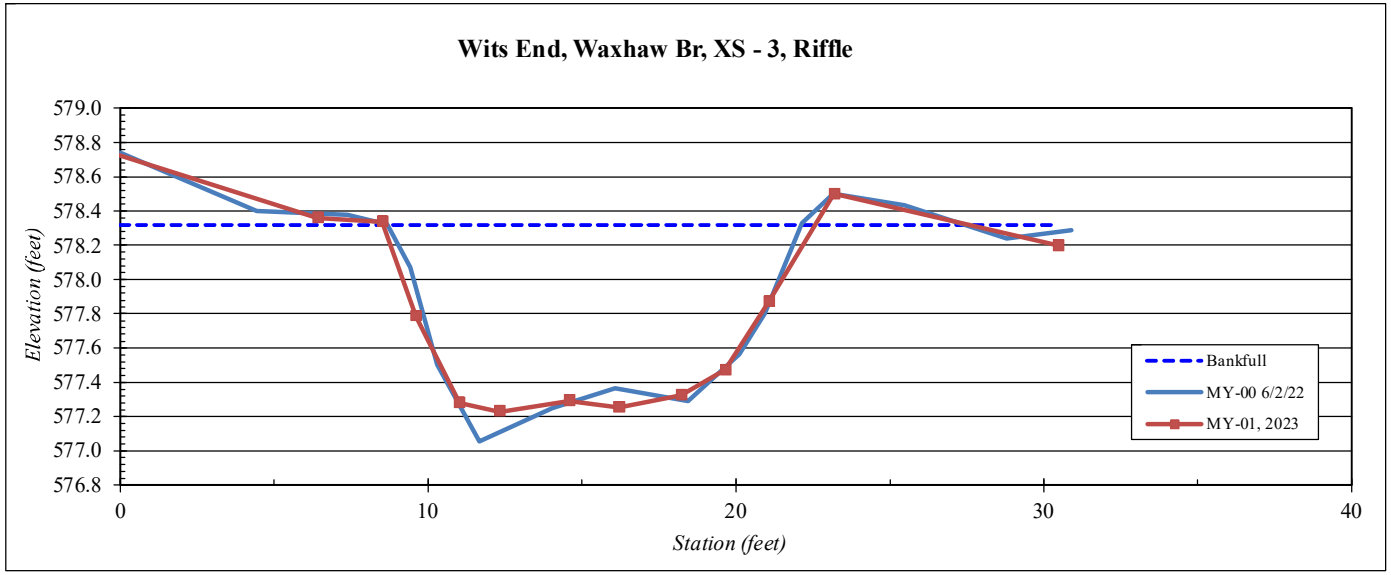


Site	Wits End Site
Watershed:	Yadkin River Basin, 03040105
XS ID	Waxhaw Br, XS -3
Feature	Riffle
Date:	4/2/2023
Field Crew:	Adams, Fleming, Perkinson, Smith

Station	Elevation
-0.3	578.7
6.4	578.4
8.5	578.3
9.6	577.8
11.0	577.3
12.3	577.2
14.6	577.3
16.2	577.3
18.2	577.3
19.7	577.5
21.1	577.9
23.2	578.5
30.5	578.2

SUMMARY DATA	
Bankfull Elevation:	578.32
Bank Hieght Ratio:	1.02
Thalweg Elevation:	577.23
LTOB Elevation:	578.34
LTOB Max Depth:	1.11
LTOB Cross Sectional Area:	11.8

Stream Type	E/C

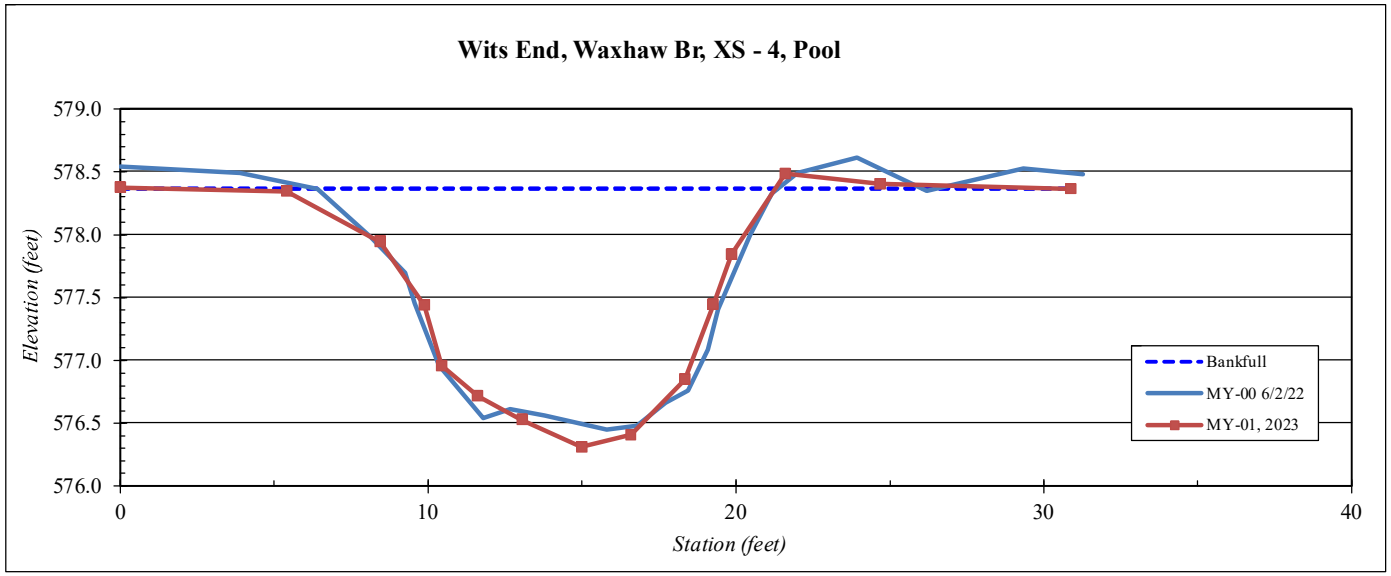


Site	Wits End Site
Watershed:	Yadkin River Basin, 03040105
XS ID	Waxhaw Br, XS -4
Feature	Pool
Date:	4/2/2023
Field Crew:	Adams, Fleming, Perkinson, Smith

Station	Elevation
0.0	578.4
5.4	578.3
8.4	577.9
9.9	577.4
10.4	577.0
11.6	576.7
13.1	576.5
15.0	576.3
16.6	576.4
18.3	576.8
19.3	577.4
19.9	577.8
21.6	578.5
24.7	578.4
30.9	578.4

SUMMARY DATA	
Bankfull Elevation:	578.37
Bank Hieght Ratio:	0.99
Thalweg Elevation:	576.31
LTOB Elevation:	578.35
LTOB Max Depth:	2.03
LTOB Cross Sectional Area:	18.2

Stream Type	E/C

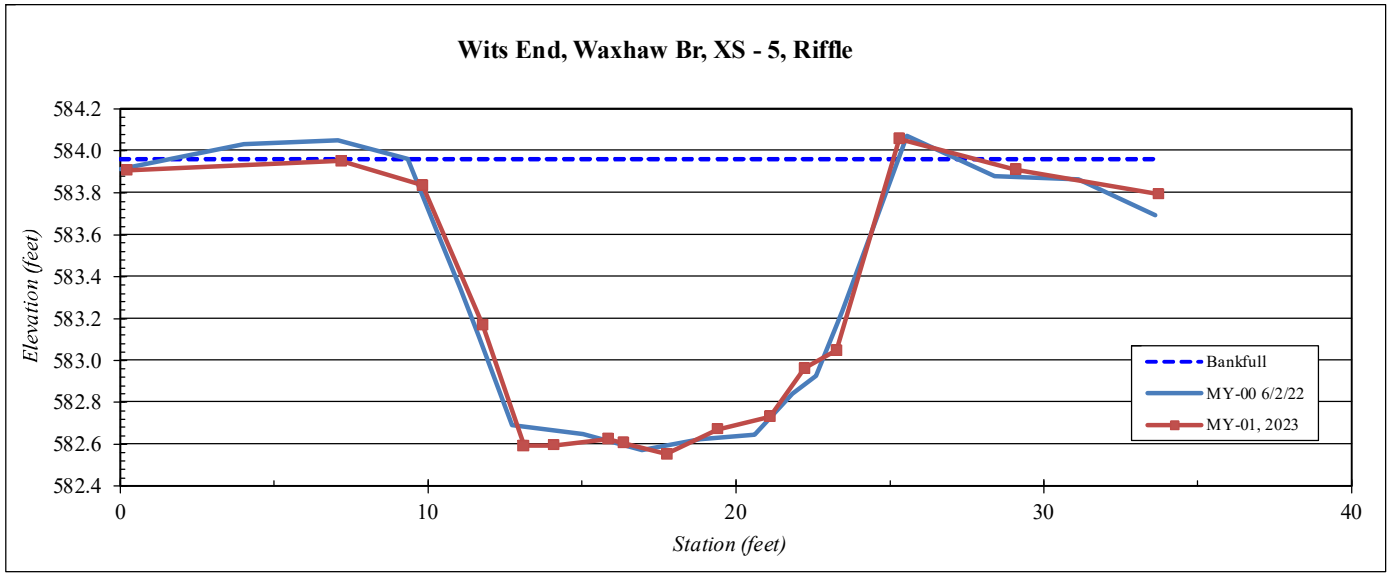


Site	Wits End Site
Watershed:	Yadkin River Basin, 03040105
XS ID	Waxhaw Br, XS -5
Feature	Riffle
Date:	4/2/2023
Field Crew:	Adams, Fleming, Perkinson, Smith

Station	Elevation
0.2	583.9
7.2	584.0
9.8	583.8
11.8	583.2
13.1	582.6
14.1	582.6
15.8	582.6
16.3	582.6
17.7	582.6
19.4	582.7
21.1	582.7
22.2	583.0
23.3	583.0
25.3	584.1
29.1	583.9
33.7	583.8

SUMMARY DATA	
Bankfull Elevation:	583.96
Bank Hieght Ratio:	0.99
Thalweg Elevation:	582.55
LTOB Elevation:	583.95
LTOB Max Depth:	1.40
LTOB Cross Sectional Area:	16.2

Stream Type	E/C

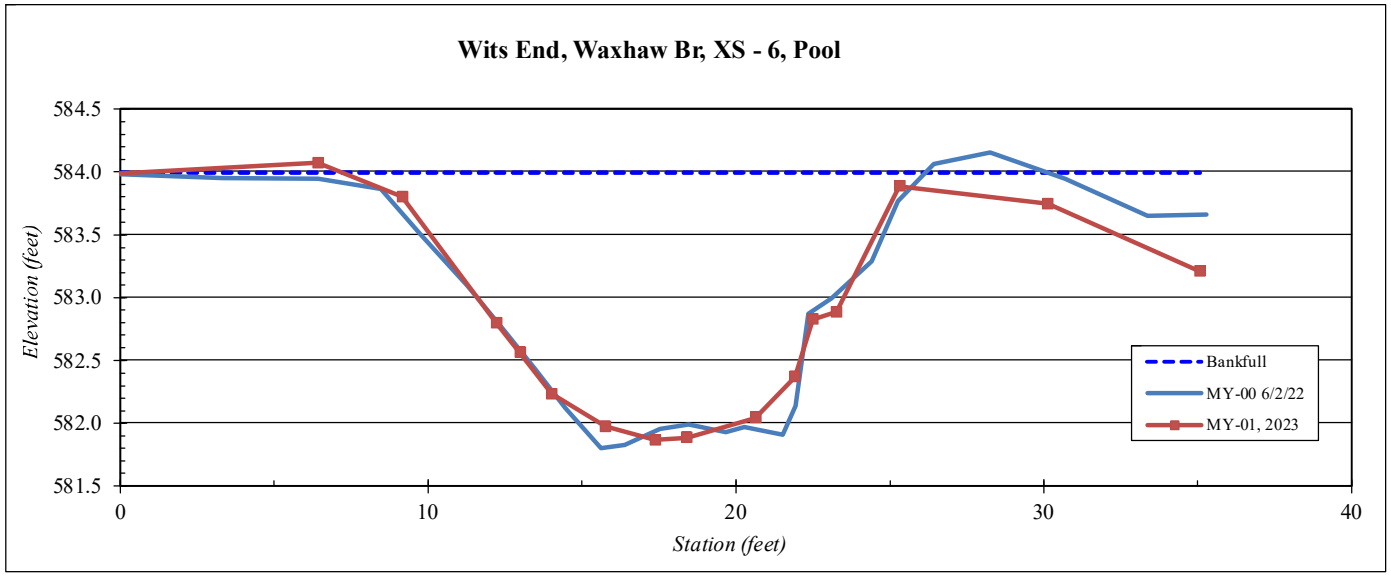


Site	Wits End Site
Watershed:	Yadkin River Basin, 03040105
XS ID	Waxhaw Br, XS -6
Feature	Pool
Date:	4/2/2023
Field Crew:	Adams, Fleming, Perkinson, Smith

Station	Elevation
-0.5	584.0
6.4	584.1
9.2	583.8
12.2	582.8
13.0	582.6
14.0	582.2
15.8	582.0
17.4	581.9
18.4	581.9
20.6	582.0
21.9	582.4
22.5	582.8
23.3	582.9
25.3	583.9
30.1	583.7
35.1	583.2

SUMMARY DATA	
Bankfull Elevation:	583.99
Bank Hieght Ratio:	0.95
Thalweg Elevation:	581.87
LTOB Elevation:	583.89
LTOB Max Depth:	2.02
LTOB Cross Sectional Area:	21.7

Stream Type	E/C

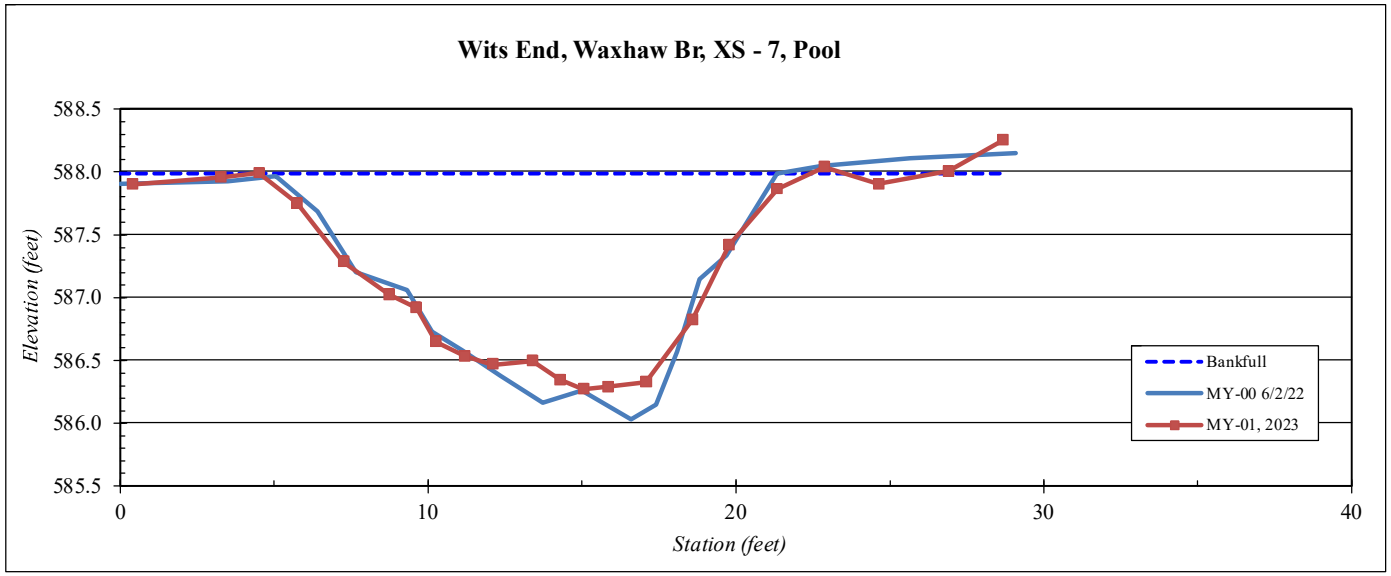


Site	Wits End Site
Watershed:	Yadkin River Basin, 03040105
XS ID	Waxhaw Br, XS -7
Feature	Pool
Date:	4/2/2023
Field Crew:	Adams, Fleming, Perkinson, Smith

Station	Elevation
0.4	587.9
3.3	588.0
4.5	588.0
5.7	587.8
7.2	587.3
8.7	587.0
9.6	586.9
10.2	586.6
11.2	586.5
12.1	586.5
13.4	586.5
14.3	586.3
15.1	586.3
15.8	586.3
17.1	586.3
18.6	586.8
19.8	587.4
21.3	587.9
22.9	588.0
24.6	587.9
26.9	588.01
28.7	588.3

SUMMARY DATA	
Bankfull Elevation:	587.99
Bank Hieght Ratio:	1.00
Thalweg Elevation:	586.27
LTOB Elevation:	587.99
LTOB Max Depth:	1.72
LTOB Cross Sectional Area:	18.3

Stream Type	C

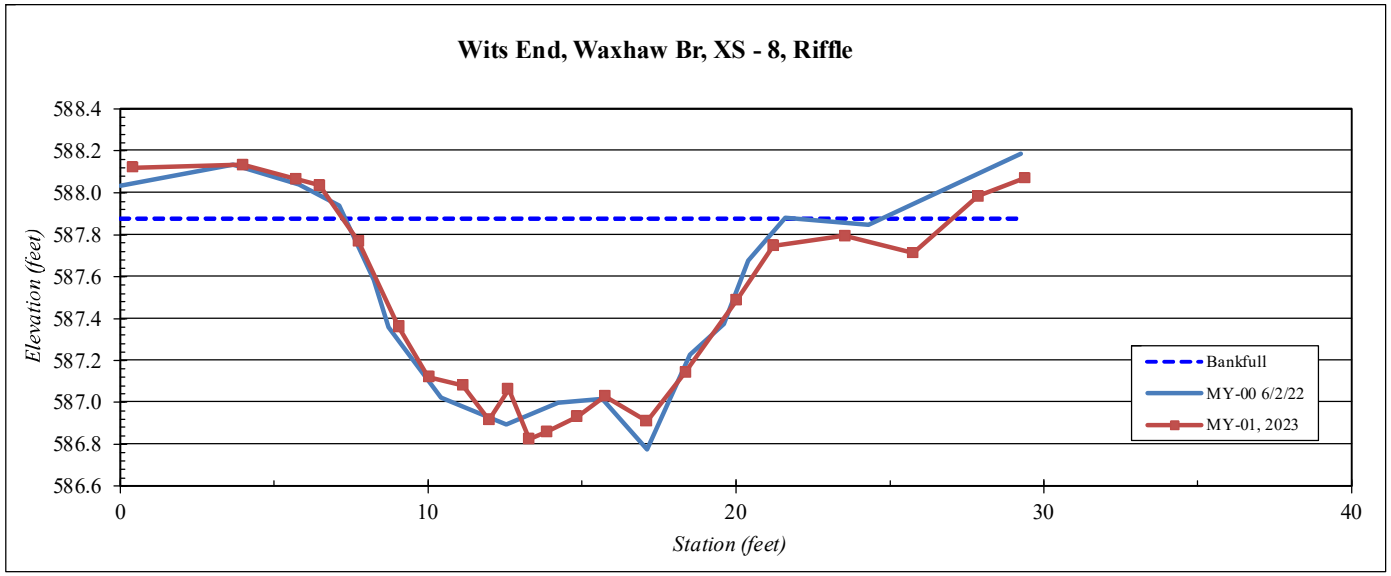


Site	Wits End Site
Watershed:	Yadkin River Basin, 03040105
XS ID	Waxhaw Br, XS -8
Feature	Riffle
Date:	4/2/2023
Field Crew:	Adams, Fleming, Perkinson, Smith

Station	Elevation
0.4	588.1
4.0	588.1
5.7	588.1
6.5	588.0
7.7	587.8
9.0	587.4
10.0	587.1
11.1	587.1
12.0	586.9
12.6	587.1
13.3	586.8
13.9	586.9
14.8	586.9
15.7	587.0
17.1	586.9
18.4	587.1
20.0	587.5
21.2	587.7
23.5	587.8
25.8	587.7
27.9	587.99
29.4	588.1

SUMMARY DATA	
Bankfull Elevation:	587.88
Bank Hieght Ratio:	0.92
Thalweg Elevation:	586.82
LTOB Elevation:	587.80
LTOB Max Depth:	0.97
LTOB Cross Sectional Area:	8.7

Stream Type	C

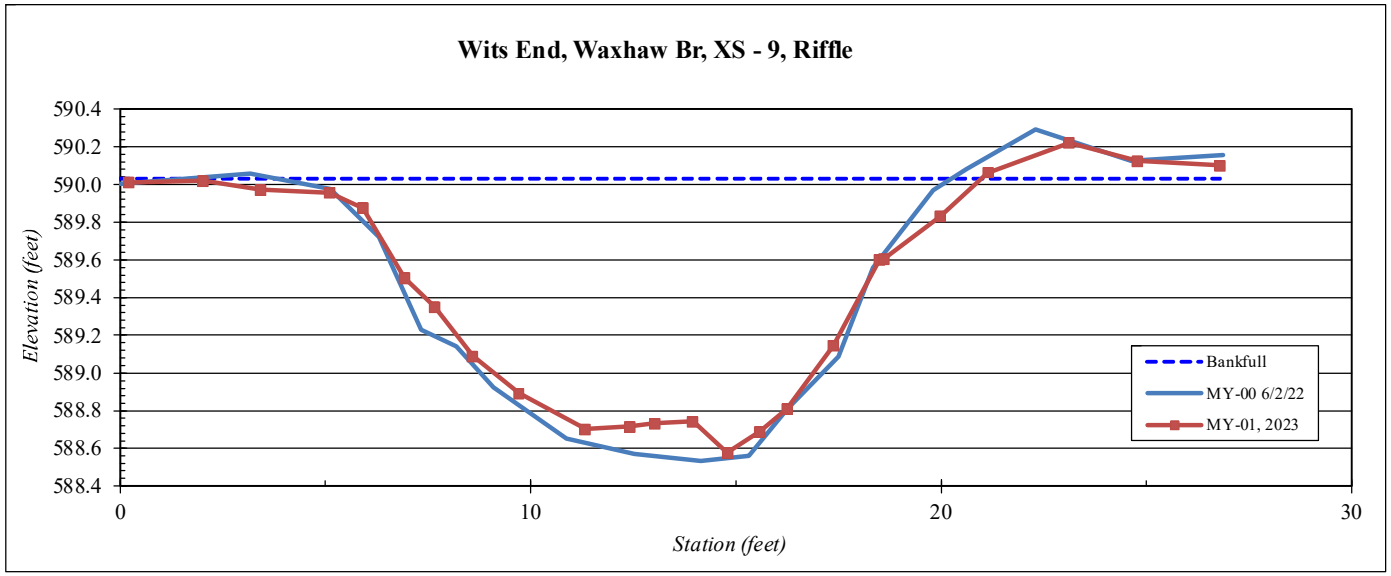


Site	Wits End Site
Watershed:	Yadkin River Basin, 03040105
XS ID	Waxhaw Br, XS -9
Feature	Riffle
Date:	4/2/2023
Field Crew:	Adams, Fleming, Perkinson, Smith

Station	Elevation
0.2	590.0
2.0	590.0
3.4	590.0
5.1	590.0
5.9	589.9
6.9	589.5
7.7	589.3
8.6	589.1
9.7	588.9
11.3	588.7
12.4	588.7
13.0	588.7
13.9	588.7
14.8	588.6
15.6	588.7
16.2	588.8
17.4	589.1
18.5	589.6
18.6	589.6
20.0	589.8
21.1	590.06
23.1	590.2
24.8	590.1
26.8	590.1

SUMMARY DATA	
Bankfull Elevation:	590.03
Bank Hieght Ratio:	0.95
Thalweg Elevation:	588.57
LTOB Elevation:	589.95
LTOB Max Depth:	1.38
LTOB Cross Sectional Area:	12.7

Stream Type	E/C

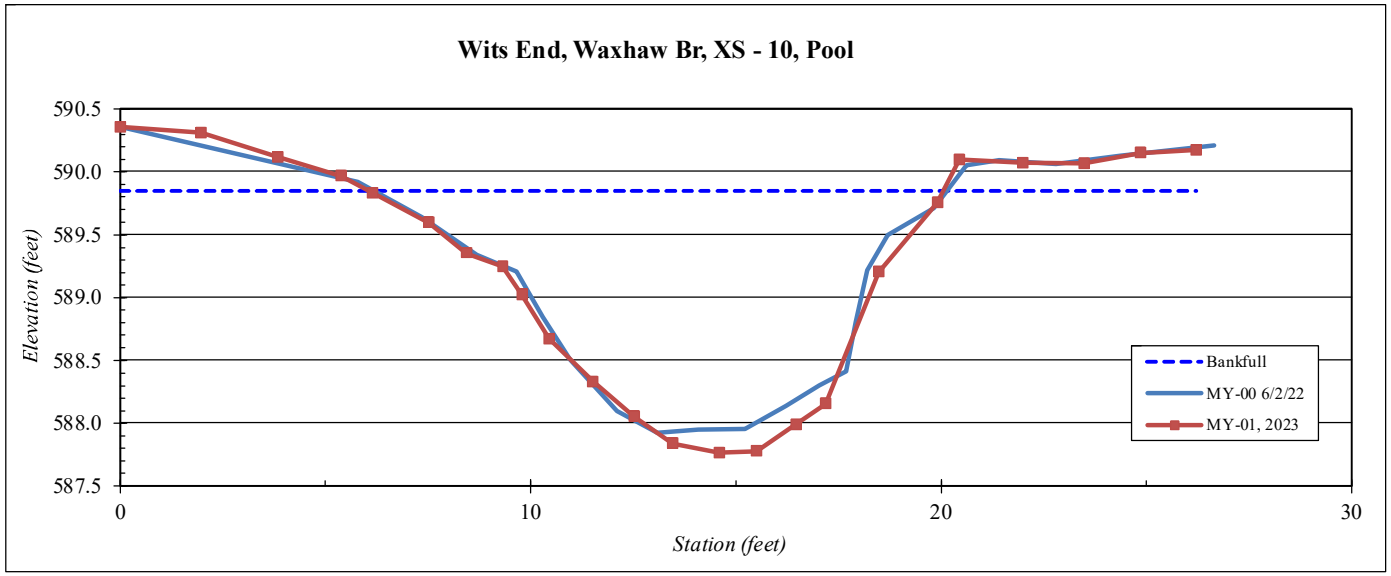


Site	Wits End Site
Watershed:	Yadkin River Basin, 03040105
XS ID	Waxhaw Br, XS -10
Feature	Pool
Date:	4/2/2023
Field Crew:	Adams, Fleming, Perkinson, Smith

Station	Elevation
0.0	590.4
2.0	590.3
3.8	590.1
5.4	590.0
6.1	589.8
7.5	589.6
8.4	589.4
9.3	589.2
9.8	589.0
10.4	588.7
11.5	588.3
12.5	588.1
13.5	587.8
14.6	587.8
15.5	587.8
16.5	588.0
17.2	588.2
18.5	589.2
19.9	589.8
20.4	590.1
22.0	590.07
23.5	590.1
24.9	590.2
26.2	590.2

SUMMARY DATA	
Bankfull Elevation:	589.85
Bank Hieght Ratio:	1.06
Thalweg Elevation:	587.77
LTOB Elevation:	589.97
LTOB Max Depth:	2.20
LTOB Cross Sectional Area:	18.1

Stream Type	E/C

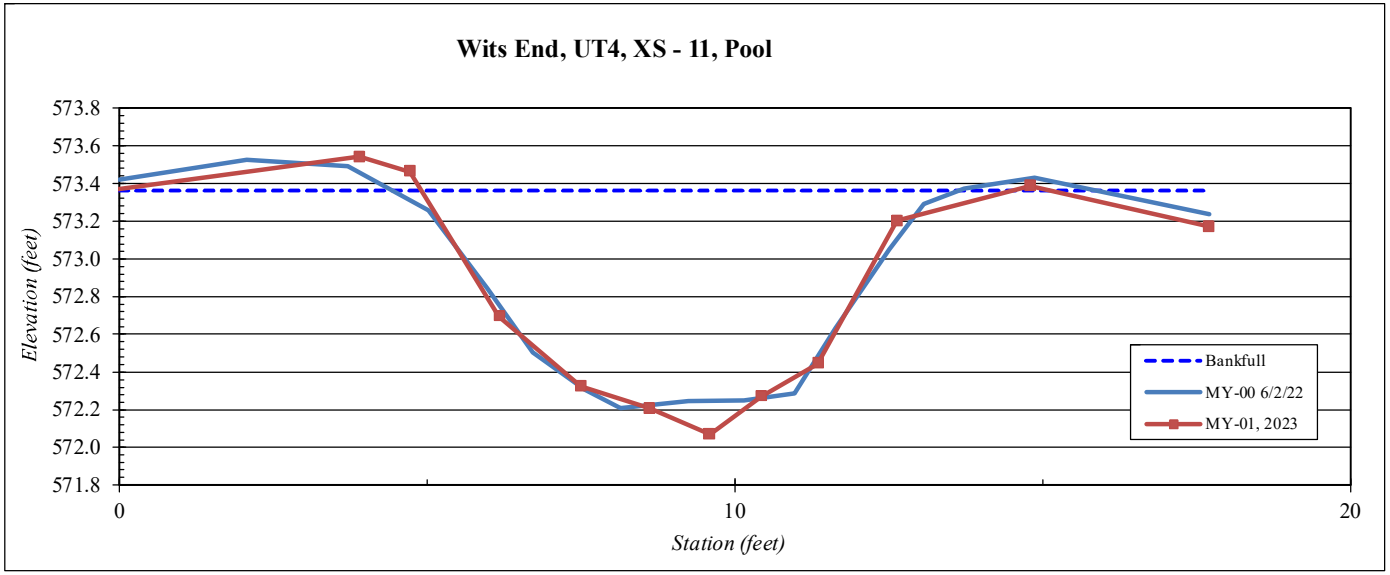


Site	Wits End Site
Watershed:	Yadkin River Basin, 03040105
XS ID	UT4, XS -11
Feature	Pool
Date:	4/2/2023
Field Crew:	Adams, Fleming, Perkinson, Smith

Station	Elevation
-0.1	573.4
3.9	573.5
4.7	573.5
6.2	572.7
7.5	572.3
8.6	572.2
9.6	572.1
10.4	572.3
11.4	572.4
12.6	573.2
14.8	573.4
17.7	573.2

SUMMARY DATA	
Bankfull Elevation:	573.36
Bank Hieght Ratio:	1.02
Thalweg Elevation:	572.07
LTOB Elevation:	573.39
LTOB Max Depth:	1.32
LTOB Cross Sectional Area:	7.0

Stream Type	E/C

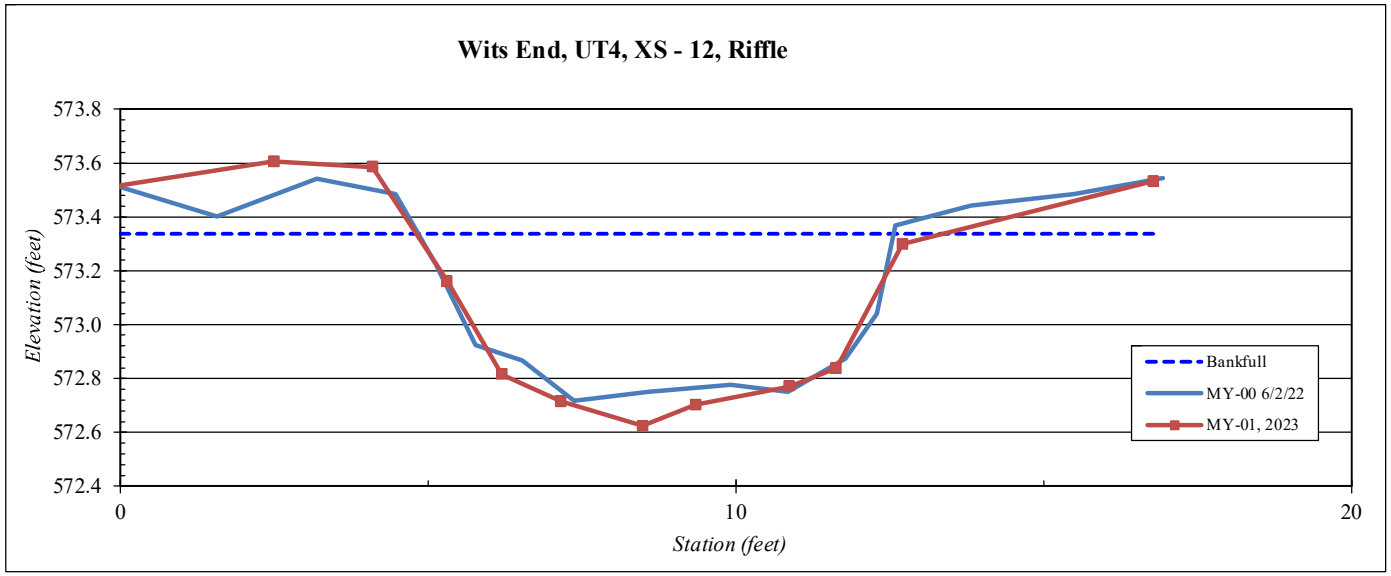


Site	Wits End Site
Watershed:	Yadkin River Basin, 03040105
XS ID	UT4, XS -12
Feature	Riffle
Date:	4/2/2023
Field Crew:	Adams, Fleming, Perkinson, Smith

Station	Elevation
-0.1	573.5
2.5	573.6
4.1	573.6
5.3	573.2
6.2	572.8
7.2	572.7
8.5	572.6
9.3	572.7
10.9	572.8
11.6	572.8
12.7	573.3
16.8	573.5

SUMMARY DATA	
Bankfull Elevation:	573.34
Bank Hieght Ratio:	0.95
Thalweg Elevation:	572.62
LTOB Elevation:	573.30
LTOB Max Depth:	0.67
LTOB Cross Sectional Area:	3.7

Stream Type	E/C

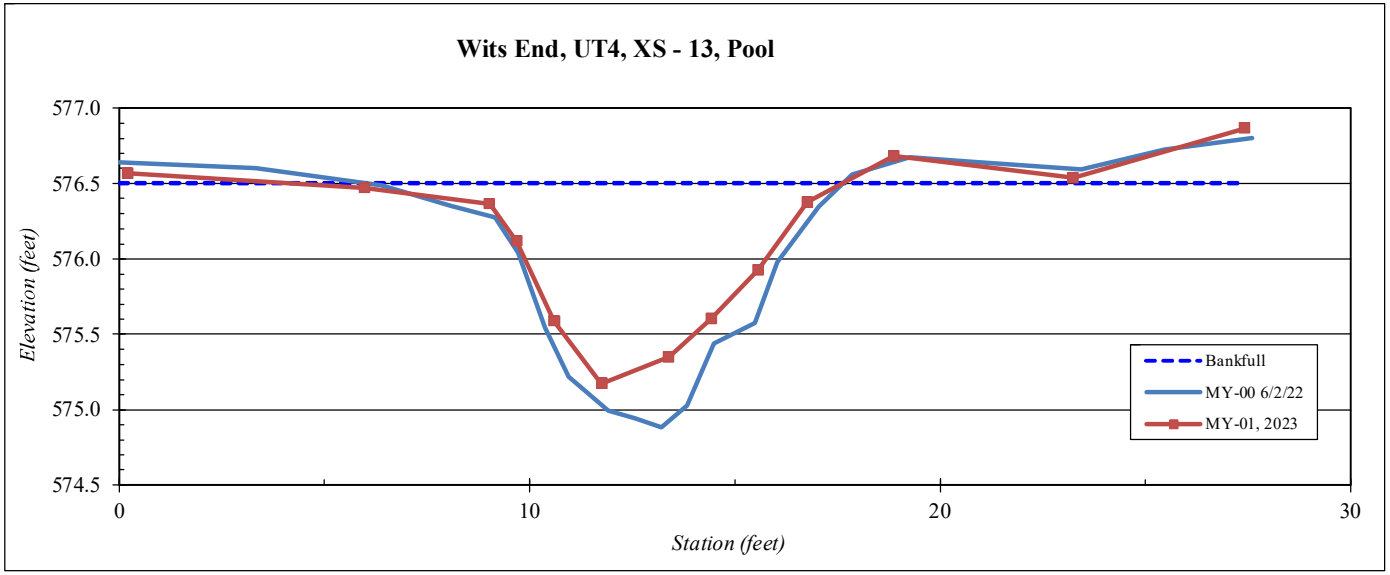


Site	Wits End Site
Watershed:	Yadkin River Basin, 03040105
XS ID	UT4, XS -13
Feature	Pool
Date:	4/2/2023
Field Crew:	Adams, Fleming, Perkinson, Smith

Station	Elevation
0.2	576.6
6.0	576.5
9.0	576.4
9.7	576.1
10.6	575.6
11.7	575.2
13.4	575.4
14.4	575.6
15.6	575.9
16.8	576.4
18.9	576.7
23.2	576.5
27.4	576.9

SUMMARY DATA	
Bankfull Elevation:	576.50
Bank Hieght Ratio:	0.89
Thalweg Elevation:	575.17
LTOB Elevation:	576.36
LTOB Max Depth:	1.19
LTOB Cross Sectional Area:	5.3

Stream Type	E/C

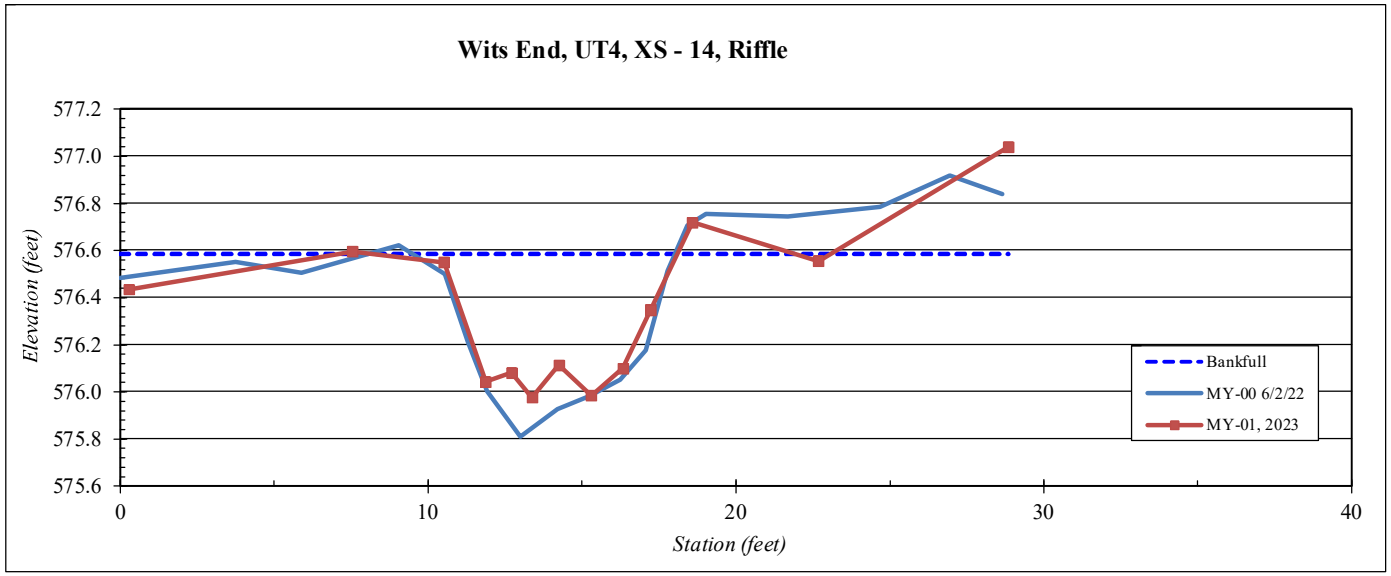


Site	Wits End Site
Watershed:	Yadkin River Basin, 03040105
XS ID	UT4, XS -14
Feature	Riffle
Date:	4/2/2023
Field Crew:	Adams, Fleming, Perkinson, Smith

Station	Elevation
0.3	576.4
7.5	576.6
10.5	576.5
11.9	576.0
12.7	576.1
13.4	576.0
14.3	576.1
15.3	576.0
16.3	576.1
17.2	576.3
18.6	576.7
22.7	576.6
28.9	577.0

SUMMARY DATA	
Bankfull Elevation:	576.58
Bank Hieght Ratio:	0.93
Thalweg Elevation:	575.97
LTOB Elevation:	576.55
LTOB Max Depth:	0.57
LTOB Cross Sectional Area:	2.9

Stream Type	E/C

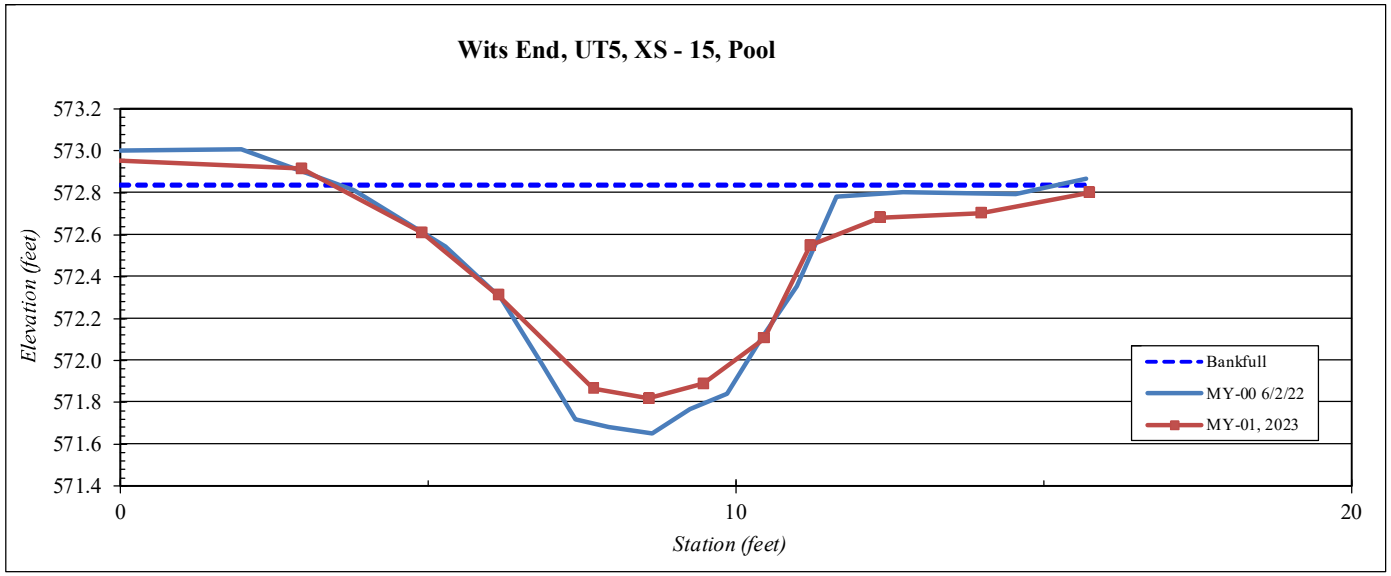


Site	Wits End Site
Watershed:	Yadkin River Basin, 03040105
XS ID	UT5, XS -15
Feature	Pool
Date:	4/2/2023
Field Crew:	Adams, Fleming, Perkinson, Smith

Station	Elevation
-0.2	573.0
2.9	572.9
4.9	572.6
6.1	572.3
7.7	571.9
8.6	571.8
9.5	571.9
10.5	572.1
11.2	572.5
12.3	572.7
14.0	572.7
15.7	572.8

SUMMARY DATA	
Bankfull Elevation:	572.84
Bank Hieght Ratio:	0.85
Thalweg Elevation:	571.82
LTOB Elevation:	572.68
LTOB Max Depth:	0.86
LTOB Cross Sectional Area:	3.7

Stream Type	E/C

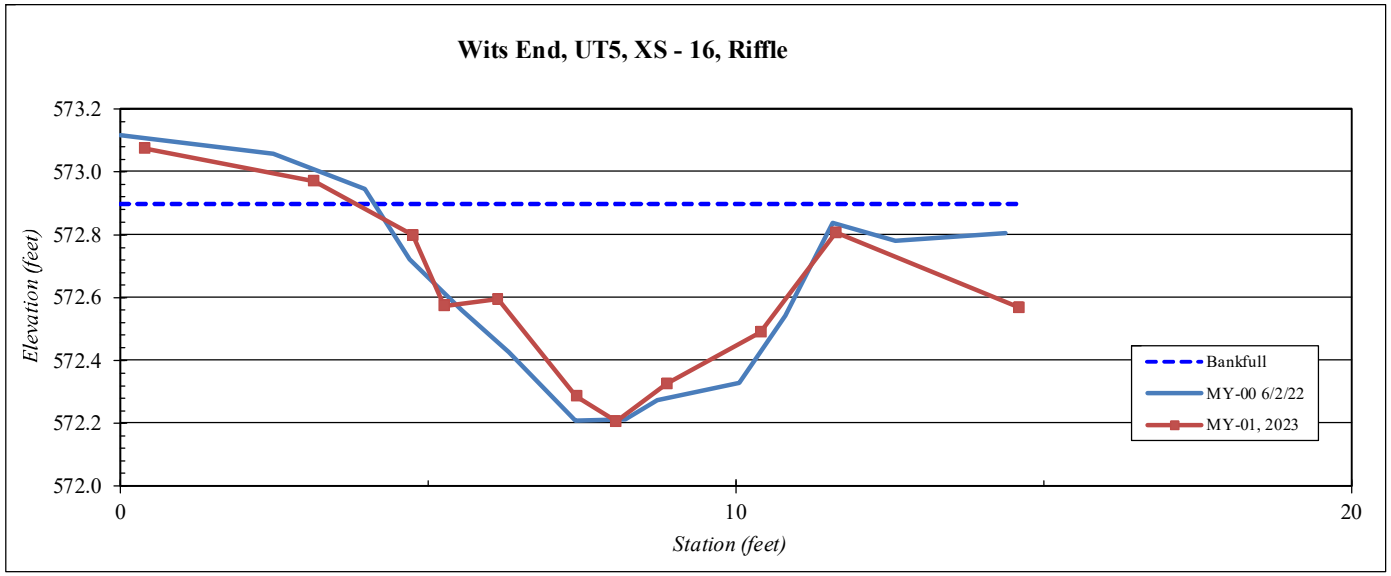


Site	Wits End Site
Watershed:	Yadkin River Basin, 03040105
XS ID	UT5, XS -16
Feature	Riffle
Date:	4/2/2023
Field Crew:	Adams, Fleming, Perkinson, Smith

Station	Elevation
0.4	573.1
3.1	573.0
4.8	572.8
5.3	572.6
6.1	572.6
7.4	572.3
8.1	572.2
8.9	572.3
10.4	572.5
11.6	572.8
14.6	572.6

SUMMARY DATA	
Bankfull Elevation:	572.90
Bank Hieght Ratio:	0.87
Thalweg Elevation:	572.21
LTOB Elevation:	572.81
LTOB Max Depth:	0.60
LTOB Cross Sectional Area:	2.3

Stream Type	E/C

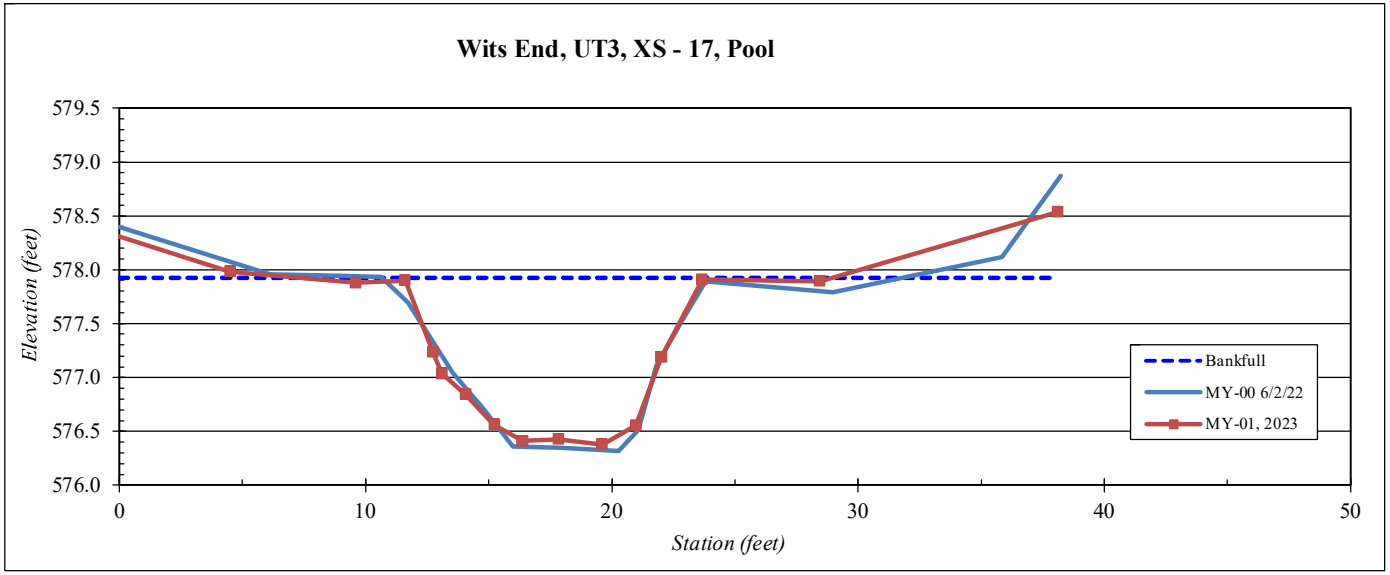


Site	Wits End Site
Watershed:	Yadkin River Basin, 03040105
XS ID	UT3, XS -17
Feature	Pool
Date:	4/2/2023
Field Crew:	Adams, Fleming, Perkinson, Smith

Station	Elevation
-0.3	578.3
4.5	578.0
9.6	577.9
11.6	577.9
12.7	577.2
13.1	577.0
14.1	576.8
15.2	576.6
16.4	576.4
17.8	576.4
19.6	576.4
21.0	576.6
22.0	577.2
23.7	577.9
28.5	577.9
38.1	578.5

SUMMARY DATA	
Bankfull Elevation:	577.92
Bank Hieght Ratio:	0.98
Thalweg Elevation:	576.38
LTOB Elevation:	577.90
LTOB Max Depth:	1.52
LTOB Cross Sectional Area:	13.0

Stream Type	C

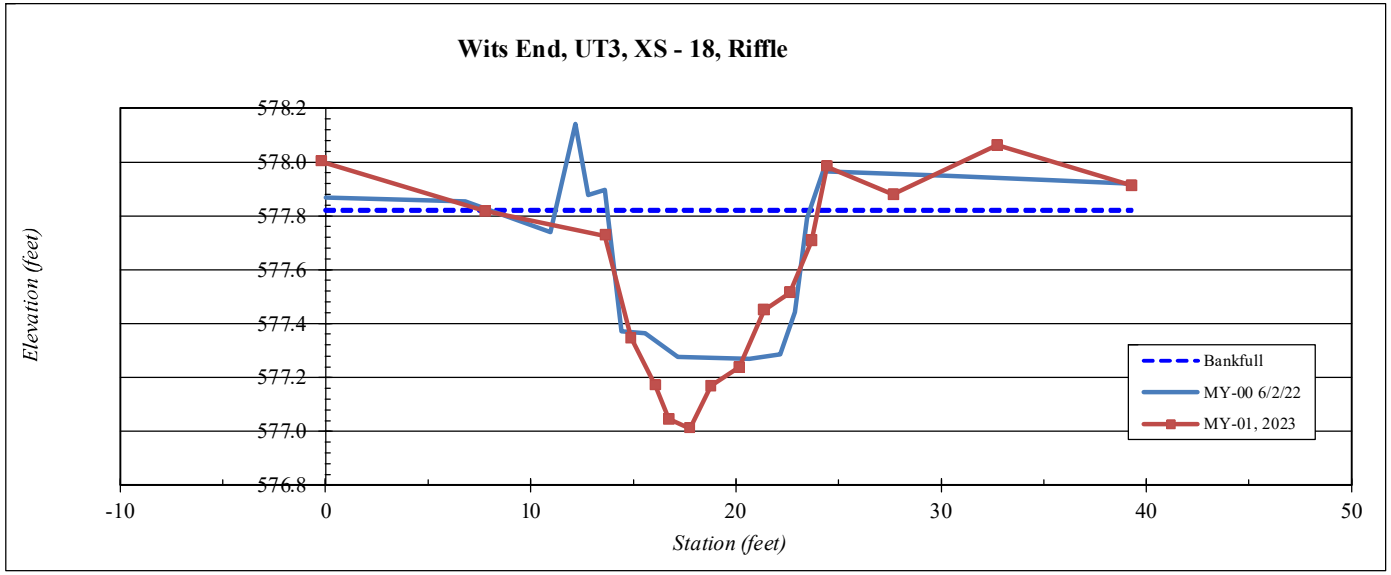


Site	Wits End Site
Watershed:	Yadkin River Basin, 03040105
XS ID	UT3, XS -18
Feature	Riffle
Date:	4/2/2023
Field Crew:	Adams, Fleming, Perkinson, Smith

Station	Elevation
-0.2	578.0
7.8	577.8
13.6	577.7
14.9	577.3
16.1	577.2
16.7	577.0
17.8	577.0
18.8	577.2
20.2	577.2
21.4	577.5
22.6	577.5
23.7	577.7
24.4	578.0
27.7	577.9
32.7	578.1
39.3	577.9

SUMMARY DATA	
Bankfull Elevation:	577.82
Bank Hieght Ratio:	1.00
Thalweg Elevation:	577.01
LTOB Elevation:	577.82
LTOB Max Depth:	0.81
LTOB Cross Sectional Area:	5.4

Stream Type	C

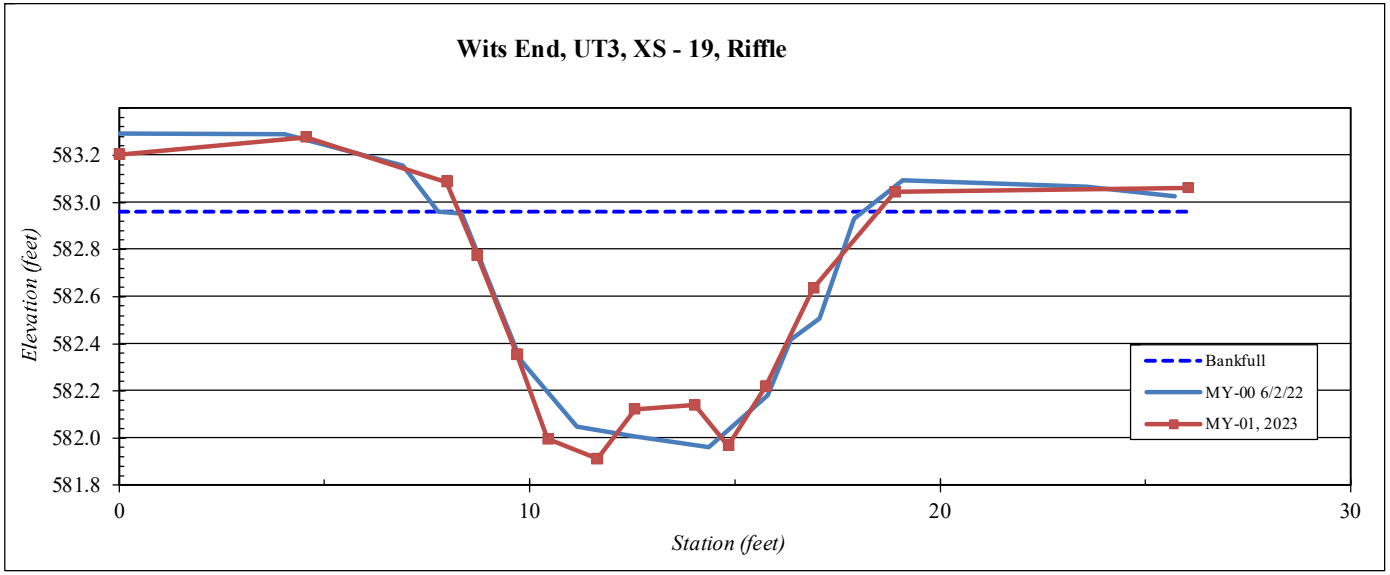


Site	Wits End Site
Watershed:	Yadkin River Basin, 03040105
XS ID	UT3, XS -19
Feature	Riffle
Date:	4/2/2023
Field Crew:	Adams, Fleming, Perkinson, Smith

Station	Elevation
0.0	583.2
4.6	583.3
8.0	583.1
8.7	582.8
9.7	582.4
10.4	582.0
11.6	581.9
12.6	582.1
14.0	582.1
14.8	582.0
15.8	582.2
16.9	582.6
18.9	583.0
26.0	583.1

SUMMARY DATA	
Bankfull Elevation:	582.96
Bank Hieght Ratio:	1.08
Thalweg Elevation:	581.91
LTOB Elevation:	583.04
LTOB Max Depth:	1.13
LTOB Cross Sectional Area:	7.6

Stream Type	E/C

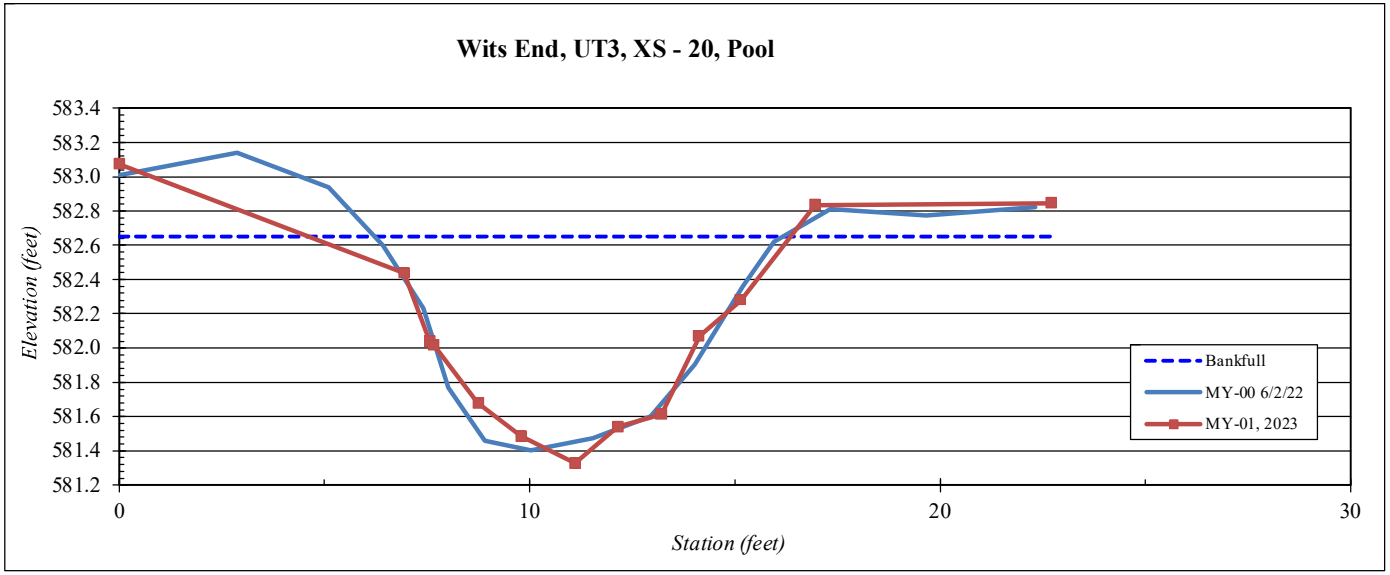


Site	Wits End Site
Watershed:	Yadkin River Basin, 03040105
XS ID	UT3, XS -20
Feature	Pool
Date:	4/2/2023
Field Crew:	Adams, Fleming, Perkinson, Smith

Station	Elevation
0.0	583.1
6.9	582.4
7.6	582.0
7.7	582.0
8.7	581.7
9.8	581.5
11.1	581.3
12.1	581.5
13.2	581.6
14.1	582.1
15.1	582.3
17.0	582.8
22.7	582.8

SUMMARY DATA	
Bankfull Elevation:	582.65
Bank Hieght Ratio:	0.84
Thalweg Elevation:	581.33
LTOB Elevation:	582.44
LTOB Max Depth:	1.11
LTOB Cross Sectional Area:	5.9

Stream Type	E/C

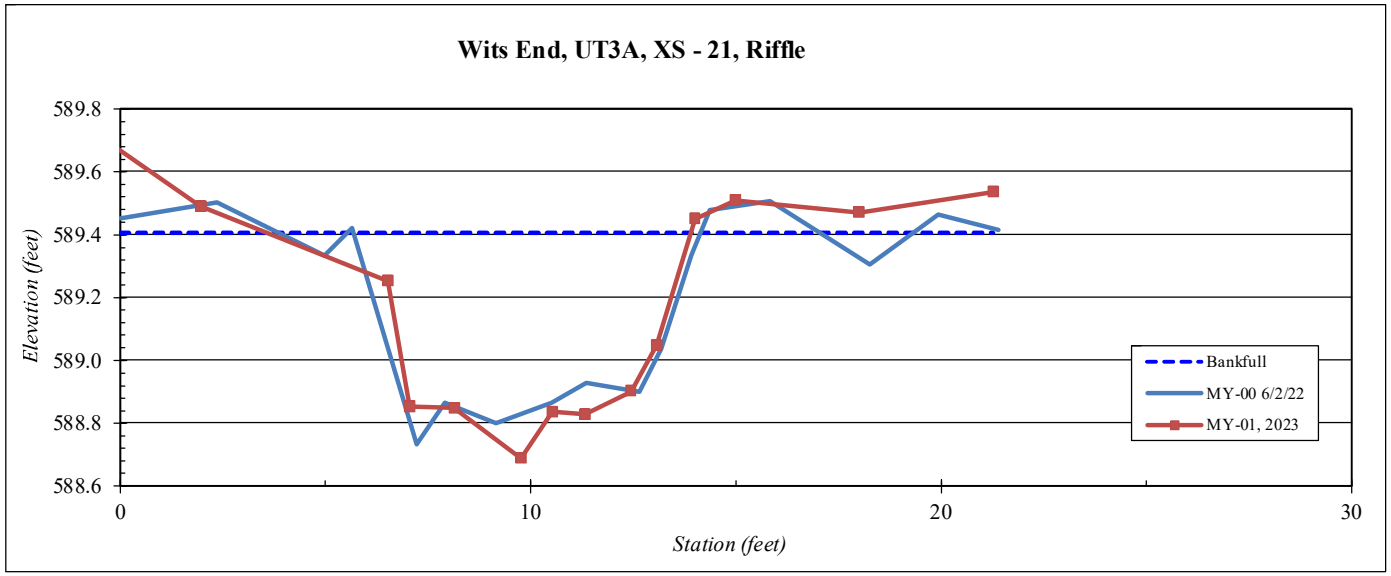


Site	Wits End Site
Watershed:	Yadkin River Basin, 03040105
XS ID	UT3A, XS -21
Feature	Riffle
Date:	4/2/2023
Field Crew:	Adams, Fleming, Perkinson, Smith

Station	Elevation
-0.2	589.7
2.0	589.5
6.5	589.3
7.0	588.9
8.1	588.8
9.8	588.7
10.5	588.8
11.3	588.8
12.4	588.9
13.1	589.0
14.0	589.5
15.0	589.5
18.0	589.5
21.3	589.5

SUMMARY DATA	
Bankfull Elevation:	589.41
Bank Hieght Ratio:	1.06
Thalweg Elevation:	588.69
LTOB Elevation:	589.45
LTOB Max Depth:	0.76
LTOB Cross Sectional Area:	4.5

Stream Type	E/C

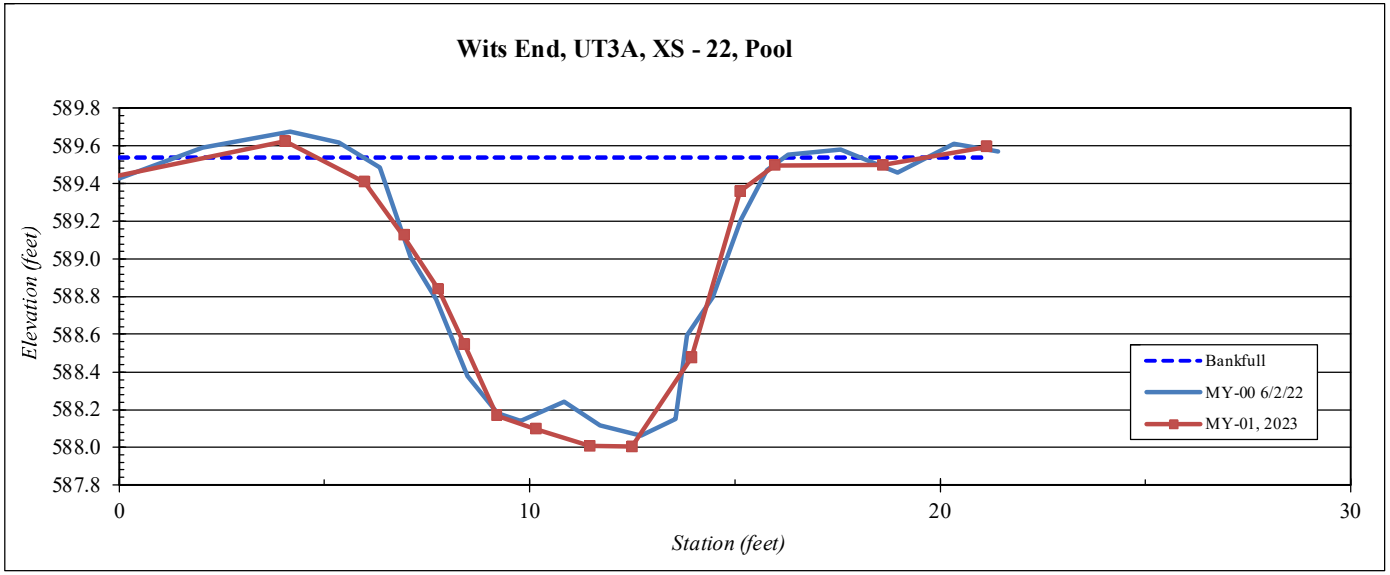


Site	Wits End Site
Watershed:	Yadkin River Basin, 03040105
XS ID	UT3A, XS -22
Feature	Pool
Date:	4/2/2023
Field Crew:	Adams, Fleming, Perkinson, Smith

Station	Elevation
-0.4	589.4
4.0	589.6
6.0	589.4
6.9	589.1
7.8	588.8
8.4	588.5
9.2	588.2
10.2	588.1
11.5	588.0
12.5	588.0
13.9	588.5
15.1	589.4
16.0	589.5
18.6	589.5
21.1	589.6

SUMMARY DATA	
Bankfull Elevation:	589.54
Bank Hieght Ratio:	0.97
Thalweg Elevation:	588.01
LTOB Elevation:	589.50
LTOB Max Depth:	1.49
LTOB Cross Sectional Area:	9.4

Stream Type	E/C

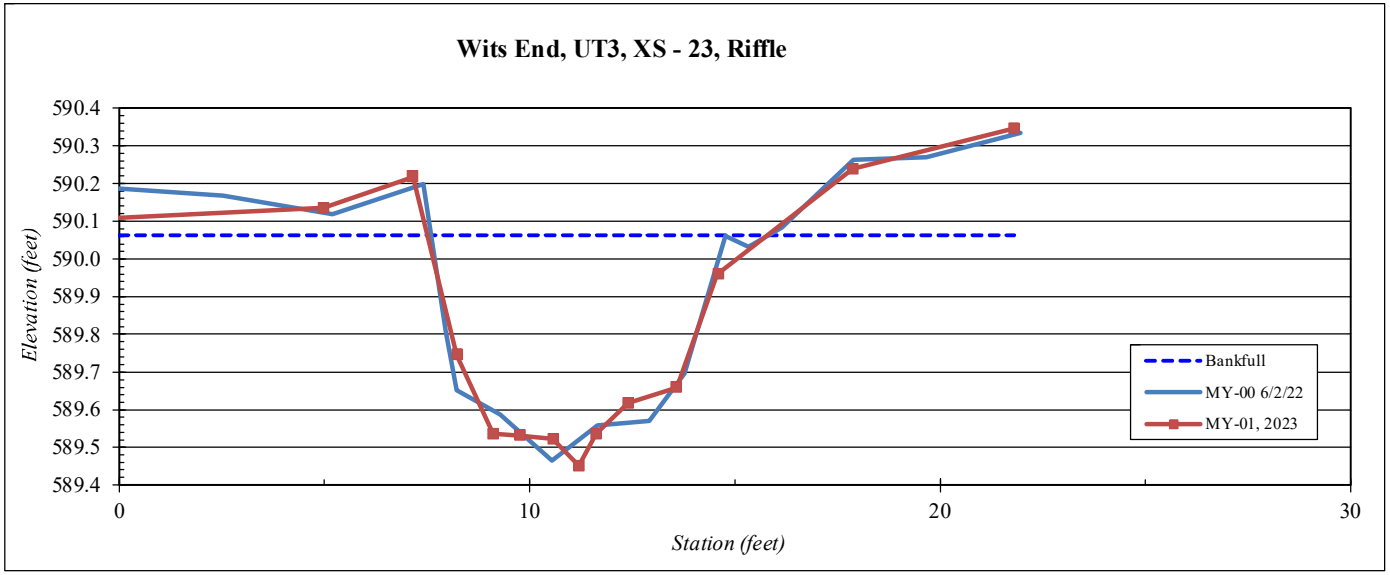


Site	Wits End Site
Watershed:	Yadkin River Basin, 03040105
XS ID	UT3, XS -23
Feature	Riffle
Date:	4/2/2023
Field Crew:	Adams, Fleming, Perkinson, Smith

Station	Elevation
-0.4	590.1
5.0	590.1
7.2	590.2
8.2	589.7
9.1	589.5
9.7	589.5
10.6	589.5
11.2	589.5
11.6	589.5
12.4	589.6
13.6	589.7
14.6	590.0
17.9	590.2
21.8	590.3

SUMMARY DATA	
Bankfull Elevation:	590.06
Bank Hieght Ratio:	1.12
Thalweg Elevation:	589.45
LTOB Elevation:	590.14
LTOB Max Depth:	0.68
LTOB Cross Sectional Area:	3.7

Stream Type	E/C

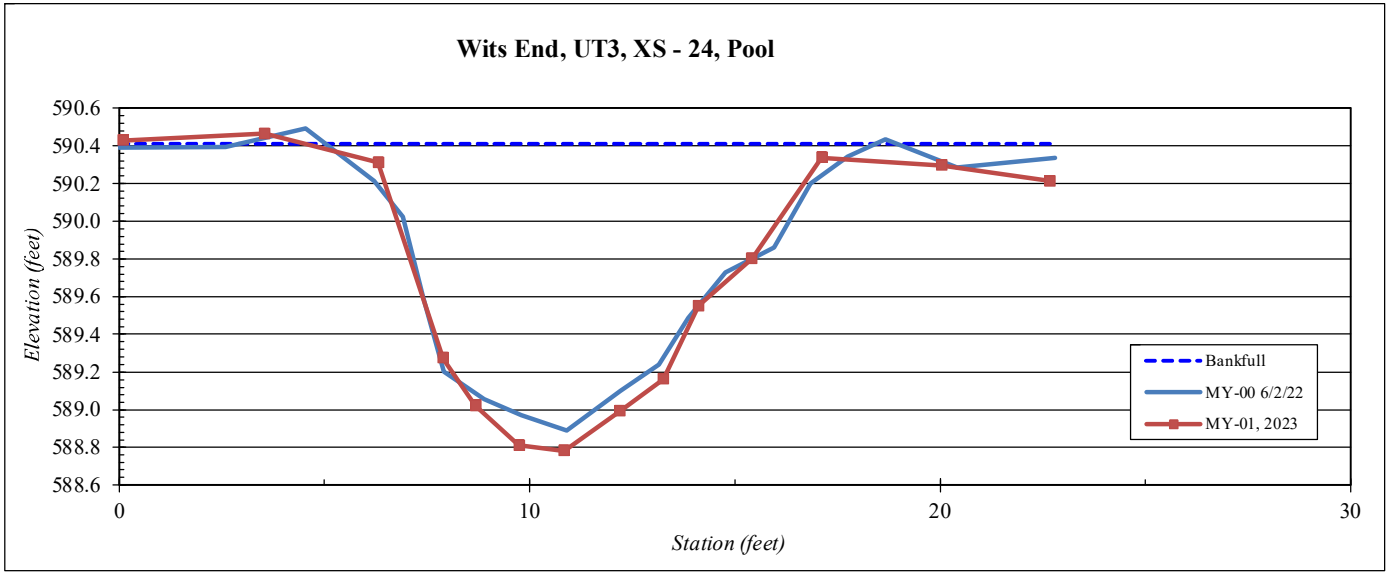


Site	Wits End Site
Watershed:	Yadkin River Basin, 03040105
XS ID	UT3, XS -24
Feature	Pool
Date:	4/2/2023
Field Crew:	Adams, Fleming, Perkinson, Smith

Station	Elevation
0.1	590.4
3.5	590.5
6.3	590.3
7.9	589.3
8.7	589.0
9.7	588.8
10.8	588.8
12.2	589.0
13.3	589.2
14.1	589.6
15.4	589.8
17.1	590.3
20.0	590.3
22.7	590.2

SUMMARY DATA	
Bankfull Elevation:	590.41
Bank Hieght Ratio:	0.95
Thalweg Elevation:	588.78
LTOB Elevation:	590.34
LTOB Max Depth:	1.55
LTOB Cross Sectional Area:	10.5

Stream Type	E/C

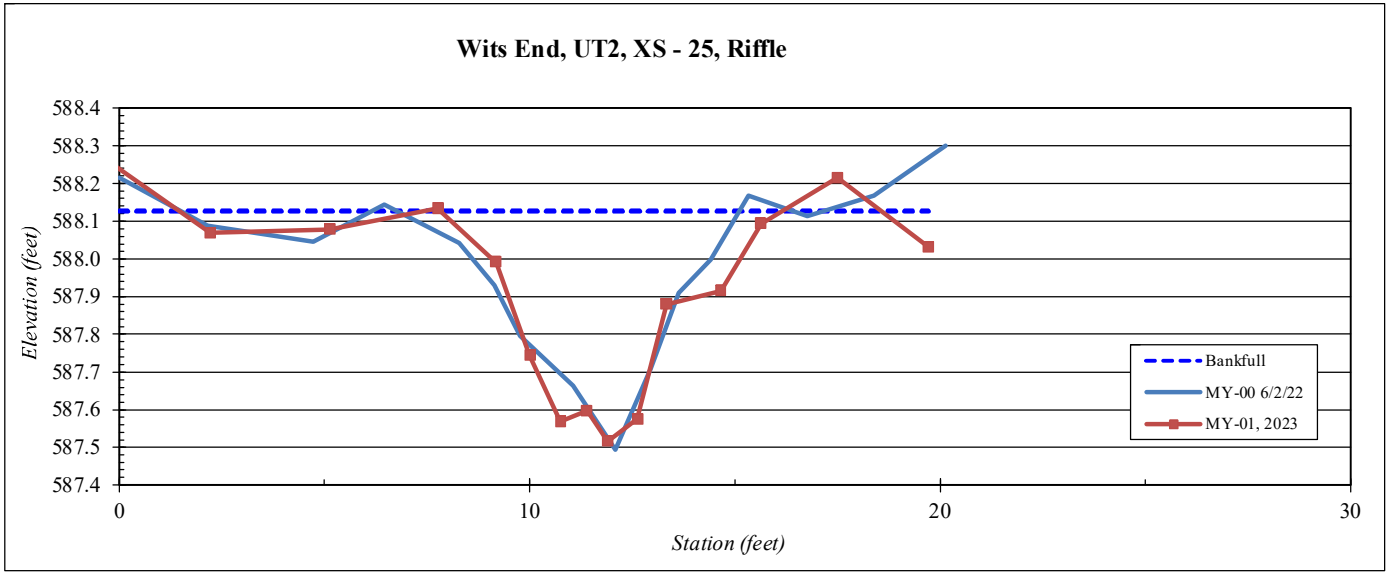


Site	Wits End Site
Watershed:	Yadkin River Basin, 03040105
XS ID	UT2, XS -25
Feature	Riffle
Date:	4/2/2023
Field Crew:	Adams, Fleming, Perkinson, Smith

Station	Elevation
-0.3	588.3
2.2	588.1
5.1	588.1
7.8	588.1
9.2	588.0
10.0	587.7
10.7	587.6
11.4	587.6
11.9	587.5
12.6	587.6
13.3	587.9
14.7	587.9
15.6	588.1
17.5	588.2
19.7	588.0

SUMMARY DATA	
Bankfull Elevation:	588.13
Bank Hieght Ratio:	1.01
Thalweg Elevation:	587.52
LTOB Elevation:	588.13
LTOB Max Depth:	0.62
LTOB Cross Sectional Area:	2.5

Stream Type	C

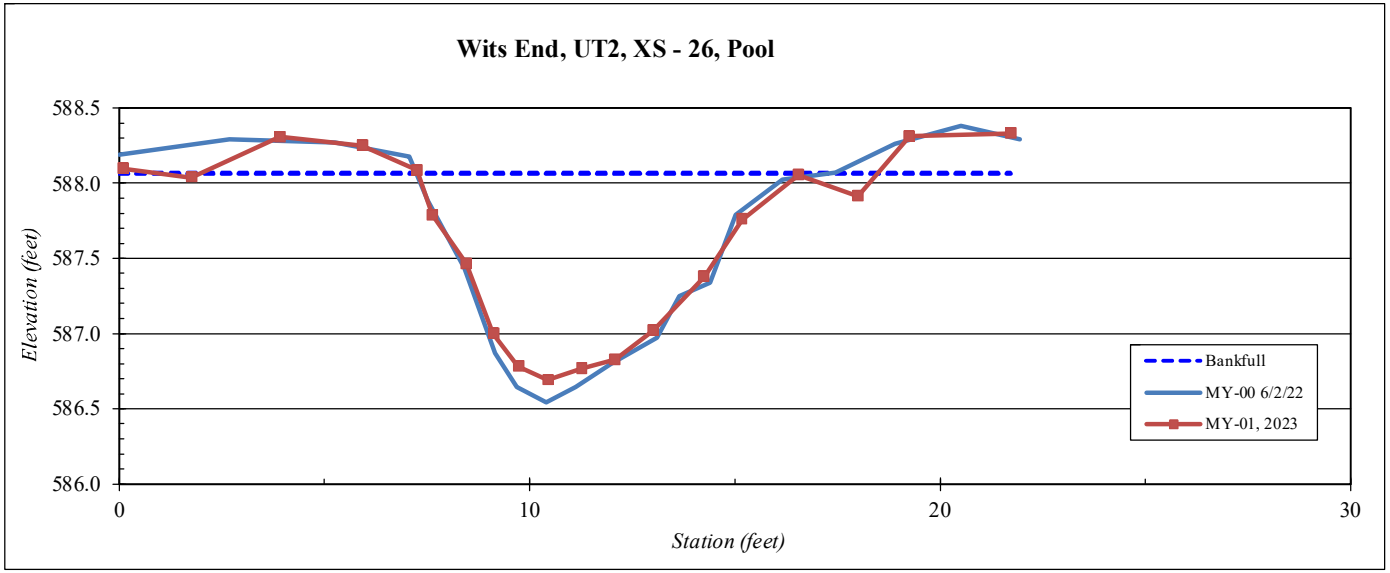


Site	Wits End Site
Watershed:	Yadkin River Basin, 03040105
XS ID	UT2, XS -26
Feature	Pool
Date:	4/2/2023
Field Crew:	Adams, Fleming, Perkinson, Smith

Station	Elevation
0.1	588.1
1.8	588.0
3.9	588.3
5.9	588.2
7.3	588.1
7.6	587.8
8.4	587.5
9.1	587.0
9.7	586.8
10.4	586.7
11.3	586.8
12.1	586.8
13.0	587.0
14.3	587.4
15.2	587.8
16.5	588.1
18.0	587.9
19.2	588.3
21.7	588.3

SUMMARY DATA	
Bankfull Elevation:	588.06
Bank Hieght Ratio:	0.99
Thalweg Elevation:	586.69
LTOB Elevation:	588.06
LTOB Max Depth:	1.36
LTOB Cross Sectional Area:	7.5

Stream Type	C

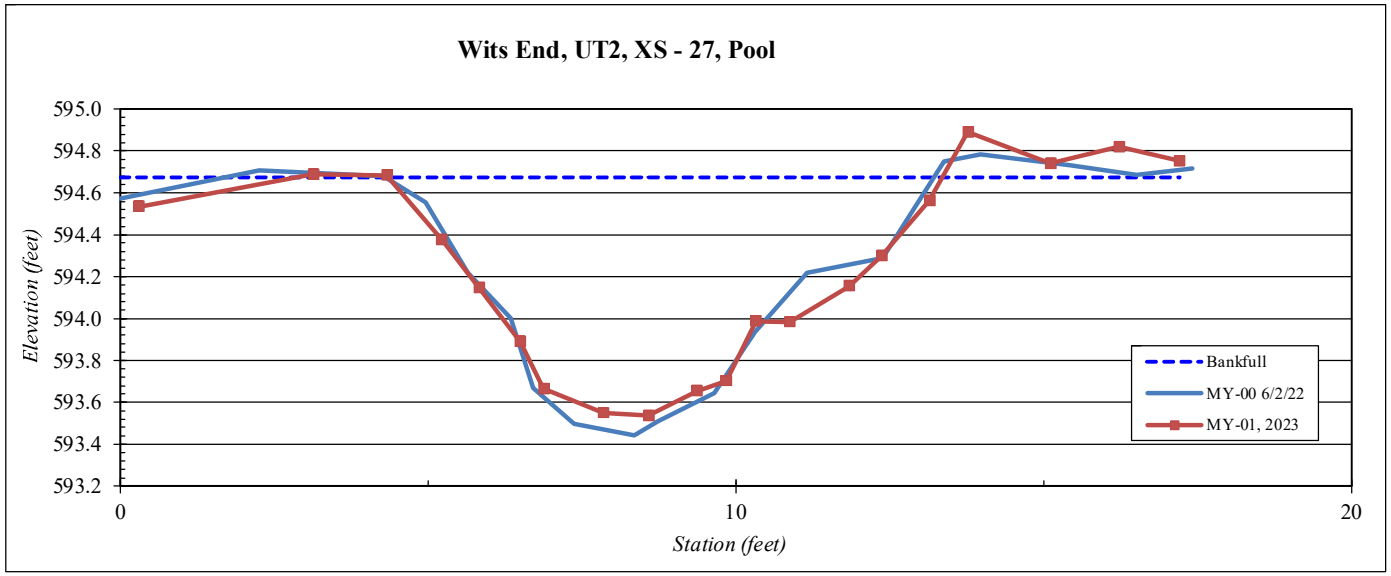


Site	Wits End Site
Watershed:	Yadkin River Basin, 03040105
XS ID	UT2, XS -27
Feature	Pool
Date:	4/2/2023
Field Crew:	Adams, Fleming, Perkinson, Smith

Station	Elevation
0.3	594.5
3.1	594.7
4.3	594.7
5.2	594.4
5.8	594.1
6.5	593.9
6.9	593.7
7.9	593.5
8.6	593.5
9.4	593.7
9.8	593.7
10.3	594.0
10.9	594.0
11.8	594.2
12.4	594.3
13.1	594.6
13.8	594.9
15.1	594.7
16.2	594.8
17.2	594.8

SUMMARY DATA	
Bankfull Elevation:	594.67
Bank Hieght Ratio:	0.90
Thalweg Elevation:	593.54
LTOB Elevation:	594.56
LTOB Max Depth:	1.03
LTOB Cross Sectional Area:	5.2

Stream Type	C



Site	Wits End Site
Watershed:	Yadkin River Basin, 03040105
XS ID	UT2, XS -28
Feature	Riffle
Date:	4/2/2023
Field Crew:	Adams, Fleming, Perkinson, Smith

Station	Elevation
0.0	594.8
1.7	594.6
2.9	594.7
4.0	594.7
4.6	594.7
5.5	594.4
6.3	594.3
6.9	594.3
7.7	594.2
8.2	594.2
9.0	594.2
10.0	594.1
10.8	594.4
12.1	594.7
12.7	594.8
14.0	594.9
15.2	594.9
16.5	594.8

SUMMARY DATA	
Bankfull Elevation:	594.72
Bank Hieght Ratio:	0.96
Thalweg Elevation:	594.18
LTOB Elevation:	594.70
LTOB Max Depth:	0.52
LTOB Cross Sectional Area:	2.7

Stream Type	C

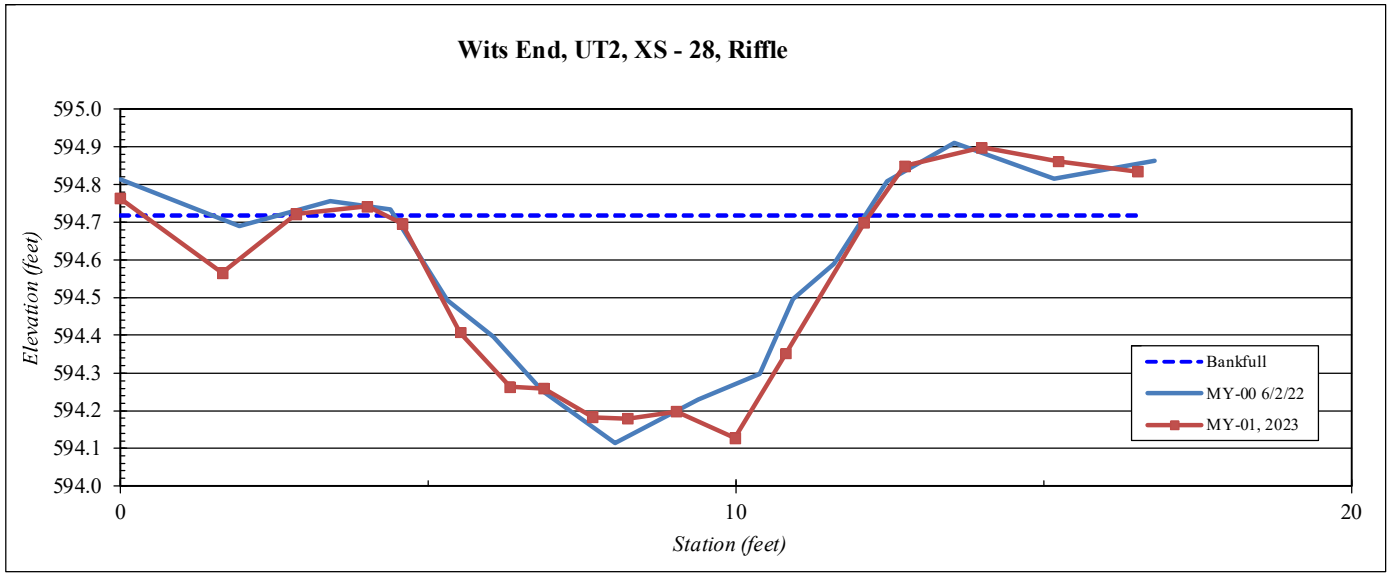


Table 9A. Baseline Stream Data Summary Wits End - Waxhaw Branch downstream										
Parameter	**Pre-Existing Condition (applicaple)**					**Design**		**Monitoring Baseline (MY0)**		
Riffle Only	Min	Mean	Med	Max	n	Min	Max	Min	Max	n
Bankfull Width (ft)	12.0		13.2	13.4		15.9	18.4	18.0	18.0	1
Floodprone Width (ft)	20		32	150		100	200	150	150	1
Bankfull Mean Depth (ft)	1.5		1.6	1.7		1.2	1.3	1.1	1.1	1
Bankfull Max Depth (ft)	2.1		2.4	2.7		1.5	2	1.5	1.5	1
Bankfull Cross Sectional Area (ft^2)	21.2		21.2	21.2		21.2	21.2	19.2	19.2	1
Width/Depth Ratio	7.1		8.3	8.9		12	16	16.9	16.9	1
Entrenchment Ratio	1.5		2.7	11.3		6.3	10.9	8.3	8.3	1
Bank Height Ratio	**1.5**		**1.8**	**2.2**		**1**	**1.3**	**1**	**1**	1
Max part size (mm) mobilized at bankfull										
Rosgen Classification	Eg 4/5					Ce 3/4		Ce 3/4		
Bankfull Discharge (cfs)	88.3					88.3		88.3		
Sinuosity (ft)	1.06					1.15		1.15		
Water Surface Slope (Channel) (ft/ft)	0.0042					0.0039		0.004		
Other										

Table 9B. Baseline Stream Data Summary Wits End - Waxhaw Branch upstream										
Parameter	**Pre-Existing Condition (applicaple)**					**Design**		**Monitoring Baseline (MY0)**		
Riffle Only	Min	Mean	Med	Max	n	Min	Max	Min	Max	n
Bankfull Width (ft)	10.4		11.6	13.3		13.4	15.5	18.0	18.0	1
Floodprone Width (ft)	150		150	150		50	150	150	150	1
Bankfull Mean Depth (ft)	1.1		1.3	1.4		1	1.1	1.1	1.1	1
Bankfull Max Depth (ft)	2		2.1	2.3		1.2	1.7	1.5	1.5	1
Bankfull Cross Sectional Area (ft^2)	15		15	15		15	15	19.2	19.2	1
Width/Depth Ratio	7.4		8.9	12.2		12	16	16.9	16.9	1
Entrenchment Ratio	11.2		12.9	14.4		3.7	9.7	8.3	8.3	1
Bank Height Ratio	**1.3**		**1.5**	**1.6**		**1**	**1.3**	**1**	**1**	1
Max part size (mm) mobilized at bankfull										
Rosgen Classification	Eg 4/5					Ce 3/4		Ce 3/4		
Bankfull Discharge (cfs)	61.3					61.3		61.3		
Sinuosity (ft)	1.01					1.15		1.15		
Water Surface Slope (Channel) (ft/ft)	0.0052					0.0046		0.0043		
Other										

Table 9C. Baseline Stream Data Summary Wits End - UT 1										
Parameter	**Pre-Existing Condition (applicaple)**					**Design**		**Monitoring Baseline (MY0)**		
Riffle Only	Min	Mean	Med	Max	n	Min	Max	Min	Max	n
Bankfull Width (ft)	4.0		4.6	5.1		5.8	6.7	18.0	18.0	1
Floodprone Width (ft)	40		45	50		25	75	150	150	1
Bankfull Mean Depth (ft)	0.5		0.6	0.7		0.4	0.5	1.1	1.1	1
Bankfull Max Depth (ft)	0.9		1	1		0.5	0.7	1.5	1.5	1
Bankfull Cross Sectional Area (ft^2)	2.8		2.8	2.8		2.8	2.8	19.2	19.2	1
Width/Depth Ratio	5.7		8	10.2		12	16	16.9	16.9	1
Entrenchment Ratio	7.8		10.2	12.5		4.3	11.2	8.3	8.3	1
Bank Height Ratio	**1.1**		**1.3**	**1.5**		**1**	**1.3**	**1**	**1**	1
Max part size (mm) mobilized at bankfull										
Rosgen Classification	Eg 4/5					Ce 3/4		Ce 3/4		
Bankfull Discharge (cfs)	61.3					61.3		61.3		
Sinuosity (ft)	1.06					1.1		1.1		
Water Surface Slope (Channel) (ft/ft)	0.0262					0.0253		0.0071		
Other										

Table 9D. Baseline Stream Data Summary Wits End - UT 2										
Parameter	**Pre-Existing Condition (applicaple)**					**Design**		**Monitoring Baseline (MY0)**		
Riffle Only	Min	Mean	Med	Max	n	Min	Max	Min	Max	n
Bankfull Width (ft)	4.1		4.8	7		6.9	8	7.7	8.7	1
Floodprone Width (ft)	22		33	40		25	75	50	50	1
Bankfull Mean Depth (ft)	0.6		0.8	1		0.5	0.6	0.3	0.4	1
Bankfull Max Depth (ft)	1.2		1.4	1.4		0.6	0.9	0.6	0.6	1
Bankfull Cross Sectional Area (ft^2)	4		4	4		4	4	2.4	2.8	1
Width/Depth Ratio	2		4.1	6		12	16	21.2	31.4	1
Entrenchment Ratio	4.7		5.4	8.3		3.1	9.6	5.8	6.5	1
Bank Height Ratio	**1**		**1.1**	**1.5**		**1**	**1.3**	**1**	**1**	1
Max part size (mm) mobilized at bankfull										
Rosgen Classification	E 6					Ce 3/4		Ce 4		
Bankfull Discharge (cfs)	14.8					14.8		14.8		
Sinuosity (ft)	1					1.1		1.1		
Water Surface Slope (Channel) (ft/ft)	0.0089					0.0076		0.0077		
Other										

Table 9E. Baseline Stream Data Summary Wits End - UT 3 Lower										
Parameter	**Pre-Existing Condition (applicaple)**					**Design**		**Monitoring Baseline (MY0)**		
Riffle Only	Min	Mean	Med	Max	n	Min	Max	Min	Max	n
Bankfull Width (ft)	7.1		8	10.3		9.7	11.2	9.7	10.3	1
Floodprone Width (ft)	8		10	23		50	100	75	75	1
Bankfull Mean Depth (ft)	0.8		1	1.1		0.7	0.8	0.5	0.7	1
Bankfull Max Depth (ft)	1.1		1.3	1.5		0.9	1.2	0.6	1.0	1
Bankfull Cross Sectional Area (ft^2)	7.8		7.8	7.8		7.8	7.8	5.4	6.7	1
Width/Depth Ratio	6.5		8	19.8		12	16	14.1	19.7	1
Entrenchment Ratio	1.1		1.3	2.2		5.2	9	7.3	7.7	1
Bank Height Ratio	**1.7**		**2.3**	**3**		**1**	**1.3**	**1**	**1**	1
Max part size (mm) mobilized at bankfull										
Rosgen Classification	G 4/5					Ce 3/4		Ce 3/4		
Bankfull Discharge (cfs)	30.6					30.6		30.6		
Sinuosity (ft)	1.03					1.1		1.1		
Water Surface Slope (Channel) (ft/ft)	0.0071					0.0066		0.0065		
Other										

Table 9F. Baseline Stream Data Summary Wits End - UT 3A										
Parameter	**Pre-Existing Condition (applicaple)**					**Design**		**Monitoring Baseline (MY0)**		
Riffle Only	Min	Mean	Med	Max	n	Min	Max	Min	Max	n
Bankfull Width (ft)	5.8		5.8	5.8		7	8.1	8.5	8.5	1
Floodprone Width (ft)	8		9	8		25	75	75	50	1
Bankfull Mean Depth (ft)	0.7		0.7	0.7		0.5	0.6	0.5	0.5	1
Bankfull Max Depth (ft)	0.9		1	1		0.6	0.9	0.7	0.7	1
Bankfull Cross Sectional Area (ft^2)	4.1		4.1	4.1		4.1	4.1	4.0	4.0	1
Width/Depth Ratio	8.3		8.3	8.3		12	16	18.2	18.2	1
Entrenchment Ratio	1.4		1.6	1.8		1	1.3	5.9	5.9	1
Bank Height Ratio	**1.4**		**1.8**	**1.8**		**1**	**1.3**	**1**	**1**	1
Max part size (mm) mobilized at bankfull										
Rosgen Classification	G 4					Ce 3/4		Ce 3/4		
Bankfull Discharge (cfs)	15.2					15.2		15.2		
Sinuosity (ft)	1.02					1.1		1.1		
Water Surface Slope (Channel) (ft/ft)	0.009					0.0084		0.008		
Other										

Table 9G. Baseline Stream Data Summary Wits End - UT 3 Upstream										
Parameter	**Pre-Existing Condition (applicaple)**					**Design**		**Monitoring Baseline (MY0)**		
Riffle Only	Min	Mean	Med	Max	n	Min	Max	Min	Max	n
Bankfull Width (ft)	5.3		5.7	6.1		7	8.1	7.2	7.2	1
Floodprone Width (ft)	7		8	8		25	75	50	50	1
Bankfull Mean Depth (ft)	0.8		0.9	0.9		0.5	0.6	0.4	0.4	1
Bankfull Max Depth (ft)	0.9		1	1.1		0.6	0.9	0.6	0.6	1
4.7	15		4.7	4.7		4.1	4.1	3.1	3.1	1
Width/Depth Ratio	5.9		6.8	7.6		12	16	16.8	16.8	1
Entrenchment Ratio	1.1		1.3	1.5		1	1.3	7.0	7.0	1
Bank Height Ratio	**2.3**		**2.9**	**3.4**		**1**	**1.3**	**1**	**1**	1
Max part size (mm) mobilized at bankfull										
Rosgen Classification	G 4/5					Ce 3/4		Ce 3/4		
Bankfull Discharge (cfs)	17.6					15.2		15.2		
Sinuosity (ft)	1.03					1.1		1.1		
Water Surface Slope (Channel) (ft/ft)	0.0089					0.0084		0.0083		
Other										

Table 9H. Baseline Stream Data Summary Wits End - UT 4 Upstream										
Parameter	**Pre-Existing Condition (applicaple)**					**Design**		**Monitoring Baseline (MY0)**		
Riffle Only	Min	Mean	Med	Max	n	Min	Max	Min	Max	n
Bankfull Width (ft)	4.4		10.6	17.9		6.9	8	18.0	18.0	1
Floodprone Width (ft)	30		50	60		25	75	150	150	1
Bankfull Mean Depth (ft)	0.2		0.6	1		0.5	0.6	1.1	1.1	1
Bankfull Max Depth (ft)	0.4		0.9	1.4		0.6	0.9	1.5	1.5	1
Bankfull Cross Sectional Area (ft^2)	4.3		4.3	4.3		4	4	19.2	19.2	1
Width/Depth Ratio	4.4		29.8	89.5		12	16	16.9	16.9	1
Entrenchment Ratio	3.1		5.1	9.6		3.1	9.6	8.3	8.3	1
Bank Height Ratio	**1**		**1.4**	**1.8**		**1**	**1.3**	**1**	**1**	1
Max part size (mm) mobilized at bankfull										
Rosgen Classification	Cg D 4/5					Ce 3/4		Ce 4		
Bankfull Discharge (cfs)	16					14.8		14.8		
Sinuosity (ft)	1.02					1.1		1.1		
Water Surface Slope (Channel) (ft/ft)	0.0076					0.0076		0.0058		
Other										

Table 9I. Baseline Stream Data Summary Wits End - UT 5 Upstream										
Parameter	**Pre-Existing Condition (applicaple)**					**Design**		**Monitoring Baseline (MY0)**		
Riffle Only	Min	Mean	Med	Max	n	Min	Max	Min	Max	n
Bankfull Width (ft)	3.1		3.4	3.7		5.4	6.2	7.3	7.3	1
Floodprone Width (ft)	10		13	15		15	50	30	30	1
Bankfull Mean Depth (ft)	0.7		0.8	0.8		0.4	0.4	0.4	0.4	1
Bankfull Max Depth (ft)	1		1.3	1.6		0.5	0.7	0.6	0.6	1
Bankfull Cross Sectional Area (ft^2)	2.4		2.4	2.4		2.4	2.4	3.0	3.0	1
Width/Depth Ratio	3.9		4.6	5.3		12	16	17.7	17.7	1
Entrenchment Ratio	3.2		3.6	4.1		2.8	8.1	4.1	4.1	1
Bank Height Ratio	**1**		**1.3**	**1.6**		**1**	**1.3**	**1**	**1**	1
Max part size (mm) mobilized at bankfull										
Rosgen Classification	Eg 4					Ce 3/4		Ce 3/4		
Bankfull Discharge (cfs)	8					8		8		
Sinuosity (ft)	1.04					1.1		1.1		
Water Surface Slope (Channel) (ft/ft)	0.0113					0.0107		0.0011		
Other										

Table 10A. Monitoring Data - Cross Section Morphology Monitoring Summary

(Wits End/ DMS:100164) Waxhaw Branch

	Waxhaw Br - Cross Section 1 (Riffle)							Waxhaw Br - Cross Section 2 (Pool)							Waxhaw Br - Cross Section 3 (Riffle)							Waxhaw Br - Cross Section 4 (Pool)							Waxhaw Br - Cross Section 5 (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	572.78	572.78						572.99	573.05						578.32	578.32						578.36	578.37						583.96	583.96					
Bank Height Ratio_Based on AB Bankfull[1] Area	1.00	1.04						1.00	0.96						1.00	1.02						1.00	0.99						1.00	0.99					
Thalweg Elevation	571.33	571.27						570.29	570.47						577.06	577.23						576.45	576.31						582.57	582.55					
LTOB[2] Elevation	572.78	572.83						572.99	572.95			`			578.32	578.34						578.36	578.35						583.96	583.95					
LTOB[2] Max Depth (ft)	1.45	1.57						2.70	2.48						1.27	1.11						1.92	2.03						1.39	1.40					
LTOB[2] Cross Sectional Area (ft^2)	19.0	19.98						32.2	29.88						11.5	11.77						18.6	18.24						16.3	16.17					

	Waxhaw Br - Cross Section 6 (Pool)							Waxhaw Br - Cross Section 7 (Pool)							Waxhaw Br - Cross Section 8 (Riffle)							Waxhaw Br - Cross Section 9 (Riffle)							Waxhaw Br - Cross Section 10 (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	583.94	583.99						587.97	587.99						587.88	587.88						589.98	590.03						589.92	589.85					
Bank Height Ratio_Based on AB Bankfull[1] Area	1.00	0.95						1.00	1.00						1.00	0.92						1.00	0.95						1.00	1.06					
Thalweg Elevation	581.80	581.87						586.03	586.27						586.78	586.82						588.56	588.57						587.92	587.77					
LTOB[2] Elevation	583.94	583.89						587.97	587.99						587.88	587.80						589.98	589.95						589.92	589.97					
LTOB[2] Max Depth (ft)	2.14	2.02						1.93	1.72						1.11	0.97						1.42	1.38						2.00	2.20					
LTOB[2] Cross Sectional Area (ft^2)	23.5	21.65						18.2	18.32						10.0	8.68						13.9	12.68						16.3	18.07					

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 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.

Table 10B. Monitoring Data - Cross Section Morphology Monitoring Summary

(Wits End/ DMS:100164) UT 2

	UT 2 - Cross Section 25 (Riffle)							UT 2 - Cross Section 26 (Pool)							UT 2 - Cross Section 27 (Pool)							UT 3 - Cross Section 28 (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	588.14	588.13						588.02	588.06						594.68	594.67						594.73	594.72													
Bank Height Ratio_Based on AB Bankfull[1] Area	1.00	1.01						1.00	0.99						1.00	0.90						1.00	0.96													
Thalweg Elevation	587.49	587.52						586.55	586.69						593.44	593.54						594.11	594.18													
LTOB[2] Elevation	588.14	588.13						588.02	588.06			`			594.68	594.56						594.73	594.70													
LTOB[2] Max Depth (ft)	0.65	0.62						1.48	1.36						1.24	1.03						0.62	0.52													
LTOB[2] Cross Sectional Area (ft^2)	2.4	2.48						7.6	7.49						6.1	5.18						2.88	2.73													
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)																																				
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 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

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.

Table 10C. Monitoring Data - Cross Section Morphology Monitoring Summary

(Wits End/ DMS:100164) UT 3

	UT 3 - Cross Section 17 (Pool)							UT 2 - Cross Section 18 (Riffle)							UT 3 - Cross Section 19 (Riffle)							UT 3 - Cross Section 20 (Pool)							UT 3 - Cross Section 23 (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	577.89	577.92						577.89	577.82						582.95	582.96						582.62	582.65						590.06	590.06					
Bank Height Ratio_Based on AB Bankfull[1] Area	1.00	0.98						1.00	1.00						1.00	1.08						1.00	0.84						1.00	1.12					
Thalweg Elevation	576.32	576.38						577.27	577.01						581.96	581.91						581.40	581.33						589.47	589.45					
LTOB[2] Elevation	577.89	577.90						577.89	577.82			`			582.95	583.04						582.62	582.44			`			590.06	590.14			`		
LTOB[2] Max Depth (ft)	1.57	1.52						0.63	0.81						0.99	1.13						1.22	1.11						0.60	0.68					
LTOB[2] Cross Sectional Area (ft^2)	13.3	13.00						5.4	5.40						6.7	7.59						7.7	5.86						3.1	3.72					

	UT 3 - Cross Section 24 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-Bankfull[1] Area	590.43	590.41					
Bank Height Ratio_Based on AB Bankfull[1] Area	1.00	0.95					
Thalweg Elevation	588.89	588.78					
LTOB[2] Elevation	590.43	590.34			`		
LTOB[2] Max Depth (ft)	1.54	1.55					
LTOB[2] Cross Sectional Area (ft^2)	11.3	10.46					

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 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

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.

Table 10D. Monitoring Data - Cross Section Morphology Monitoring Summary

(Wits End/ DMS:100164) UT 3A

	UT 3A - Cross Section 21 (Riffle)							UT 3A - Cross Section 22 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-Bankfull[1] Area	589.42	589.41						589.55	589.54					
Bank Height Ratio_Based on AB Bankfull[1] Area	1.00	1.06						1.00	0.97					
Thalweg Elevation	588.73	588.69						588.06	588.01					
LTOB[2] Elevation	589.42	589.45						589.55	589.50			`		
LTOB[2] Max Depth (ft)	0.69	0.76						1.49	1.49					
LTOB[2] Cross Sectional Area (ft^2)	4.0	4.51						9.8	9.37					
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)														
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 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

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.

Table 10E. Monitoring Data - Cross Section Morphology Monitoring Summary

(Wits End/ DMS:100164) UT 4

	UT 4 - Cross Section 11 (Pool)							UT 4 - Cross Section 12 (Riffle)							UT 4 - Cross Section 13 (Pool)							UT 4 - Cross Section 14 (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	573.37	573.36						573.37	573.34						576.28	576.50						576.50	576.58													
Bank Height Ratio_Based on AB Bankfull[1] Area	1.00	1.02						1.00	0.95						1.00	0.89						1.00	0.93													
Thalweg Elevation	572.21	572.07						572.72	572.62						574.88	575.17						575.81	575.97													
LTOB[2] Elevation	573.37	573.39						573.37	573.30			`			576.28	576.36			`			576.50	576.55			`							`			
LTOB[2] Max Depth (ft)	1.16	1.32						0.65	0.67						1.39	1.19						0.69	0.57													
LTOB[2] Cross Sectional Area (ft^2)	6.7	6.98						4.0	3.68						6.4	5.34						3.2	2.94													
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)																																				
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 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

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.

Table 10F. Monitoring Data - Cross Section Morphology Monitoring Summary

(Wits End/ DMS:100164) UT 5

	UT 5 - Cross Section 15 (Pool)							UT 5 - Cross Section 16 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-Bankfull[1] Area	572.78	572.84						572.84	572.90					
Bank Height Ratio_Based on AB Bankfull[1] Area	1.00	0.85						1.00	0.87					
Thalweg Elevation	571.65	571.82						572.21	572.21					
LTOB[2] Elevation	572.78	572.68						572.84	572.81					
LTOB[2] Max Depth (ft)	1.13	0.86						0.63	0.60					
LTOB[2] Cross Sectional Area (ft^2)	4.9	3.71						3.0	2.34					
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)														
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 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 11A. Verification of Bankfull Events
Table 11B. Bankfull Events Summary by Gauge
Crest Gauge Graphs
Table 12. Groundwater Hydrology Data
Groundwater Gauge Graphs
Table 13A-E. Channel Evidence
Surface Water Gauge Graphs
Figure D1. 30/70 Percentile Graph for Rainfall
Soil Temperature Graph

Table 11A. Verification of Bankfull Events

Date of Data Collection	Date of Occurrence	Method	Reach(es) Documented	Photo (if available)
April 3, 2023	February 12, 2023	Crest and flow gauges site-wide documented a bankfull event on Waxhaw Branch, UT-2, UT-3, UT3A, UT-4 and UT-5, with peak flow at 32 inches, 16 inches, 20 inches, 16 inches, 18 inches, and 16 inches respectively after 1.94 inches of rain were captured at an onsite rain gauge during the 3 days leading to the event.	Waxhaw Branch (US and DS), UT-2, UT-3 (US & DS), UT-3A, UT-4, UT-5	1-2
May 31, 2023	April 8, 2023	Crest and flow gauges site-wide documented a bankfull event on Waxhaw Branch, UT-2, UT-3, UT-3A, UT-4 and UT-5, with peak flow at 29 inches, 15 inches, 16 inches, 15 inches, 16 inches, and 16 inches respectively after 2.48 inches of rain were captured at an onsite rain gauge the day before the event.	Waxhaw Branch (US & DS), UT-2, UT-3 (US & DS), UT-3A, UT-4, UT-5	3
July 26, 2023	June 22, 2023	Crest and flow gauges site-wide documented a bankfull event on Waxhaw Branch, UT-2, UT-3, UT-3A, UT-4 and UT-5, with peak flow at 27 inches, 19 inches, 26 inches, 20 inches, 20 inches, and 18 inches respectively after 2.07 inches of rain were captured at an onsite rain gauge in the 4 days leading to the event.	Waxhaw Branch (US & DS), UT-2, UT-3 (US & DS), UT3A, UT-4, UT-5	--
November 8, 2023	August 28, 2023	Crest and flow gauges documented a bankfull event on Waxhaw Branch, UT-3, and UT-5, with peak flow at 29 inches, 23 inches, and 20 inches respectively after 1.50 inches of rain were captured at an onsite rain gauge during the two days leading to the event.	Waxhaw Branch (US and DS), UT-3 (DS), UT-5	--

Table 11B. Bankfull Events Summary by Gauge

Flow/Crest Gauge Bankfull Summary							
Gauge ID	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Waxhaw Br Upstream Crest	2/12/23 4/8/23 6/22/23 8/28/23						
Waxhaw Br Downstream Crest	2/12/23 4/8/23 6/22/23 8/28/23						
UT 2 Flow	2/12/23 4/8/23 6/22/23						
UT 3 Upstream Flow	2/12/23 4/8/23 6/22/23						
UT 3 Downstream Crest	2/12/23 4/8/23 6/22/23 8/28/23						
UT 3A Flow	2/12/23 4/8/23 6/22/23						
UT 4 Flow	2/12/23 4/8/23 6/22/23						
UT 5 Flow	2/12/23 4/8/23 6/22/23 8/28/23						

Photo 1: Bankfull event on UT-3A

Photo 2: Wrack on the Waxhaw Branch Floodplain after a bankfull event

Photo 3: Bankfull event on UT-3A

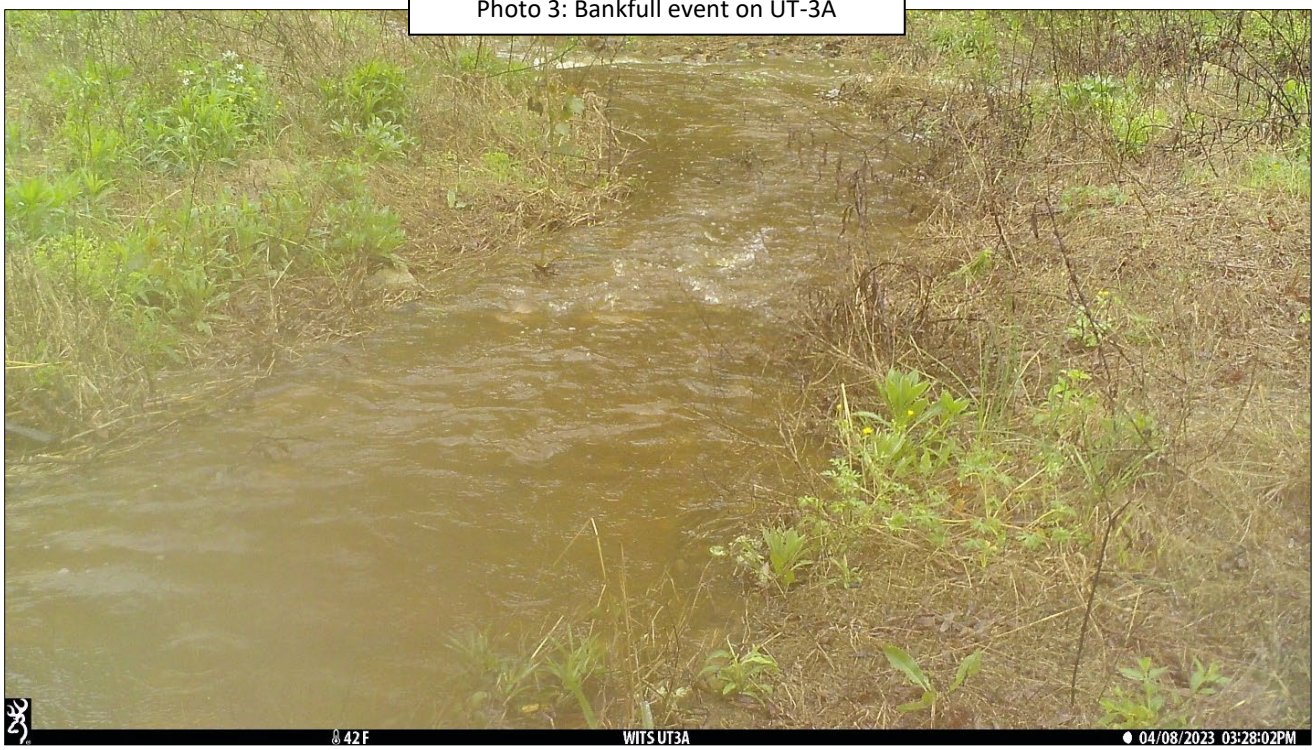


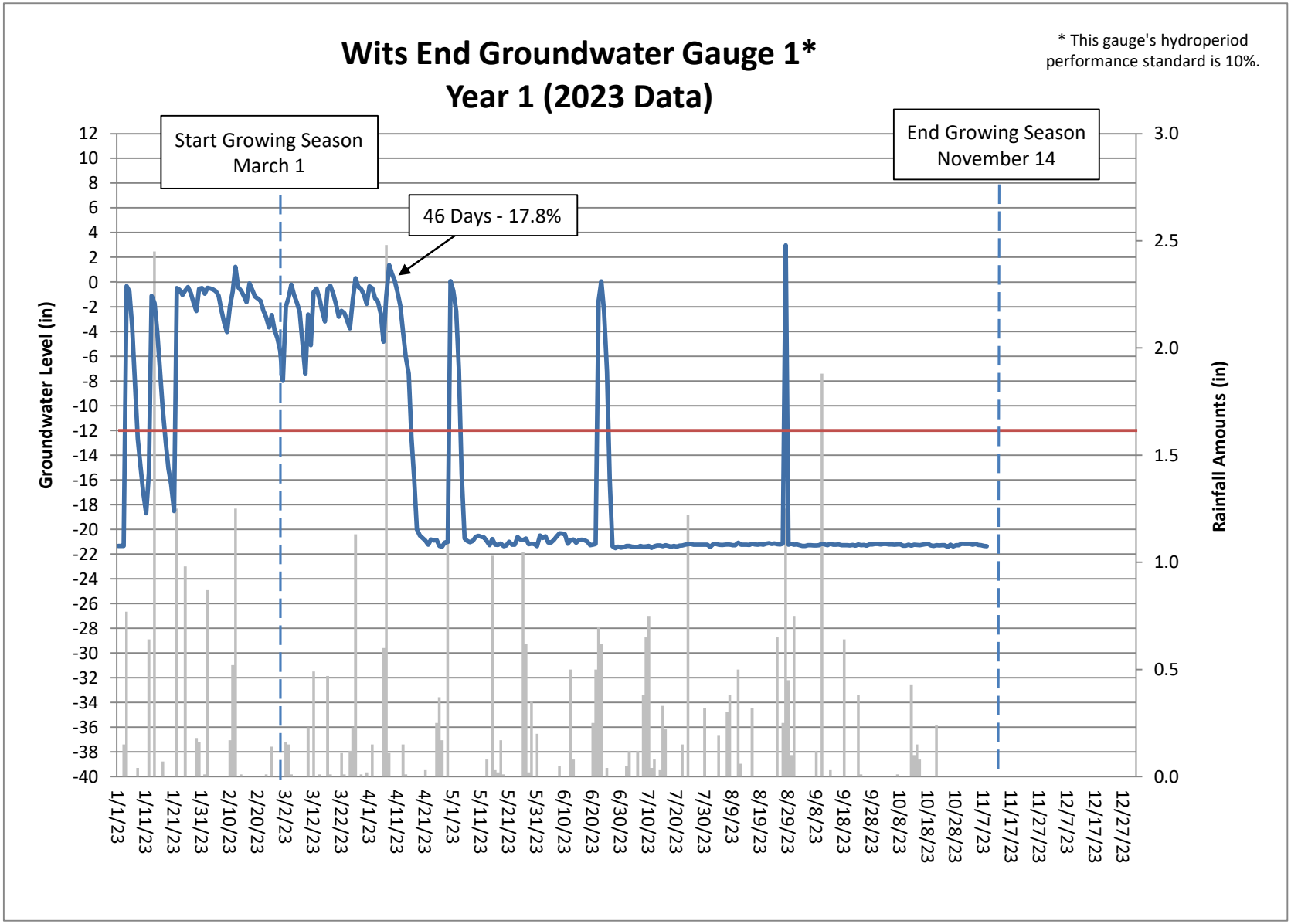
Table 12. Groundwater Hydrology Data
Summary of Monitoring Period/Hydrology Success Criteria by Year

Gauge	8% Hydroperiod Success Criteria Achieved - Max Consecutive Days During Growing Season (Percentage)						
	Year 1 (2023)	Year 2 (2024)	Year 3 (2025)	Year 4 (2026)	Year 5 (2027)	Year 6 (2028)	Year 7 (2029)
1*	Yes 46 Days (17.8%)						
2*	Yes 35 Days (13.5%)						
3	Yes 49 Days (18.9%)						
4*	Yes 46 Days (17.8%)						
5	No 10 Days (3.9%)						
6	Yes 37 Days (14.3%)						
7*	Yes 43 Days (16.6%)						
8	Yes 37 Days (14.3%)						
9	Yes 49 Days (18.9%)						
11	Yes 128 Days (49.4%)						
12	Yes 55 Days (21.2%)						
13	Yes 48 Days (18.5%)						
14	No 14 Days (5.4%)						
15	Yes 46 Days (17.8%)						
16	Yes 48 Days (18.5%)						
17	No 4 Days (1.5%)						
18	No 7 Days (2.7%)						
19	No 10 Days (3.9%)						
20	No 2 Days (0.8%)						
21	Yes 49 Days (18.9%)						
22	No 2 Days (0.8%)						
23	Yes 39 Days (15.1%)						

*These gauges have a hydroperiod success criteria of 10% of the growing season.

Table 12. Groundwater Hydrology Data (continued)
Summary of Monitoring Period/Hydrology Success Criteria by Year

Gauge	8% Hydroperiod Success Criteria Achieved - Max Consecutive Days During Growing Season (Percentage)						
	Year 1 (2023)	Year 2 (2024)	Year 3 (2025)	Year 4 (2026)	Year 5 (2027)	Year 6 (2028)	Year 7 (2029)
24	No 4 Days (1.5%)						
25	Yes 46 Days (17.8%)						
26	Yes 49 Days (18.9%)						
27	Yes 48 Days (18.5%)						
28	Yes 49 Days (18.9%)						


Wits End Groundwater Gauge 1*
Year 1 (2023 Data)
* This gauge's hydroperiod performance standard is 10%.
Start Growing Season March 1
End Growing Season November 14
46 Days - 17.8%
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
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
3/2/23
3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
8/9/23
8/19/23
8/29/23
9/8/23
9/18/23
9/28/23
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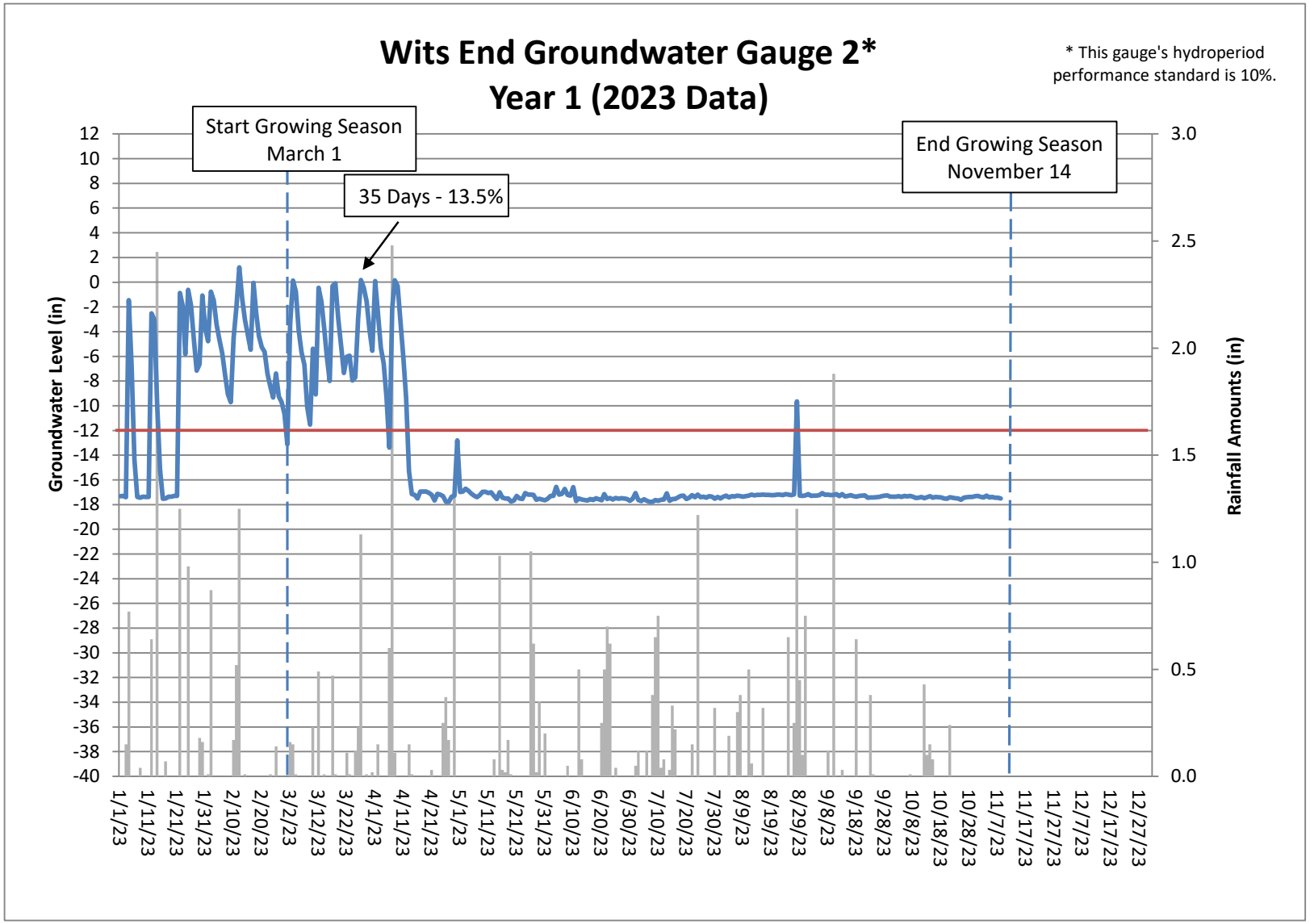
12/7/23
12/17/23
12/27/23


Wits End Groundwater Gauge 2*
Year 1 (2023 Data)
* This gauge's hydroperiod performance standard is 10%.
Start Growing Season March 1
35 Days - 13.5%
End Growing Season November 14
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
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
3/2/23
3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
8/9/23
8/19/23
8/29/23
9/8/23
9/18/23
9/28/23
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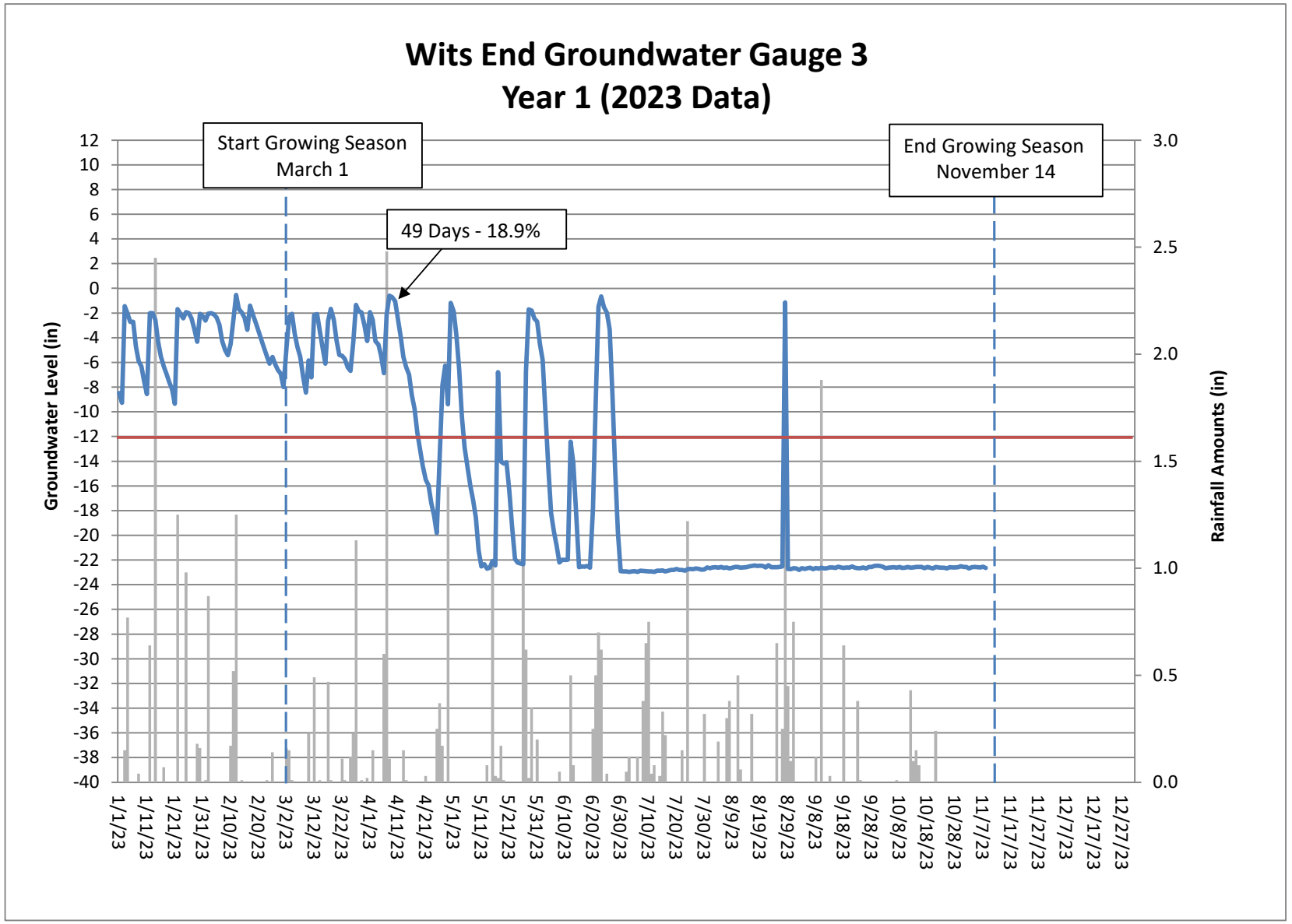
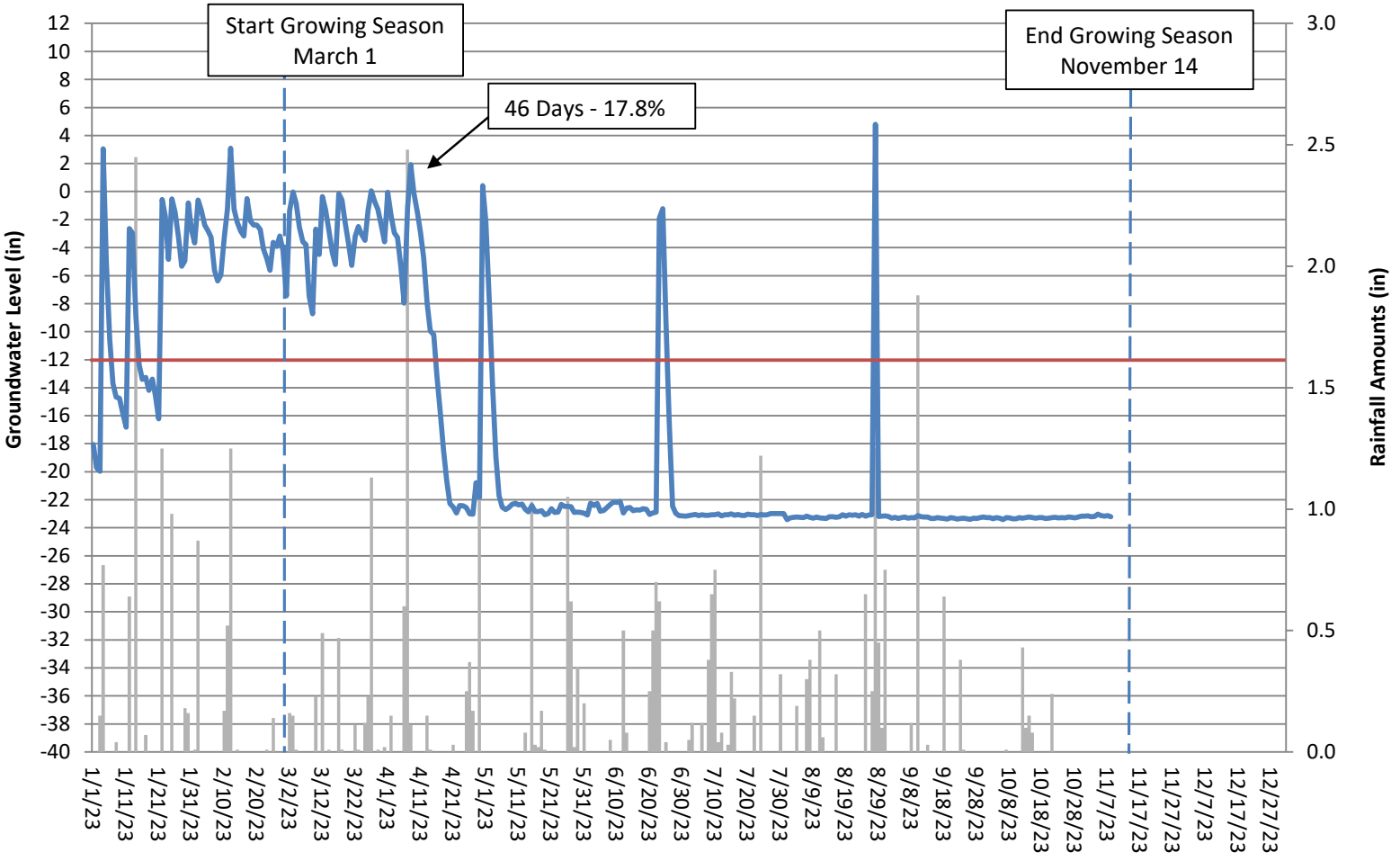
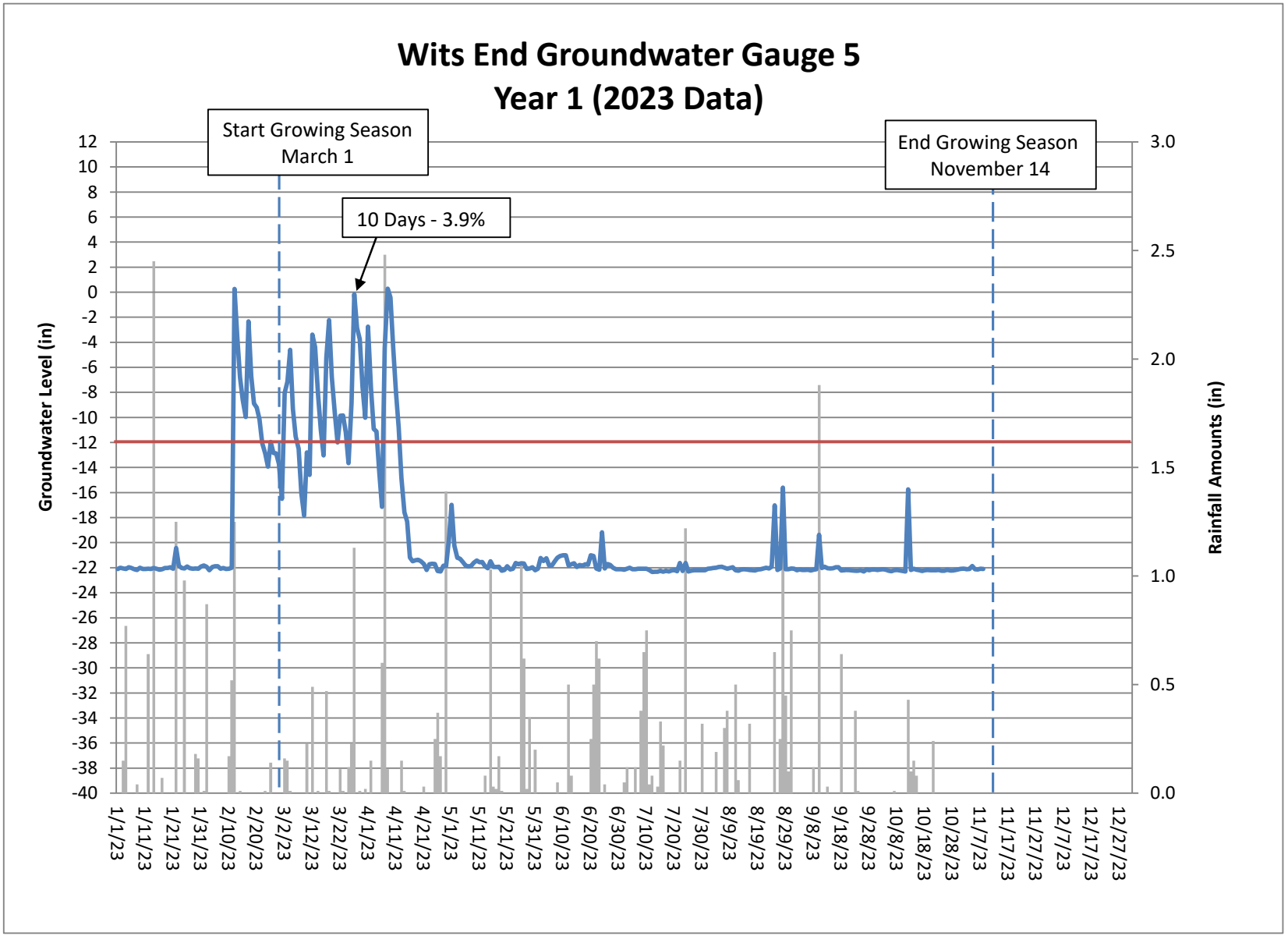
11/27/23
12/7/23
12/17/23
12/27/23


Wits End Groundwater Gauge 3
Year 1 (2023 Data)
Start Growing Season
March 1
End Growing Season
November 14
49 Days - 18.9%
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
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
3/2/23
3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
8/9/23
8/19/23
8/29/23
9/8/23
9/18/23
9/28/23
10/8/23
10/18/23
10/28/23
11/7/23
11/17/23
11/27/23
12/7/23
12/17/23
12/27/23

Wits End Groundwater Gauge 4*
Year 1 (2023 Data)

* This gauge's hydroperiod performance standard is 10%.




Wits End Groundwater Gauge 5
Year 1 (2023 Data)
Start Growing Season
March 1
End Growing Season
November 14
10 Days - 3.9%
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
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
3/2/23
3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
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7/10/23
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7/30/23
8/9/23
8/19/23
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9/8/23
9/18/23
9/28/23
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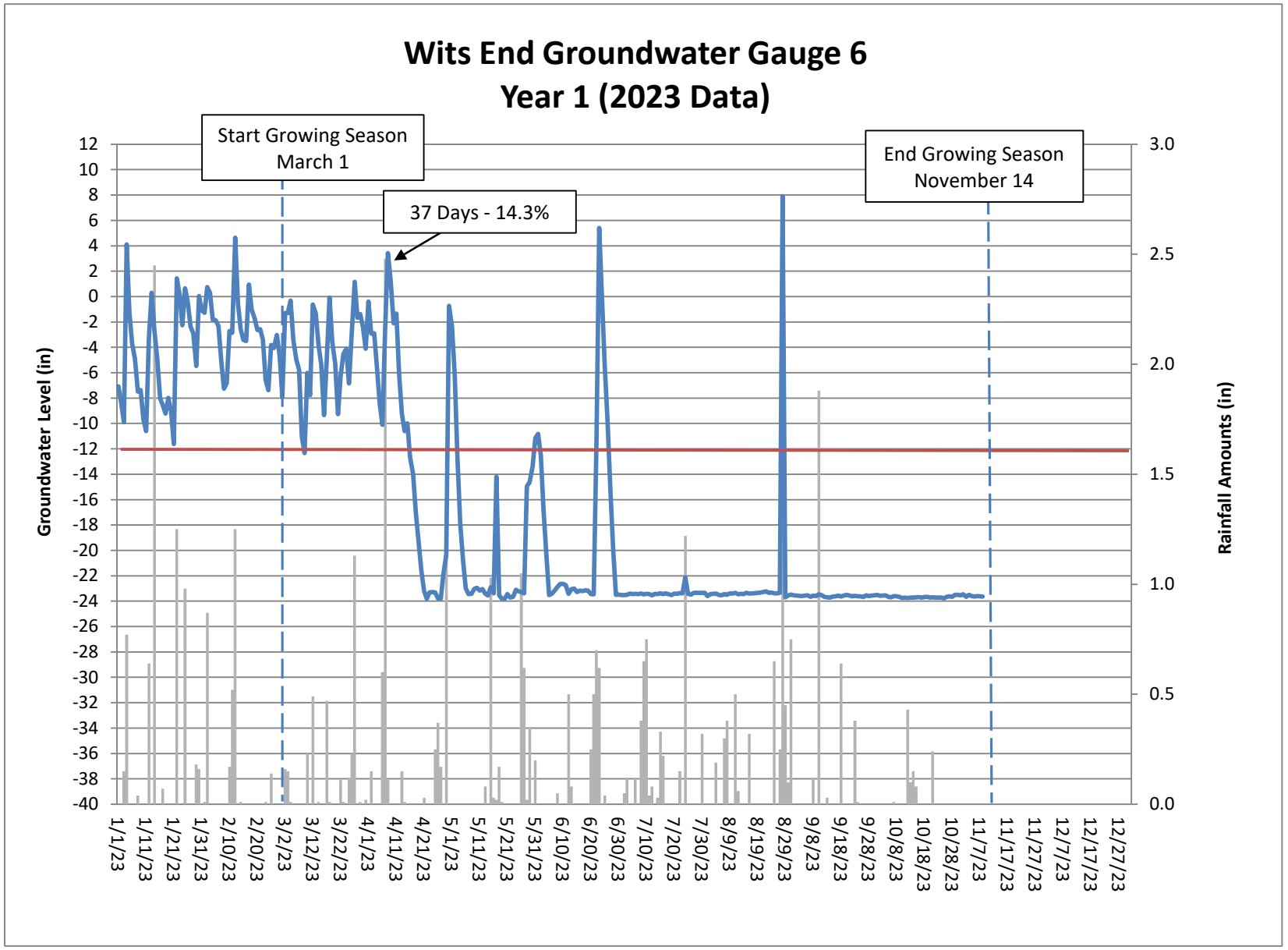
12/7/23
12/17/23
12/27/23


Wits End Groundwater Gauge 6
Year 1 (2023 Data)
Start Growing Season
March 1
End Growing Season
November 14
37 Days - 14.3%
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
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
3/2/23
3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
8/9/23
8/19/23
8/29/23
9/8/23
9/18/23
9/28/23
10/8/23
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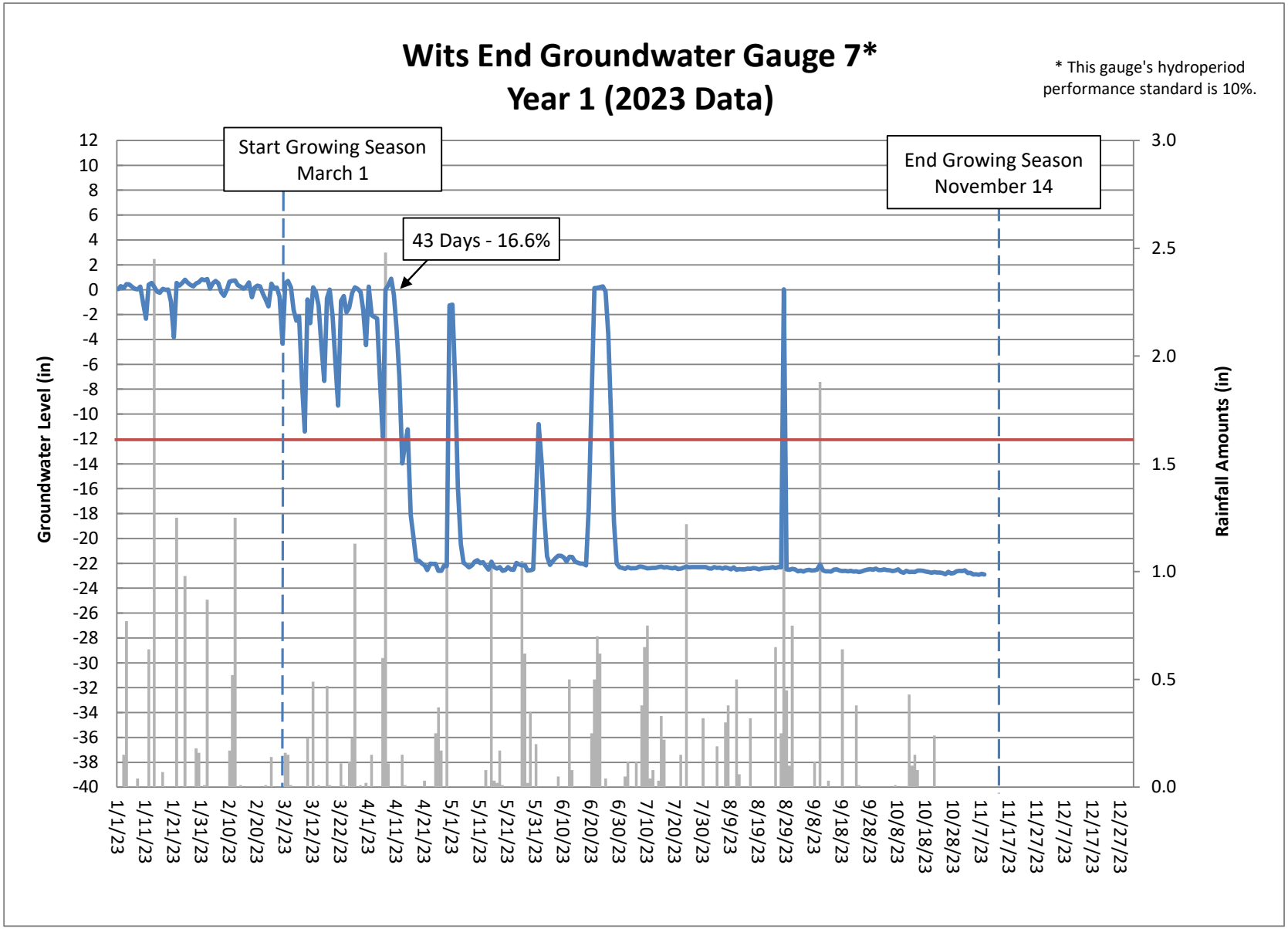
11/27/23
12/7/23
12/17/23
12/27/23


Wits End Groundwater Gauge 7*
Year 1 (2023 Data)
* This gauge's hydroperiod performance standard is 10%.
Start Growing Season March 1
End Growing Season November 14
43 Days - 16.6%
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
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
3/2/23
3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
8/9/23
8/19/23
8/29/23
9/8/23
9/18/23
9/28/23
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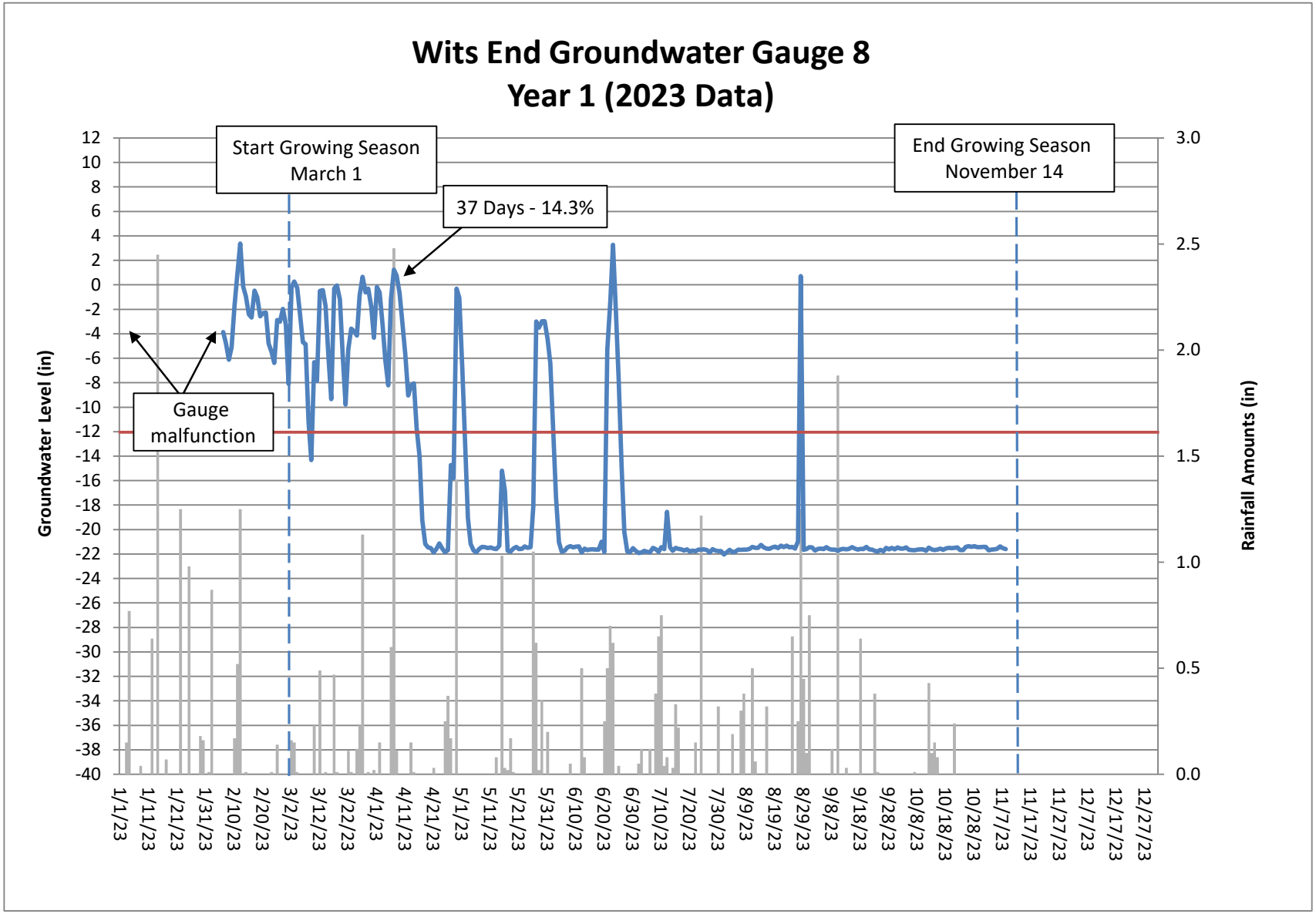
12/17/23
12/27/23


Wits End Groundwater Gauge 8
Year 1 (2023 Data)
Start Growing Season
March 1
End Growing Season
November 14
37 Days - 14.3%
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
3.0
2.5
2.0
1.5
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1/1/23
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1/31/23
2/10/23
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3/12/23
3/22/23
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4/11/23
4/21/23
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5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
8/9/23
8/19/23
8/29/23
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9/28/23
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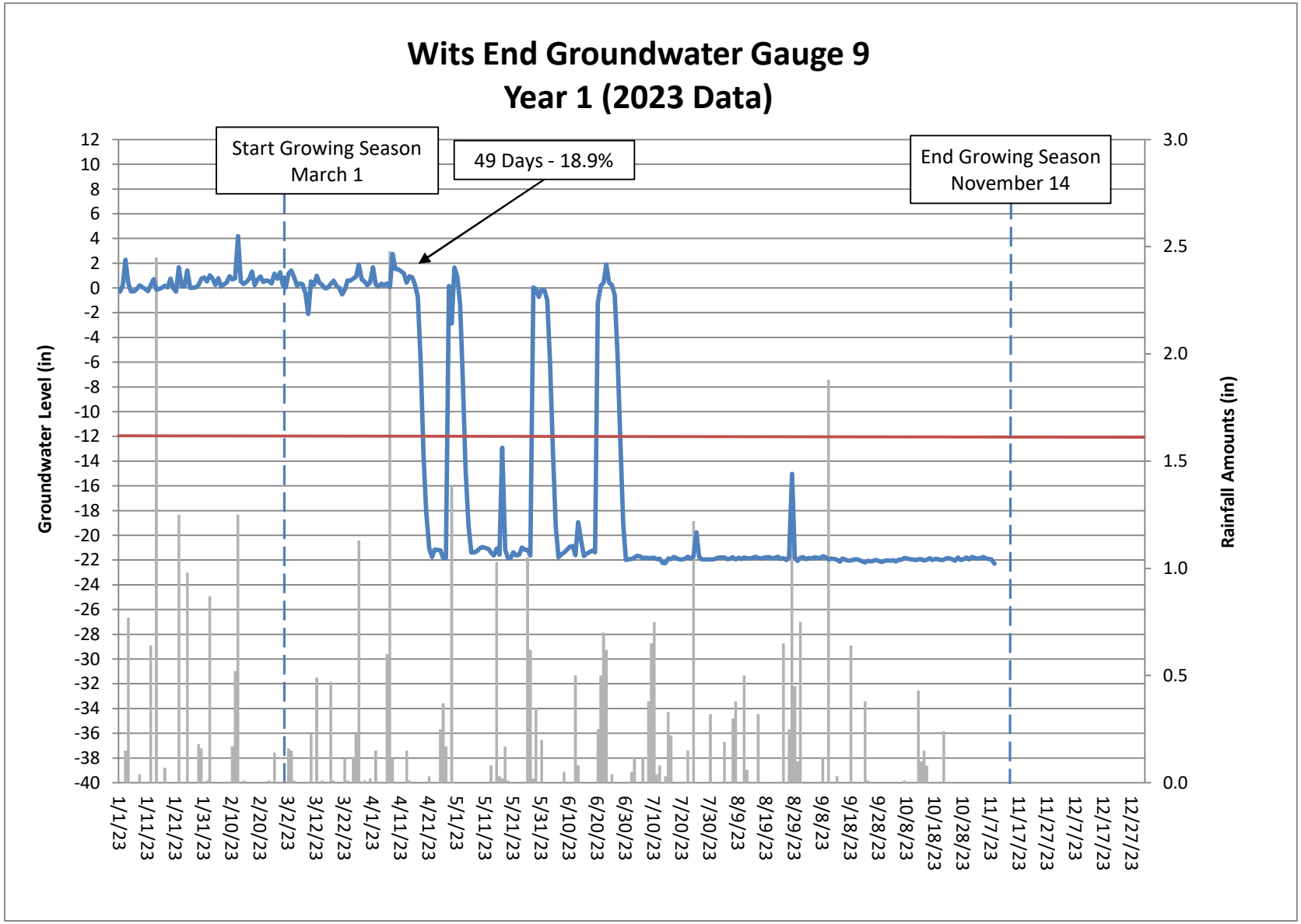
Wits End Groundwater Gauge 9
Year 1 (2023 Data)
Start Growing Season
March 1
49 Days - 18.9%
End Growing Season
November 14
Groundwater Level (in)
Rainfall Amounts (in)
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
3/2/23
3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
8/9/23
8/19/23
8/29/23
9/8/23
9/18/23
9/28/23
10/8/23
10/18/23
10/28/23
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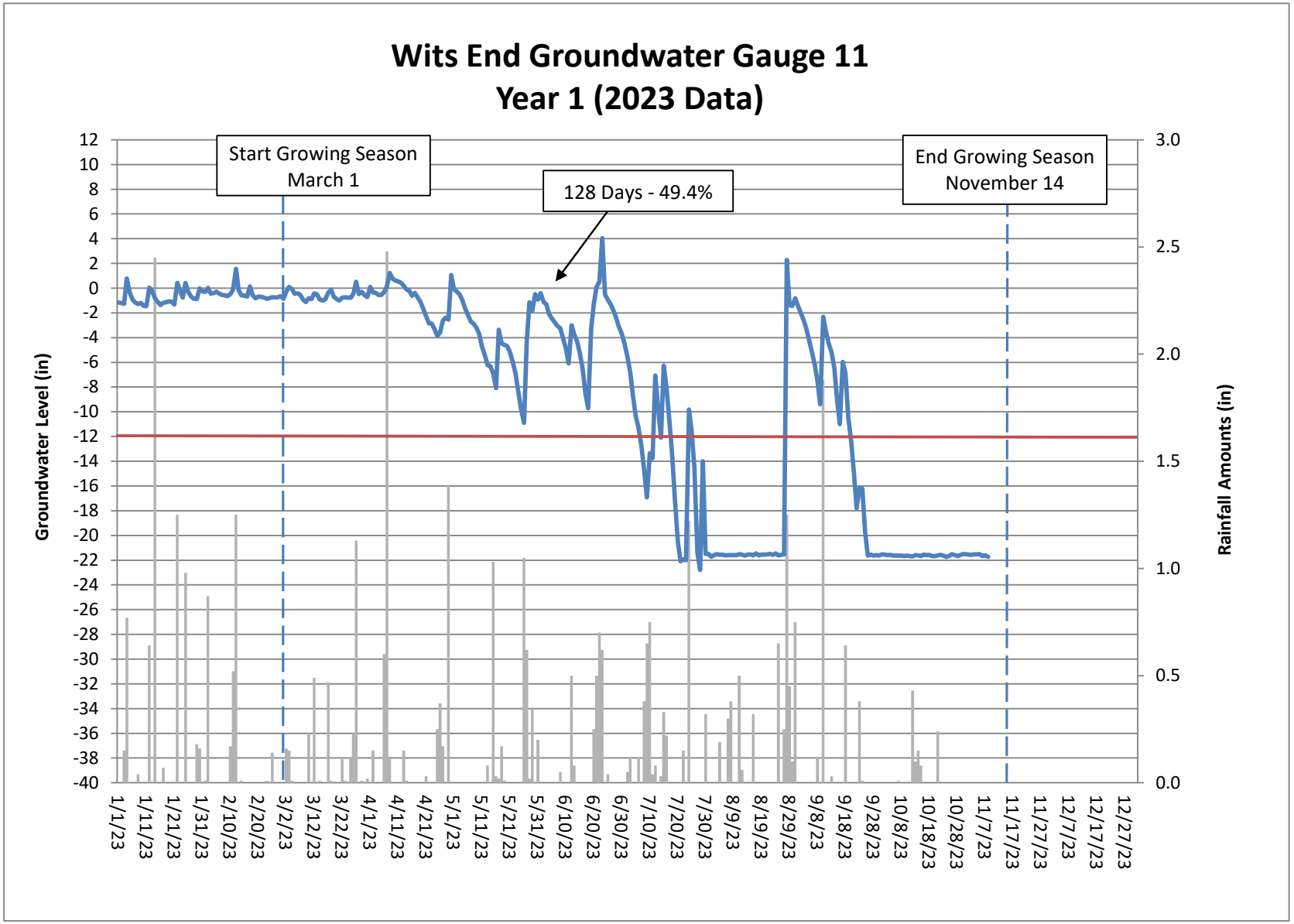
11/17/23
11/27/23
12/7/23
12/17/23
12/27/23


Wits End Groundwater Gauge 11
Year 1 (2023 Data)
Start Growing Season
March 1
128 Days - 49.4%
End Growing Season
November 14
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
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
3/2/23
3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
8/9/23
8/19/23
8/29/23
9/8/23
9/18/23
9/28/23
10/8/23
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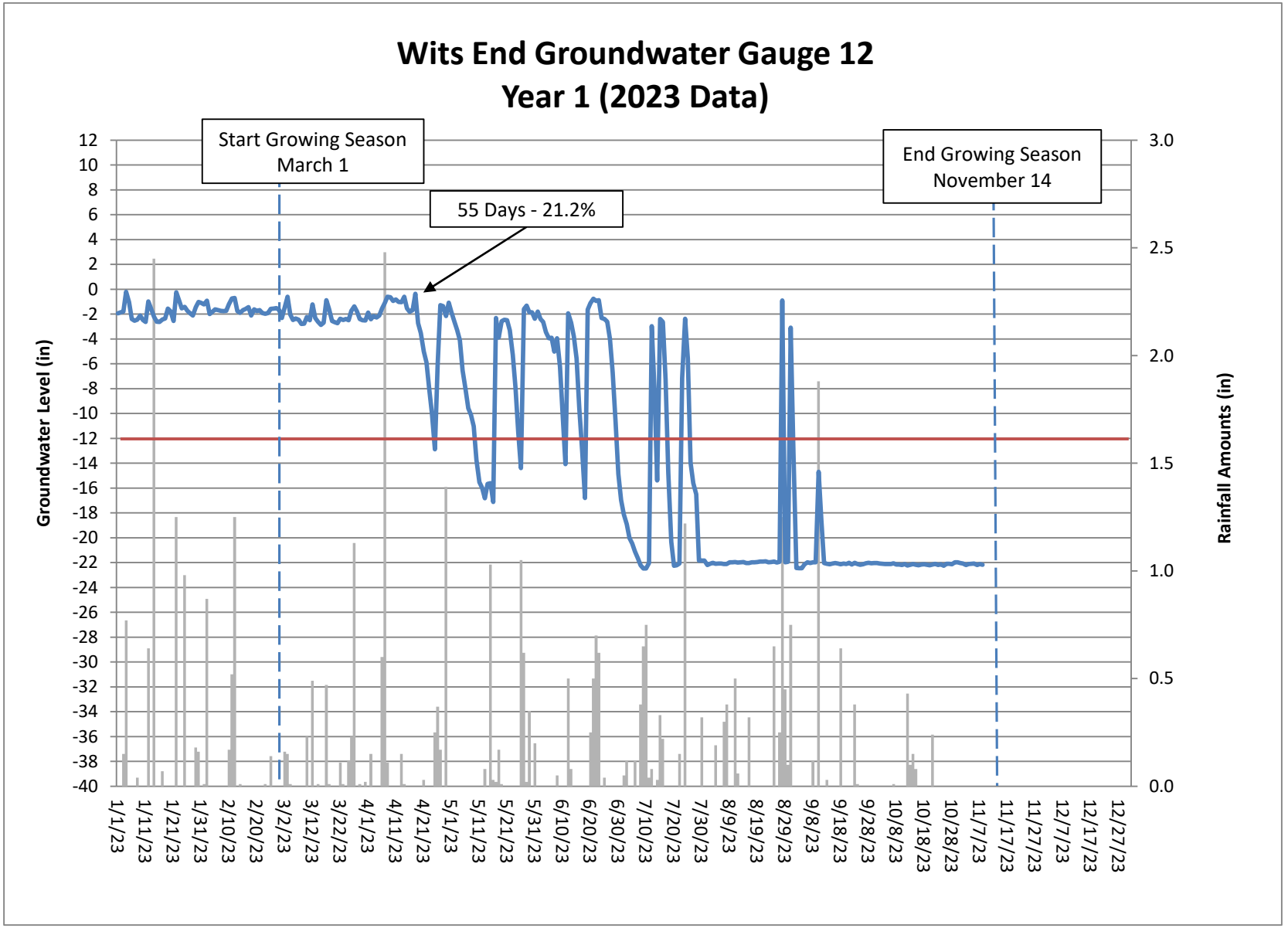
11/27/23
12/7/23
12/17/23
12/27/23


Wits End Groundwater Gauge 12
Year 1 (2023 Data)
Start Growing Season
March 1
End Growing Season
November 14
55 Days - 21.2%
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
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
3/2/23
3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
8/9/23
8/19/23
8/29/23
9/8/23
9/18/23
9/28/23
10/8/23
10/18/23
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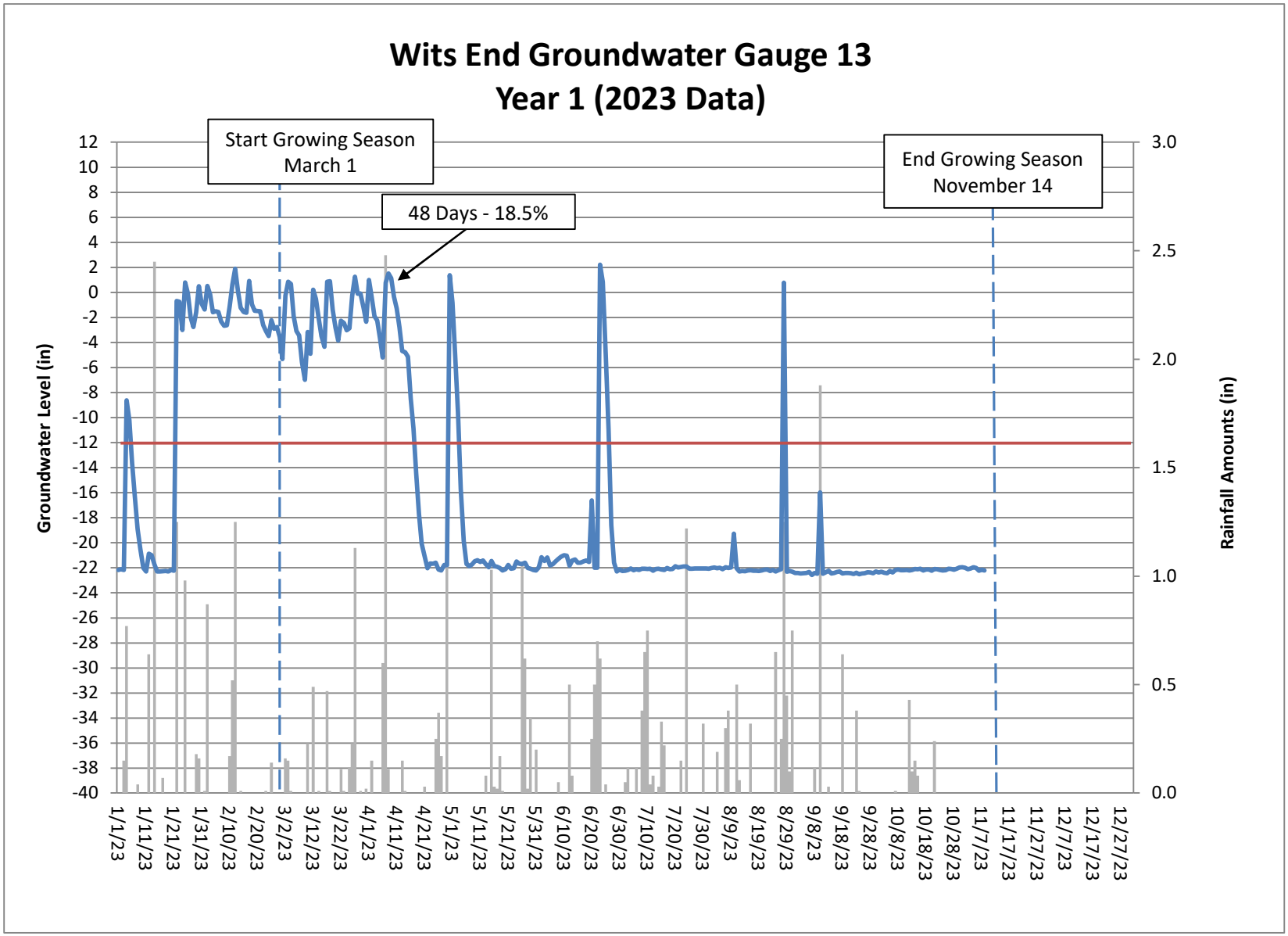
11/27/23
12/7/23
12/17/23
12/27/23


Wits End Groundwater Gauge 13
Year 1 (2023 Data)
Start Growing Season
March 1
End Growing Season
November 14
48 Days - 18.5%
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
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
3/2/23
3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
8/9/23
8/19/23
8/29/23
9/8/23
9/18/23
9/28/23
10/8/23
10/18/23
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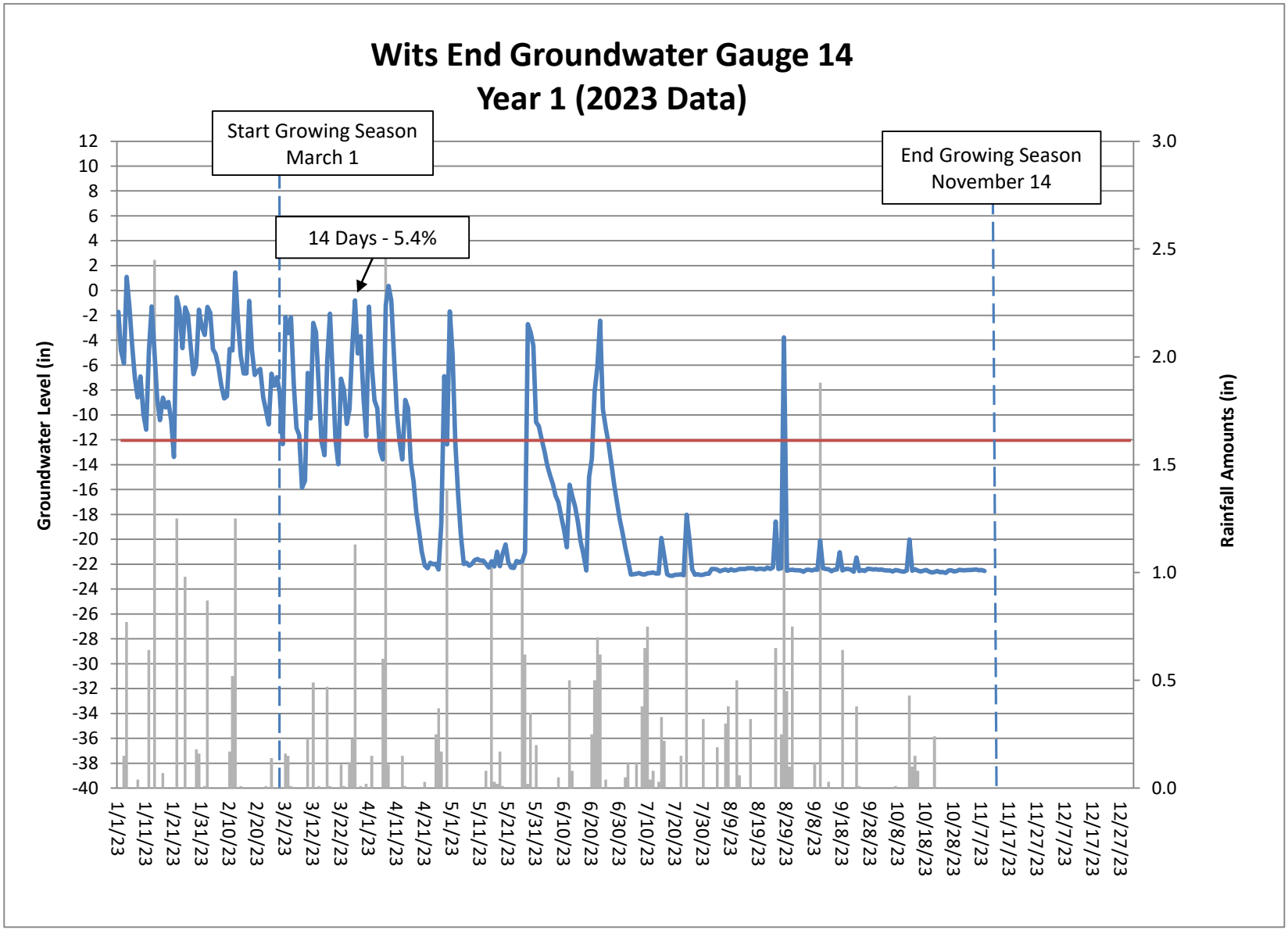
11/7/23
11/17/23
11/27/23
12/7/23
12/17/23
12/27/23


Wits End Groundwater Gauge 14
Year 1 (2023 Data)
Start Growing Season
March 1
End Growing Season
November 14
14 Days - 5.4%
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
3.0
2.5
2.0
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0.5
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1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
3/2/23
3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
8/9/23
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8/29/23
9/8/23
9/18/23
9/28/23
10/8/23
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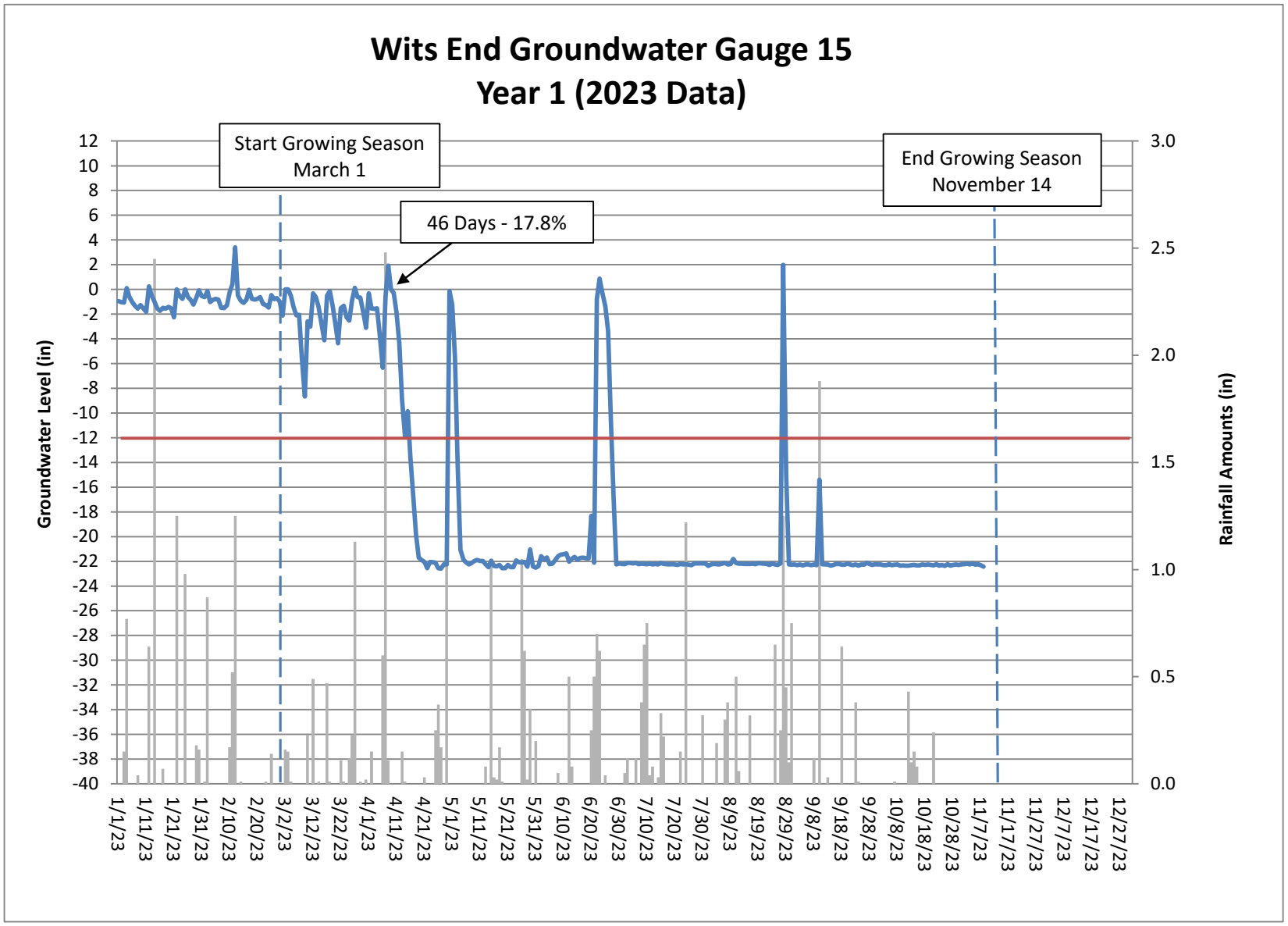
11/27/23
12/7/23
12/17/23
12/27/23


Wits End Groundwater Gauge 15
Year 1 (2023 Data)
Start Growing Season
March 1
End Growing Season
November 14
46 Days - 17.8%
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
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
3/2/23
3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
8/9/23
8/19/23
8/29/23
9/8/23
9/18/23
9/28/23
10/8/23
10/18/23
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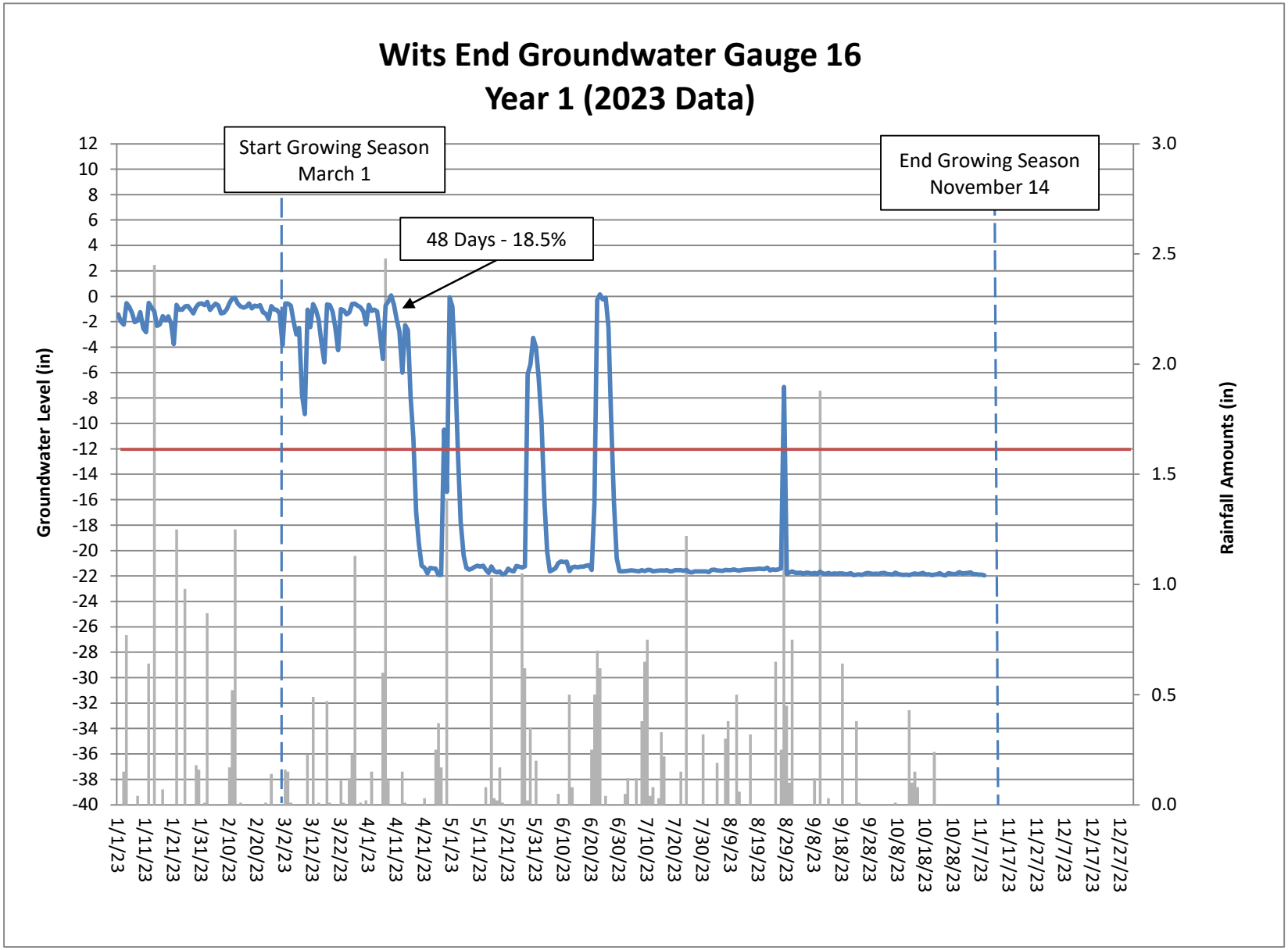
11/27/23
12/7/23
12/17/23
12/27/23


Wits End Groundwater Gauge 16
Year 1 (2023 Data)
Start Growing Season
March 1
End Growing Season
November 14
48 Days - 18.5%
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
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
3/2/23
3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
8/9/23
8/19/23
8/29/23
9/8/23
9/18/23
9/28/23
10/8/23
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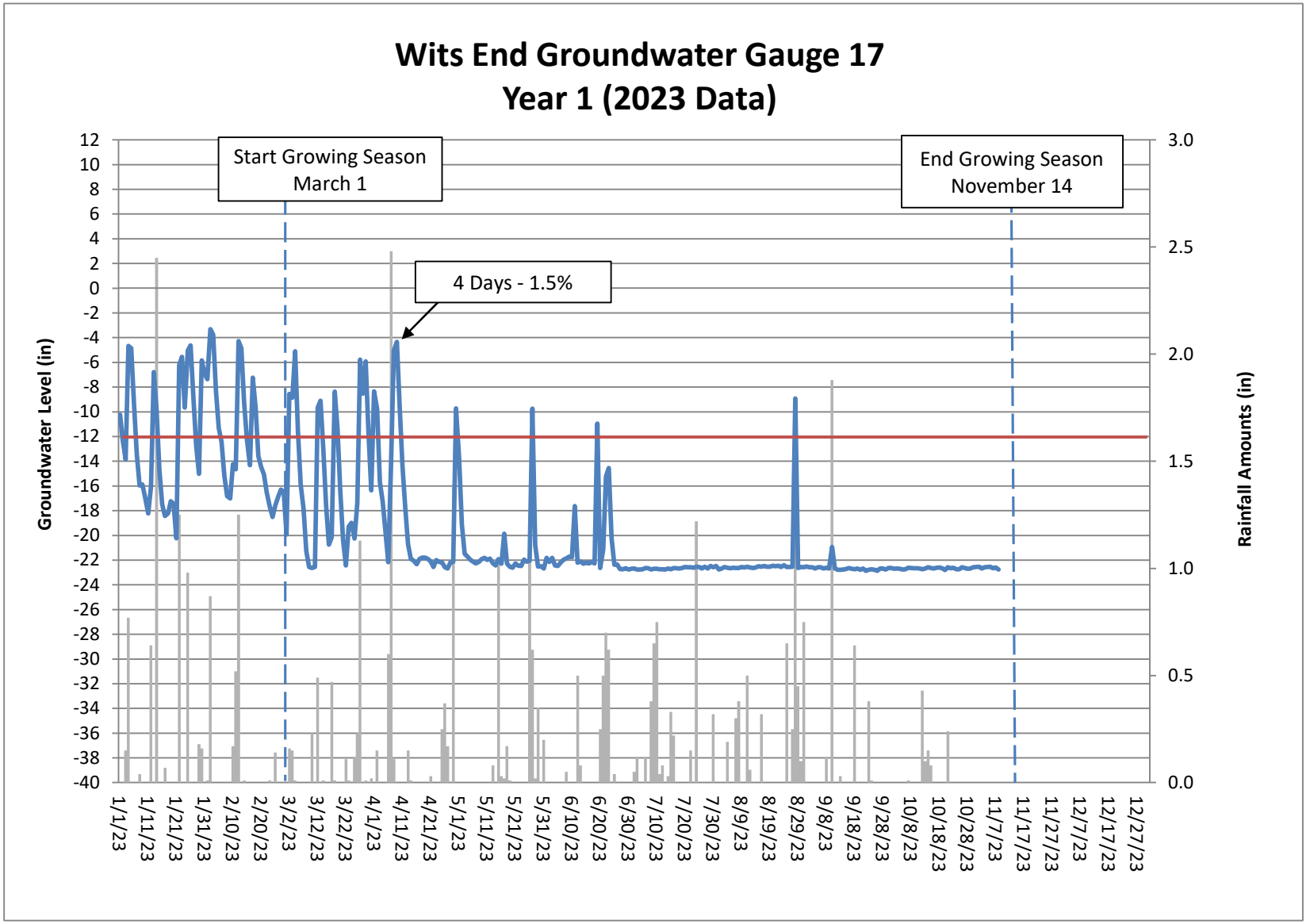
11/27/23
12/7/23
12/17/23
12/27/23


Wits End Groundwater Gauge 17
Year 1 (2023 Data)
Start Growing Season
March 1
End Growing Season
November 14
4 Days - 1.5%
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
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
3/2/23
3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
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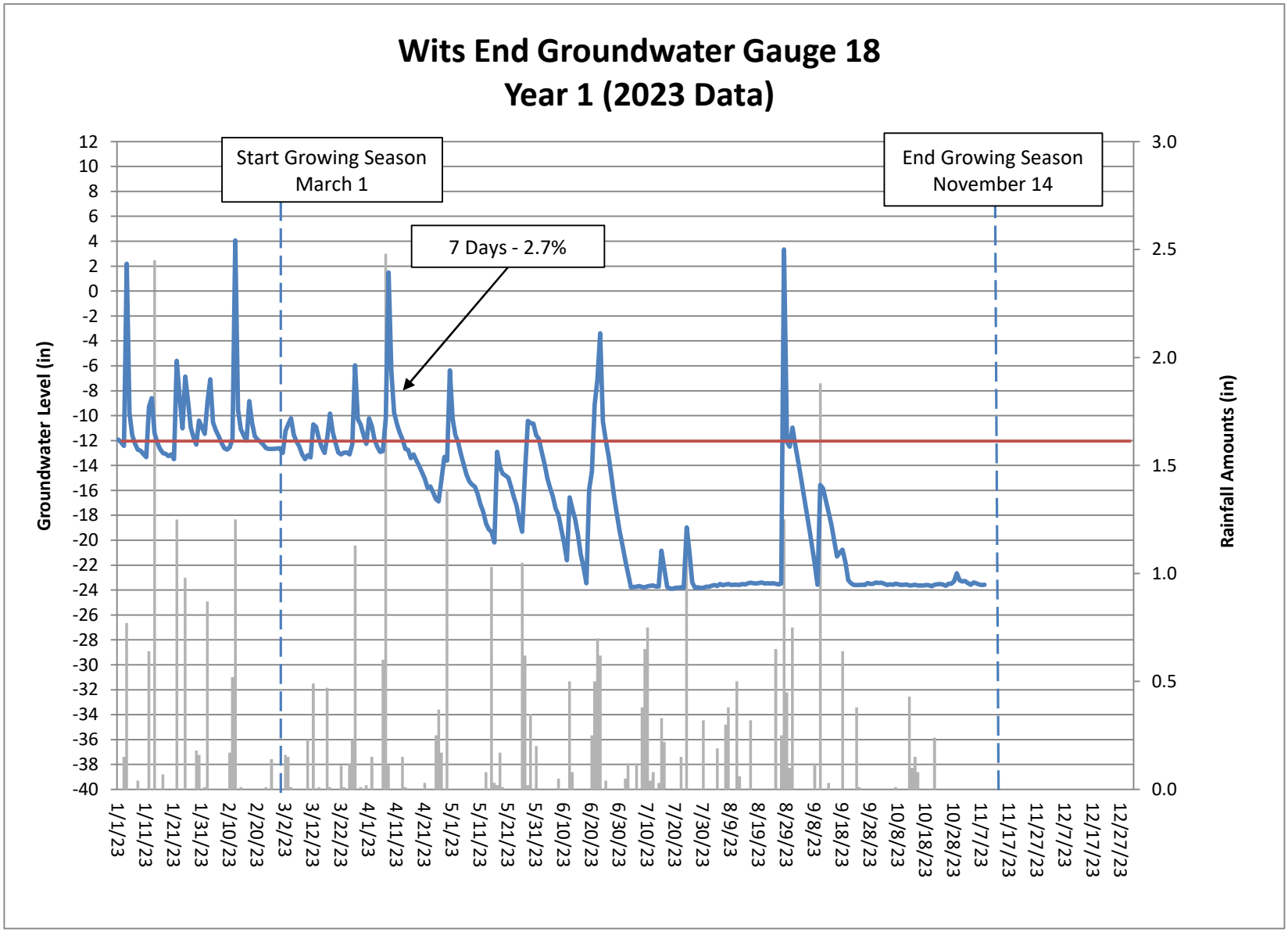
8/19/23
8/29/23
9/8/23
9/18/23
9/28/23
10/8/23
10/18/23
10/28/23
11/7/23
11/17/23
11/27/23
12/7/23
12/17/23
12/27/23


Wits End Groundwater Gauge 18
Year 1 (2023 Data)
Start Growing Season
March 1
End Growing Season
November 14
7 Days - 2.7%
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
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
3/2/23
3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
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5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
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8/19/23
8/29/23
9/8/23
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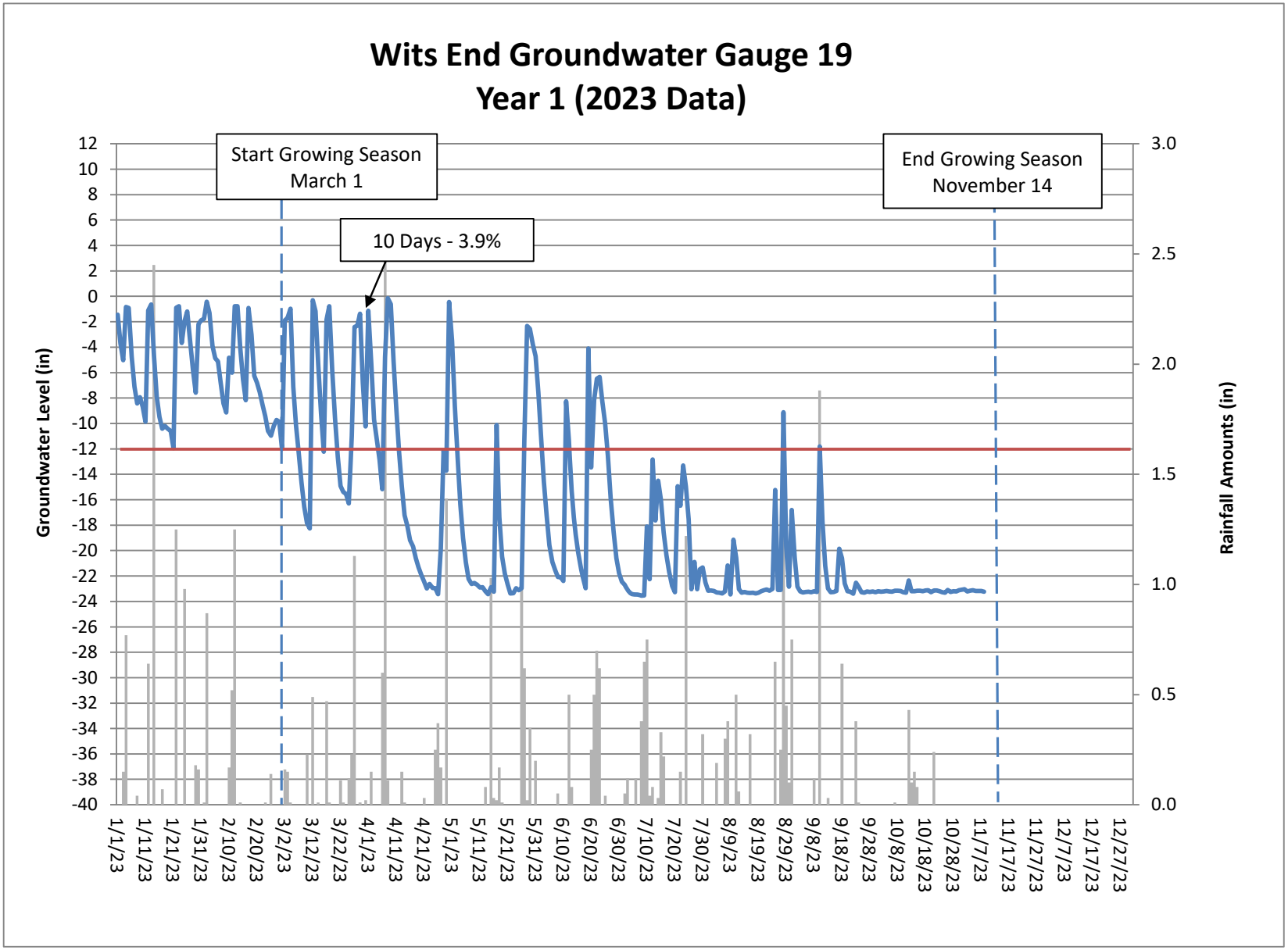
9/28/23
10/8/23
10/18/23
10/28/23
11/7/23
11/17/23
11/27/23
12/7/23
12/17/23
12/27/23


Wits End Groundwater Gauge 19
Year 1 (2023 Data)
Start Growing Season
March 1
End Growing Season
November 14
10 Days - 3.9%
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
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
3/2/23
3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
8/9/23
8/19/23
8/29/23
9/8/23
9/18/23
9/28/23
10/8/23
10/18/23
10/28/23
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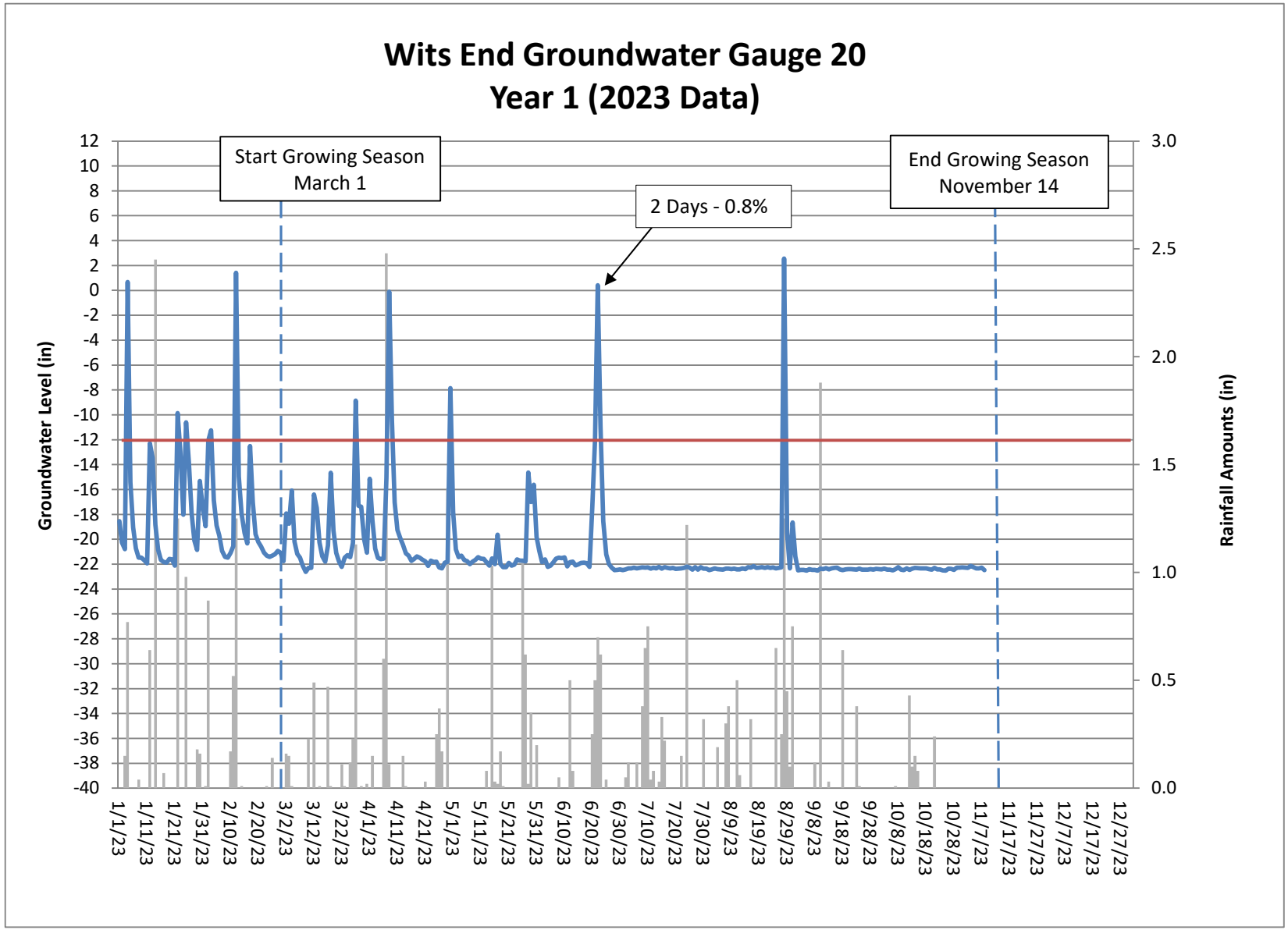
11/27/23
12/7/23
12/17/23
12/27/23


Wits End Groundwater Gauge 20
Year 1 (2023 Data)
Start Growing Season
March 1
End Growing Season
November 14
2 Days - 0.8%
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
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
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3/2/23
3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
8/9/23
8/19/23
8/29/23
9/8/23
9/18/23
9/28/23
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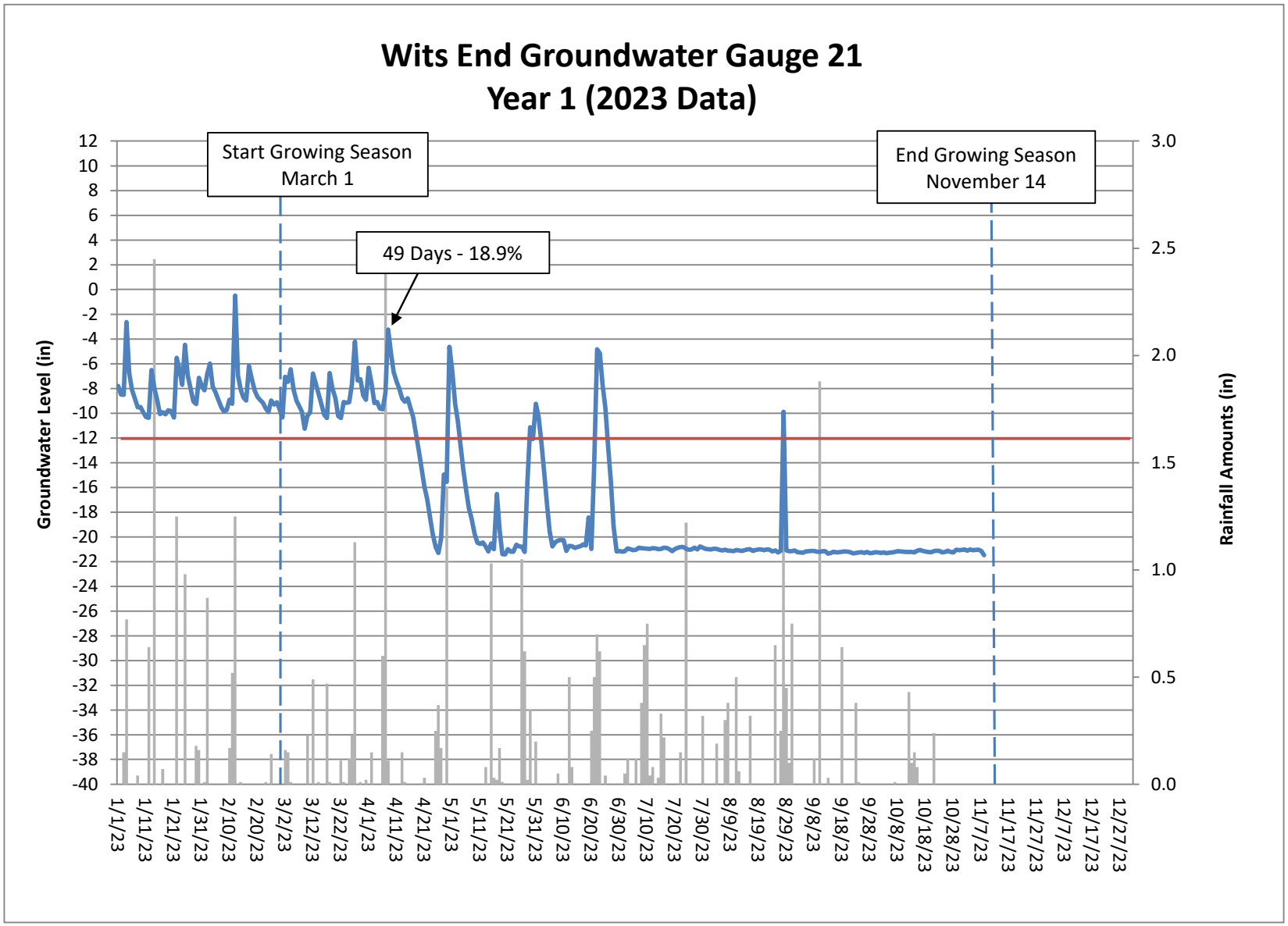
12/7/23
12/17/23
12/27/23


Wits End Groundwater Gauge 21
Year 1 (2023 Data)
Start Growing Season
March 1
End Growing Season
November 14
49 Days - 18.9%
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
3.0
2.5
2.0
1.5
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0.5
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1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
3/2/23
3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
8/9/23
8/19/23
8/29/23
9/8/23
9/18/23
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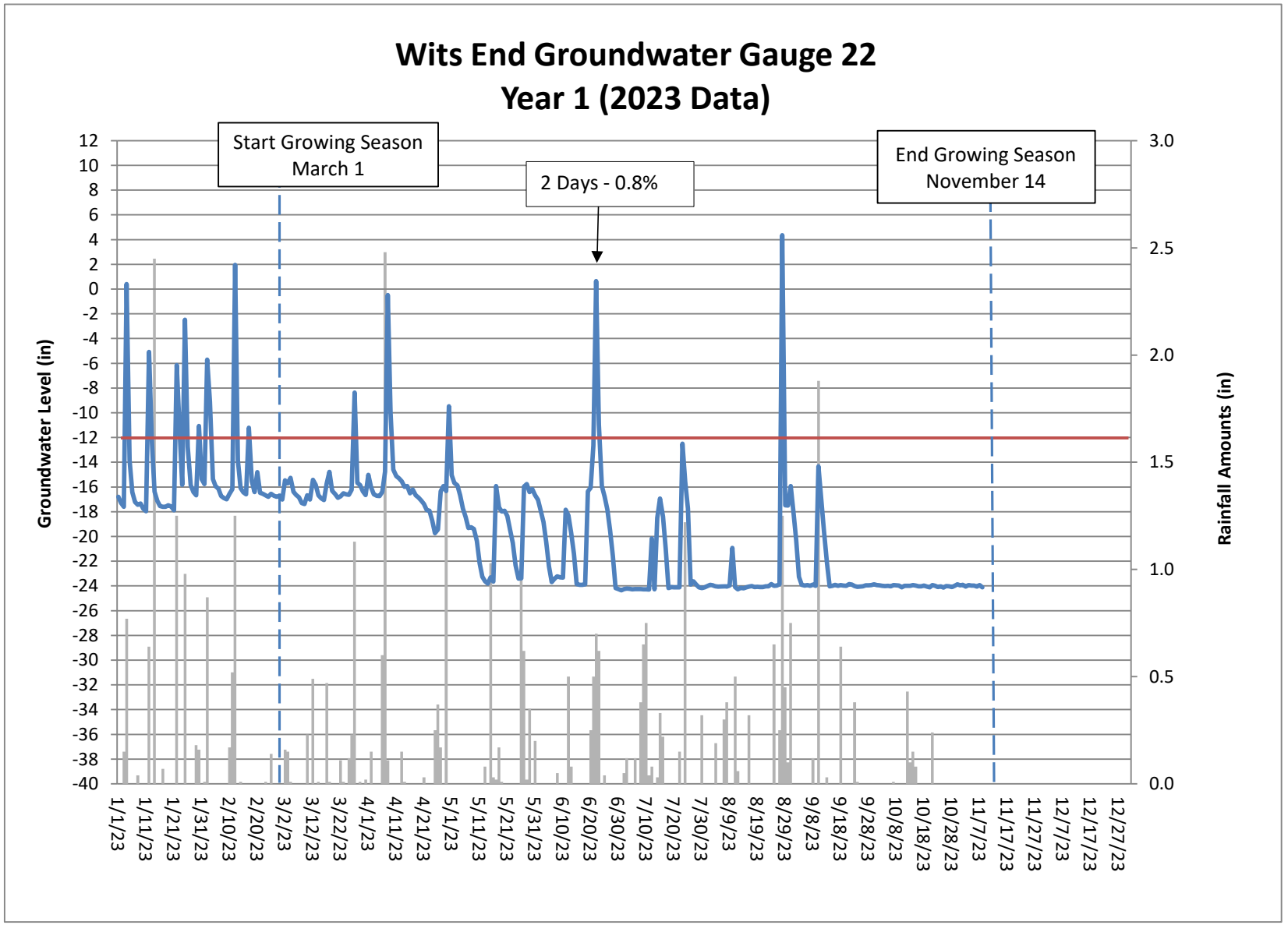
11/27/23
12/7/23
12/17/23
12/27/23


Wits End Groundwater Gauge 22
Year 1 (2023 Data)
Start Growing Season
March 1
2 Days - 0.8%
End Growing Season
November 14
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
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
3/2/23
3/12/23
3/22/23
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4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
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6/30/23
7/10/23
7/20/23
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8/29/23
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9/28/23
10/8/23
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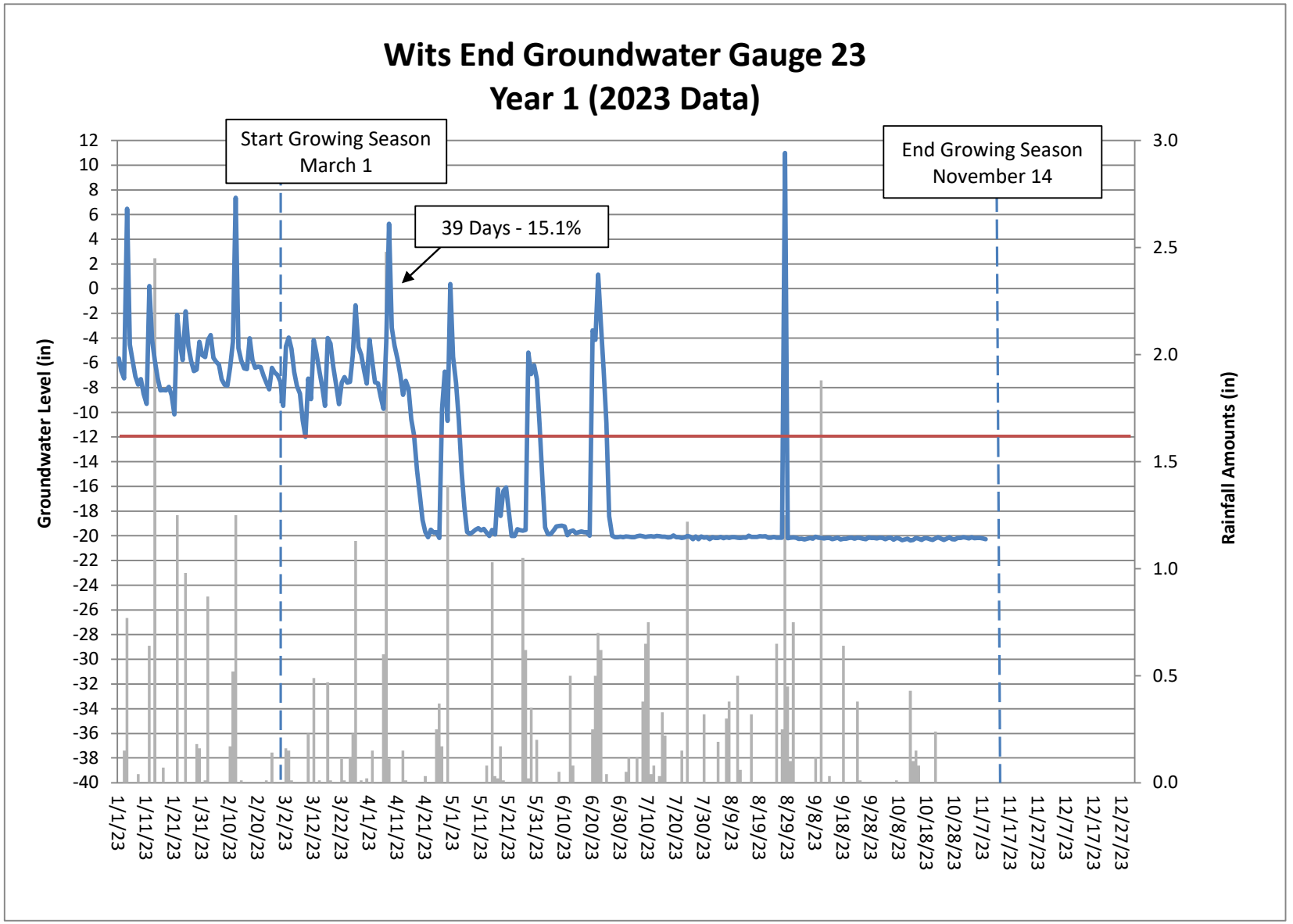
12/7/23
12/17/23
12/27/23


Wits End Groundwater Gauge 23
Year 1 (2023 Data)
Start Growing Season
March 1
End Growing Season
November 14
39 Days - 15.1%
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
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
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3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
8/9/23
8/19/23
8/29/23
9/8/23
9/18/23
9/28/23
10/8/23
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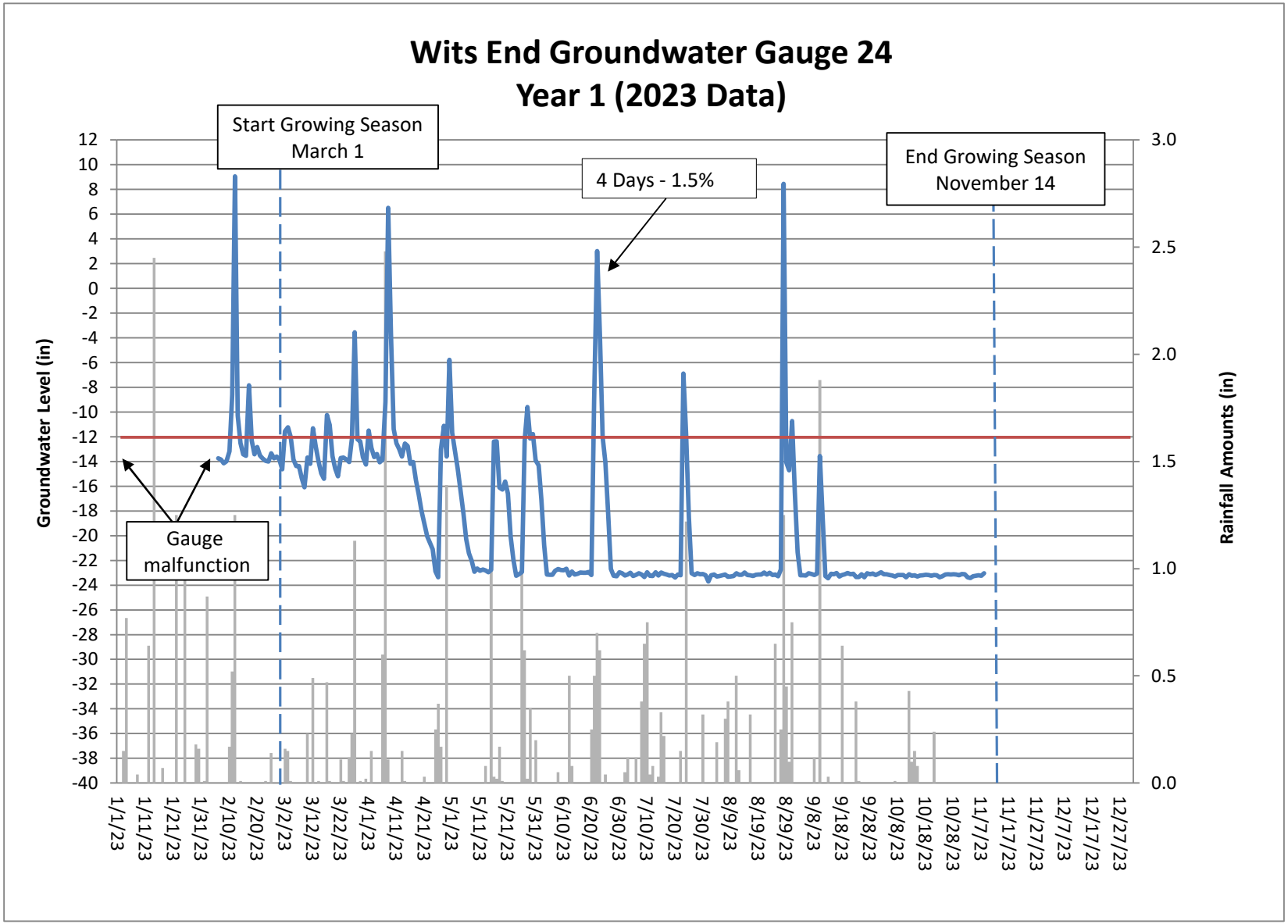
11/27/23
12/7/23
12/17/23
12/27/23


Wits End Groundwater Gauge 24
Year 1 (2023 Data)
Start Growing Season
March 1
4 Days - 1.5%
End Growing Season
November 14
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
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
3/2/23
3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
8/9/23
8/19/23
8/29/23
9/8/23
9/18/23
9/28/23
10/8/23
10/18/23
10/28/23
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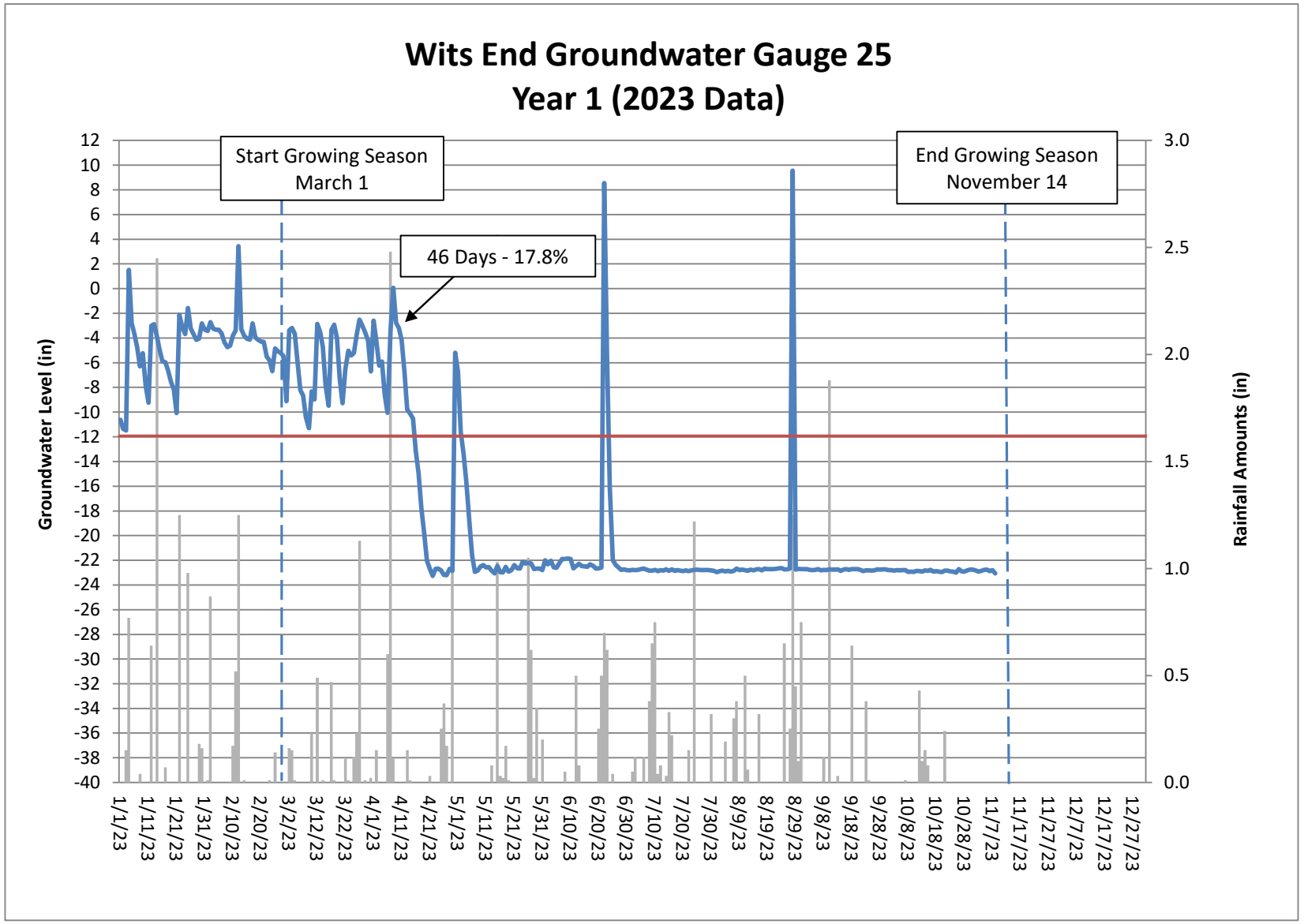
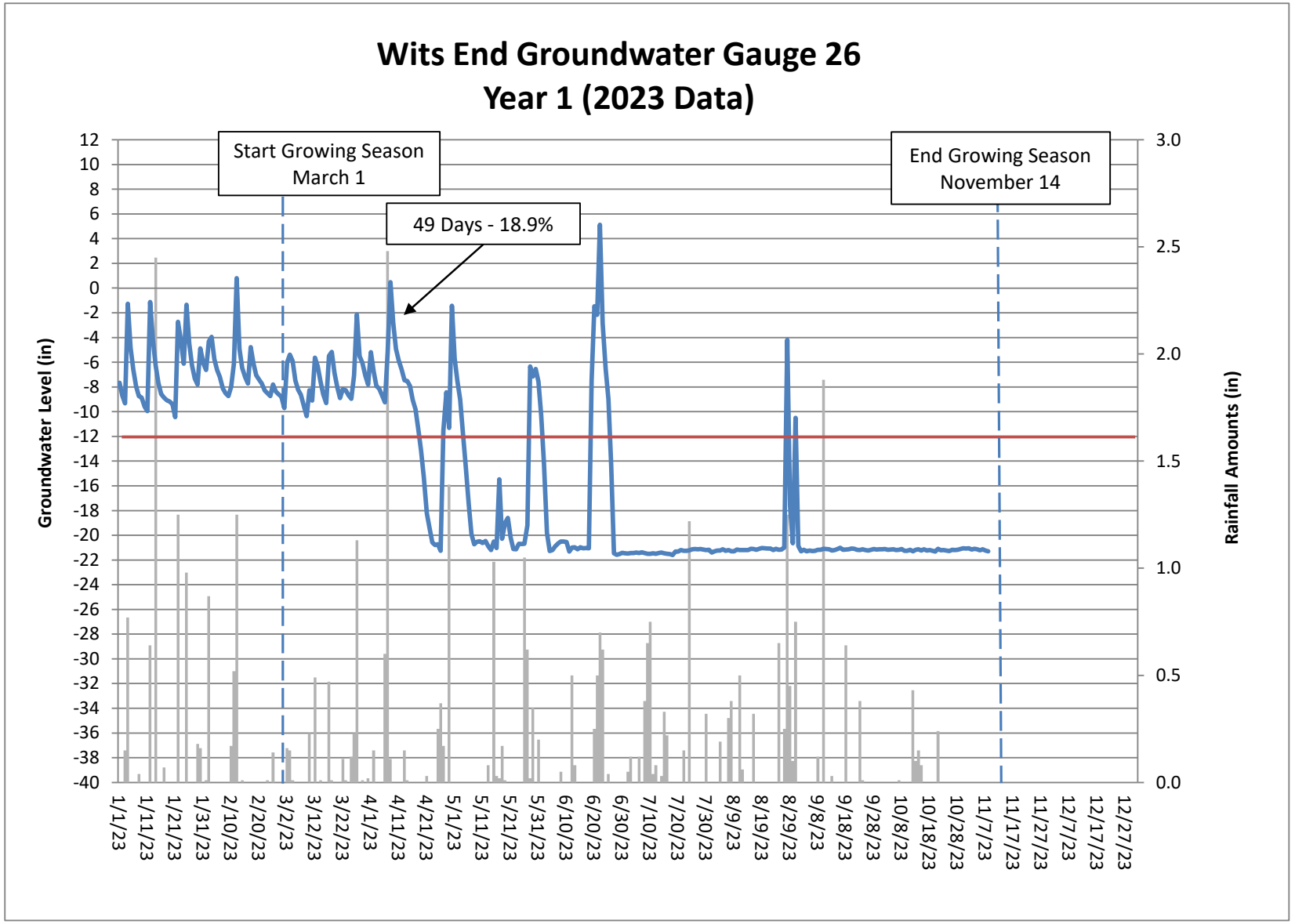
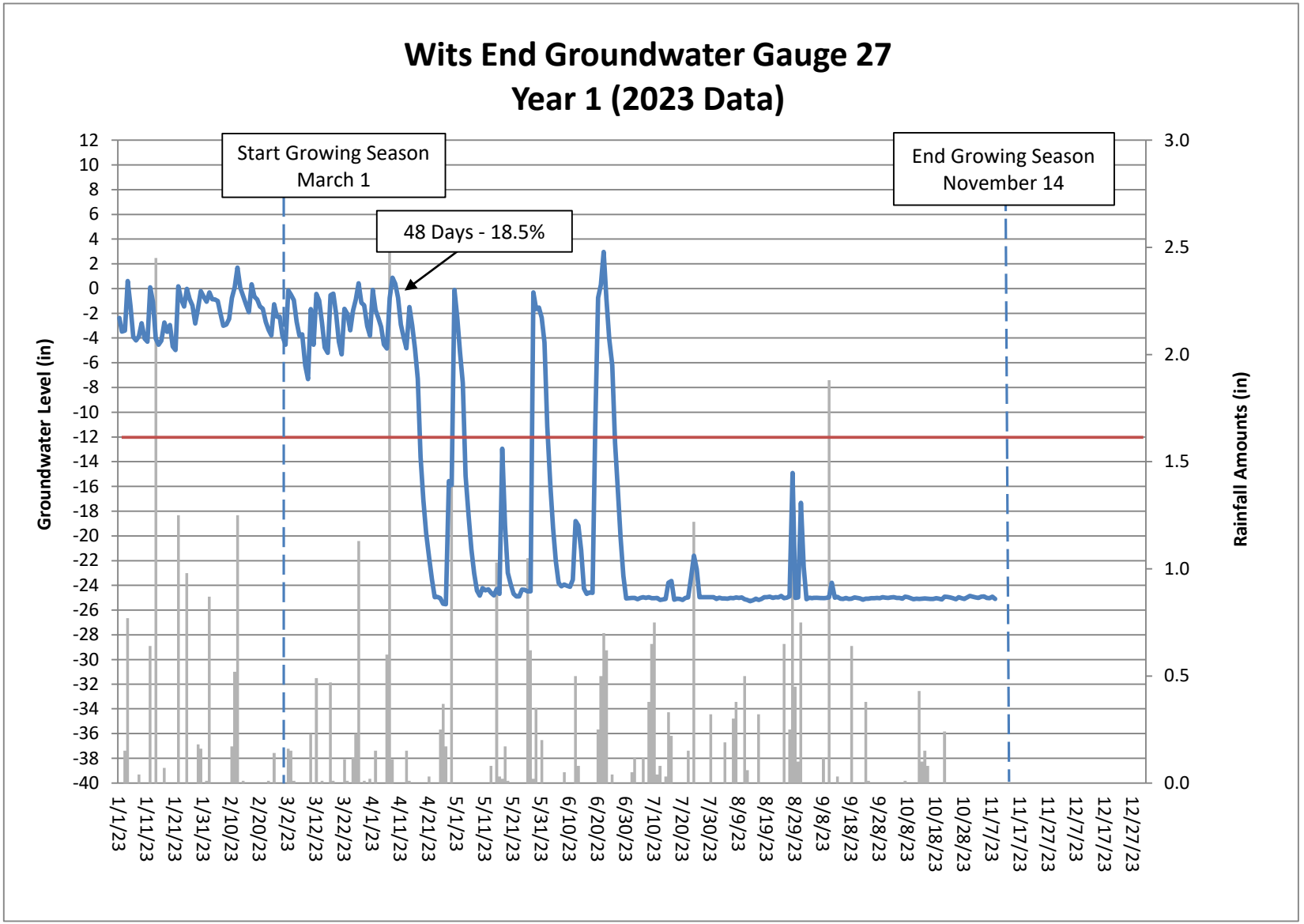
11/17/23
11/27/23
12/7/23
12/17/23
12/27/23


Wits End Groundwater Gauge 25
Year 1 (2023 Data)
Start Growing Season
March 1
End Growing Season
November 14
46 Days - 17.8%
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
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
3/2/23
3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
8/9/23
8/19/23
8/29/23
9/8/23
9/18/23
9/28/23
10/8/23
10/18/23
10/28/23
11/7/23
11/17/23
11/27/23
12/7/23
12/17/23
12/27/23


Wits End Groundwater Gauge 26
Year 1 (2023 Data)
Start Growing Season
March 1
End Growing Season
November 14
49 Days - 18.9%
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
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
3/2/23
3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
8/9/23
8/19/23
8/29/23
9/8/23
9/18/23
9/28/23
10/8/23
10/18/23
10/28/23
11/7/23
11/17/23
11/27/23
12/7/23
12/17/23
12/27/23


Wits End Groundwater Gauge 27
Year 1 (2023 Data)
Start Growing Season
March 1
End Growing Season
November 14
48 Days - 18.5%
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
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
3/2/23
3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
8/9/23
8/19/23
8/29/23
9/8/23
9/18/23
9/28/23
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11/27/23
12/7/23
12/17/23
12/27/23

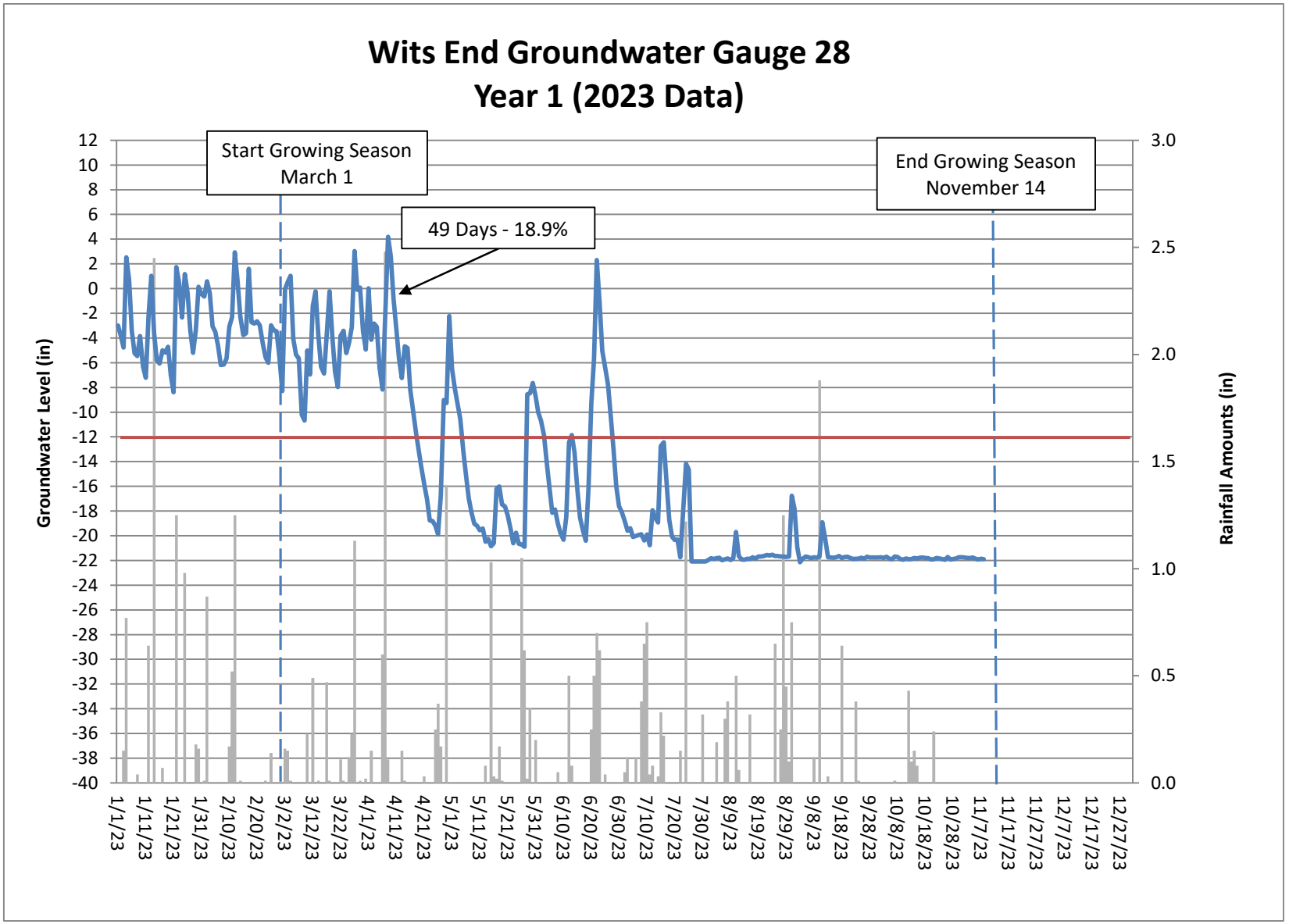

Wits End Groundwater Gauge 28
Year 1 (2023 Data)
Start Growing Season
March 1
End Growing Season
November 14
49 Days - 18.9%
Groundwater Level (in)
Rainfall Amounts (in)
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
3/2/23
3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
8/9/23
8/19/23
8/29/23
9/8/23
9/18/23
9/28/23
10/8/23
10/18/23
10/28/23
11/7/23
11/17/23
11/27/23
12/7/23
12/17/23
12/27/23

Table 13A. UT-2 Channel Evidence

UT-2 Channel Evidence	Year 1 (2023)
Max consecutive days channel flow	112
Total cumulative days channel flow	185
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 13B. UT-3 Channel Evidence

UT-3 Channel Evidence	Year 1 (2023)
Max consecutive days channel flow	147
Total cumulative days channel flow	184
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 13C. UT-3A Channel Evidence

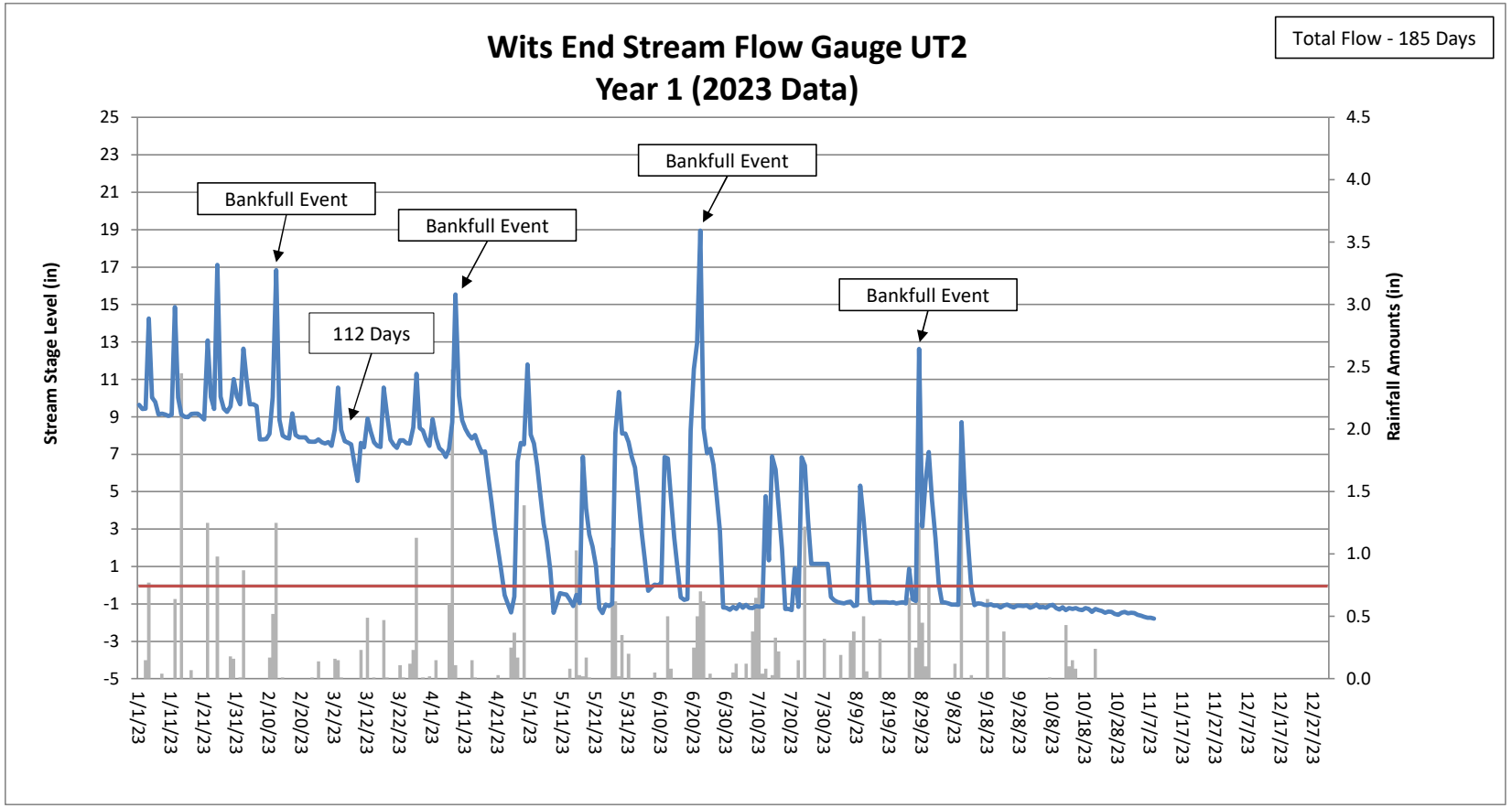
UT-3A Channel Evidence	Year 1 (2023)
Max consecutive days channel flow	109
Total cumulative days channel flow	165
Presence of litter and debris (wracking)	Yes
Leaf litter disturbed or washed away	Yes
Matted, bent, or absence of vegetation (herbaceous or otherwise)	Yes
Sediment deposition and/or scour 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:	

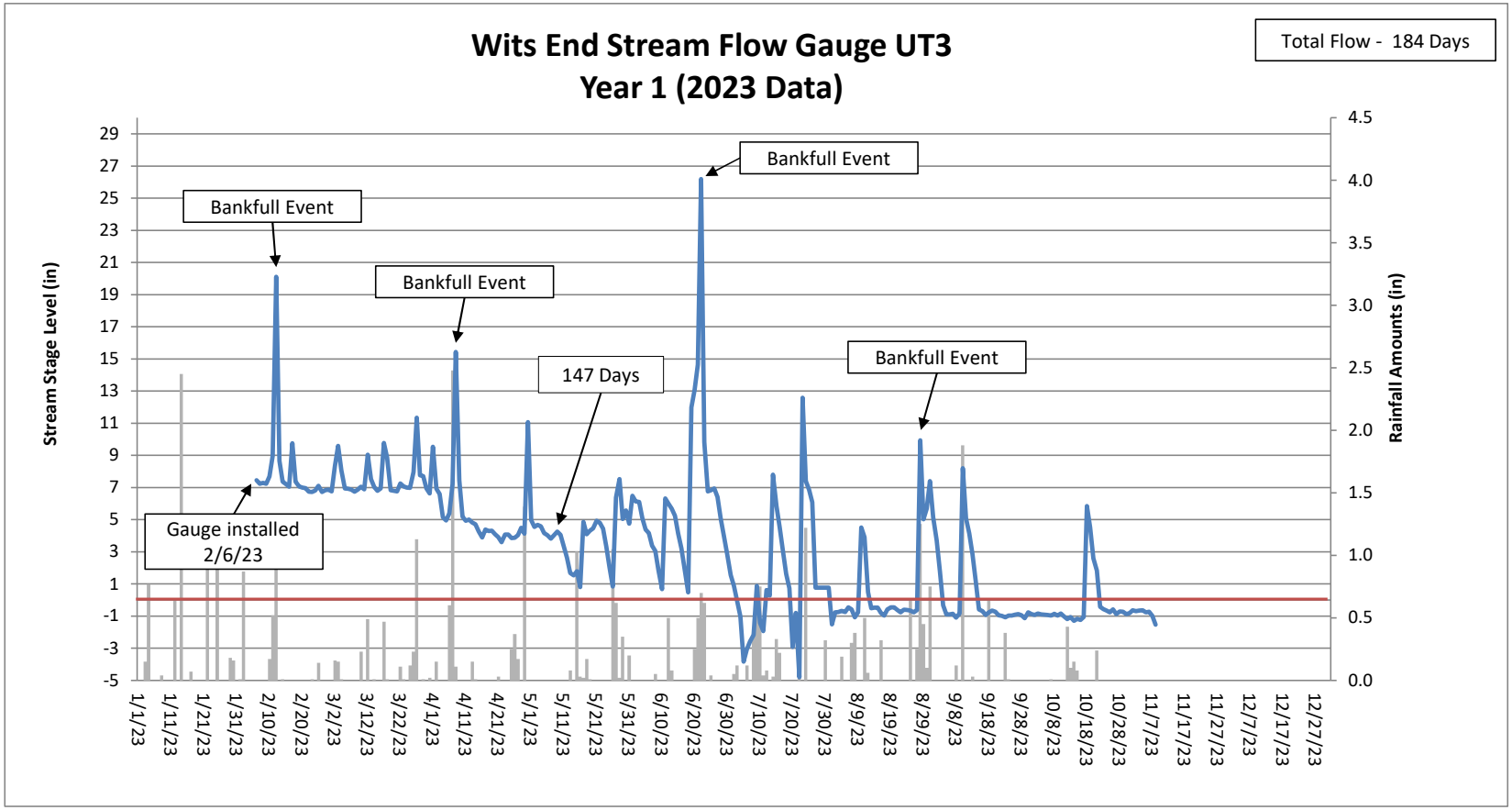
Table 13D. UT-4 Channel Evidence

UT-4 Channel Evidence	Year 1 (2023)
Max consecutive days channel flow	112
Total cumulative days channel flow	176
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 13E. UT-5 Channel Evidence

UT-5 Upstream Channel Evidence	Year 1 (2023)
Max consecutive days channel flow	110
Total cumulative days channel flow	156
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:	


Wits End Stream Flow Gauge UT2
Year 1 (2023 Data)
Total Flow - 185 Days
Stream Stage Level (in)
Rainfall Amounts (in)
Bankfull Event
Bankfull Event
Bankfull Event
Bankfull Event
112 Days
25
23
21
19
17
15
13
11
9
7
5
3
1
-1
-3
-5
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
3/2/23
3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
8/9/23
8/19/23
8/29/23
9/8/23
9/18/23
9/28/23
10/8/23
10/18/23
10/28/23
11/7/23
11/17/23
11/27/23
12/7/23
12/17/23
12/27/23


Wits End Stream Flow Gauge UT3
Year 1 (2023 Data)
Total Flow - 184 Days
Stream Stage Level (in)
Rainfall Amounts (in)
Bankfull Event
Bankfull Event
Bankfull Event
Bankfull Event
147 Days
Gauge installed 2/6/23
29
27
25
23
21
19
17
15
13
11
9
7
5
3
1
-1
-3
-5
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
3/2/23
3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
8/9/23
8/19/23
8/29/23
9/8/23
9/18/23
9/28/23
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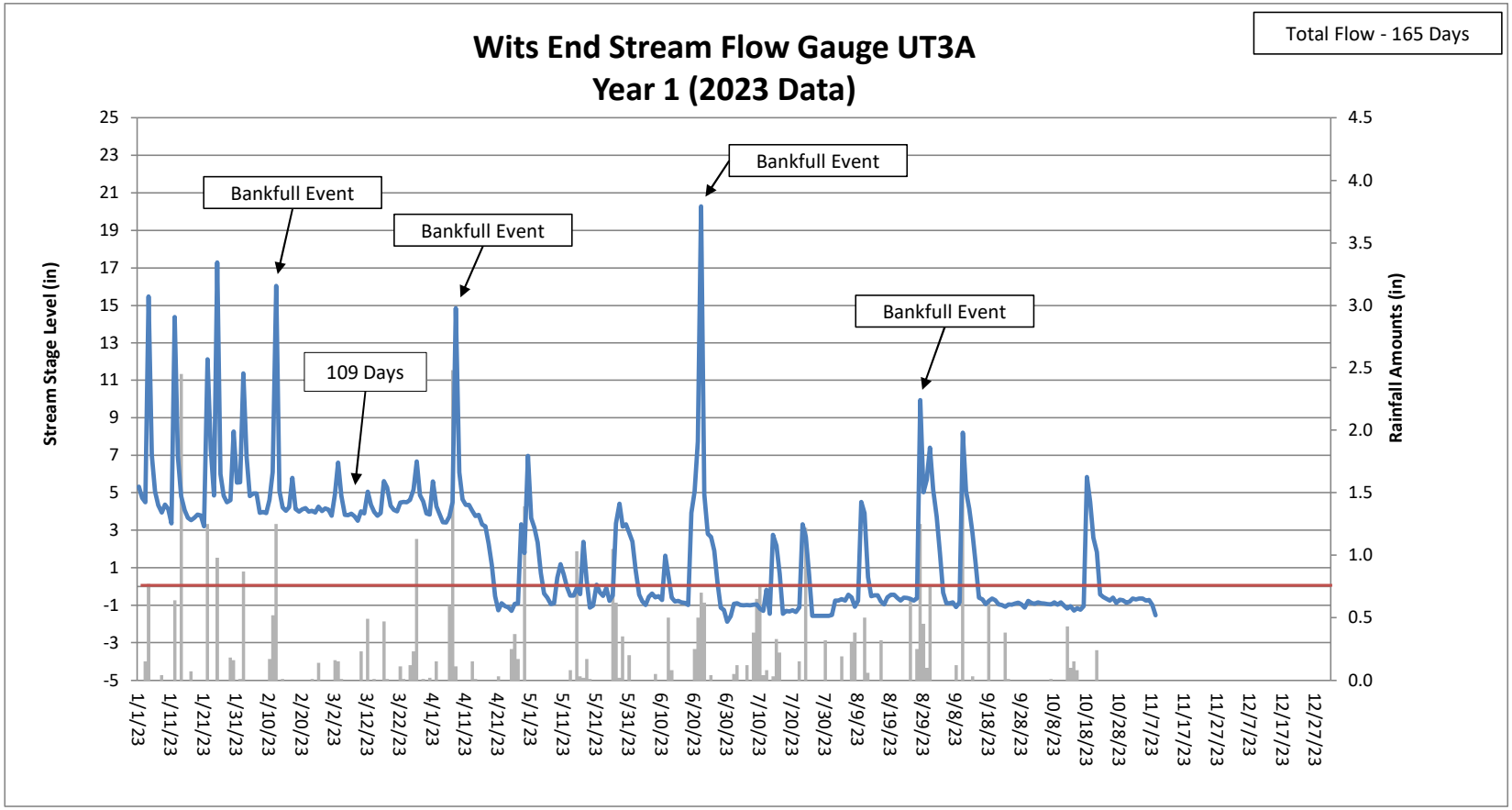
11/27/23
12/7/23
12/17/23
12/27/23


Wits End Stream Flow Gauge UT3A
Year 1 (2023 Data)
Total Flow - 165 Days
Stream Stage Level (in)
Rainfall Amounts (in)
Bankfull Event
Bankfull Event
Bankfull Event
Bankfull Event
109 Days
25
23
21
19
17
15
13
11
9
7
5
3
1
-1
-3
-5
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
3/2/23
3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
8/9/23
8/19/23
8/29/23
9/8/23
9/18/23
9/28/23
10/8/23
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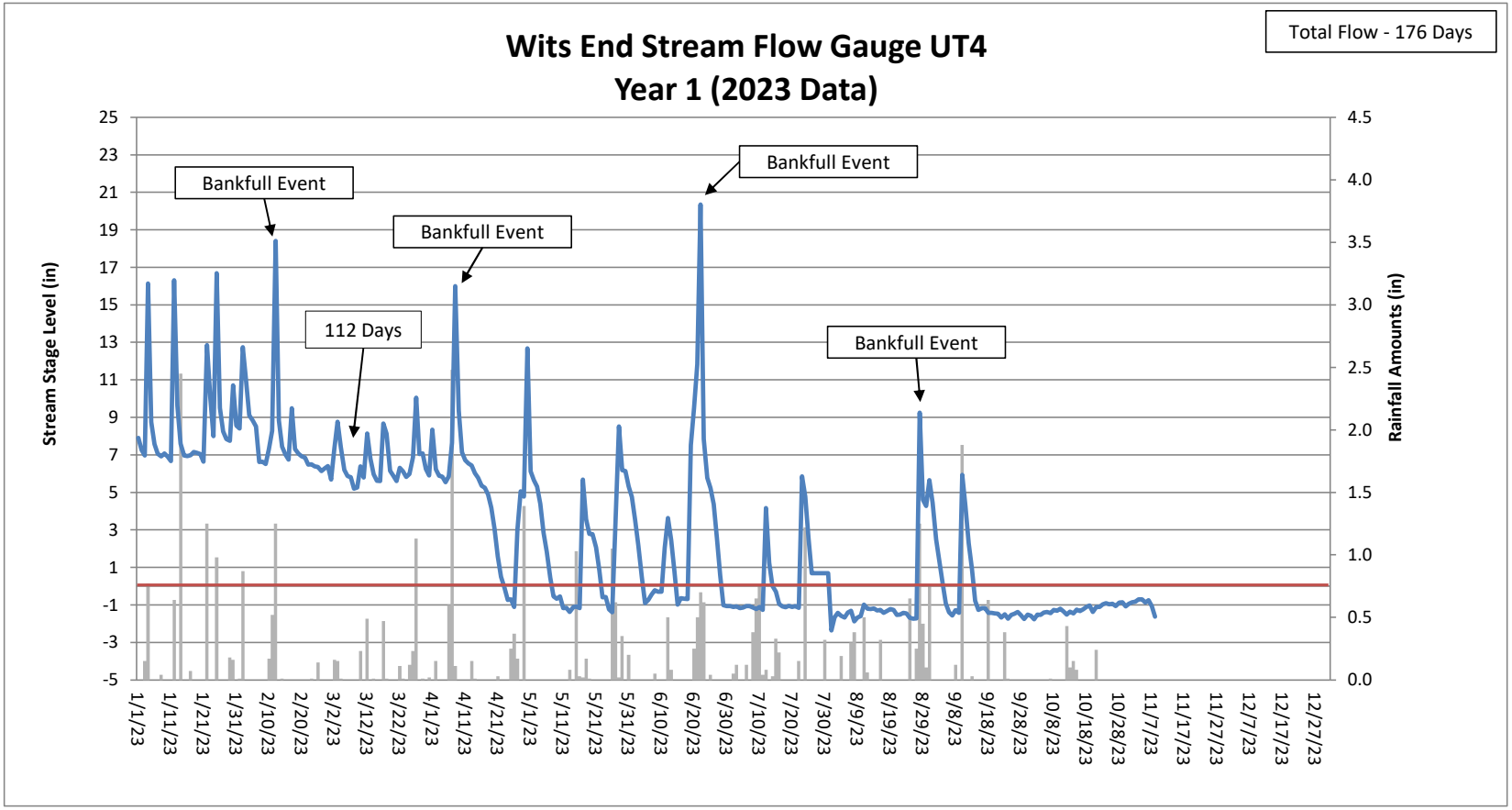
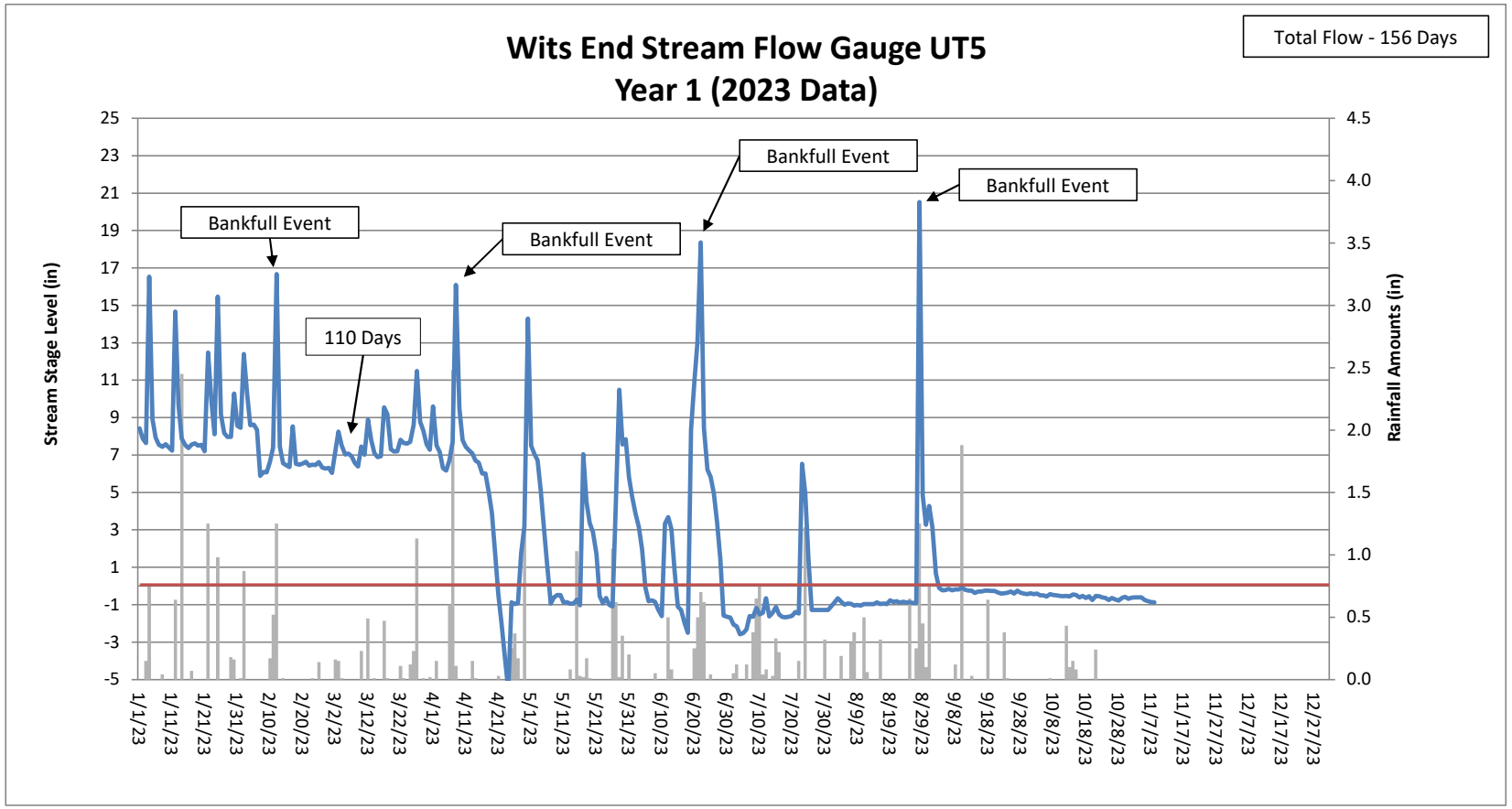
11/27/23
12/7/23
12/17/23
12/27/23


Wits End Stream Flow Gauge UT4
Year 1 (2023 Data)
Total Flow - 176 Days
Stream Stage Level (in)
Rainfall Amounts (in)
Bankfull Event
Bankfull Event
Bankfull Event
Bankfull Event
112 Days
25
23
21
19
17
15
13
11
9
7
5
3
1
-1
-3
-5
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
3/2/23
3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
8/9/23
8/19/23
8/29/23
9/8/23
9/18/23
9/28/23
10/8/23
10/18/23
10/28/23
11/7/23
11/17/23
11/27/23
12/7/23
12/17/23
12/27/23


Wits End Stream Flow Gauge UT5
Year 1 (2023 Data)
Total Flow - 156 Days
Stream Stage Level (in)
Rainfall Amounts (in)
Bankfull Event
Bankfull Event
Bankfull Event
Bankfull Event
110 Days
25
23
21
19
17
15
13
11
9
7
5
3
1
-1
-3
-5
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/23
1/11/23
1/21/23
1/31/23
2/10/23
2/20/23
3/2/23
3/12/23
3/22/23
4/1/23
4/11/23
4/21/23
5/1/23
5/11/23
5/21/23
5/31/23
6/10/23
6/20/23
6/30/23
7/10/23
7/20/23
7/30/23
8/9/23
8/19/23
8/29/23
9/8/23
9/18/23
9/28/23
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11/27/23
12/7/23
12/17/23
12/27/23

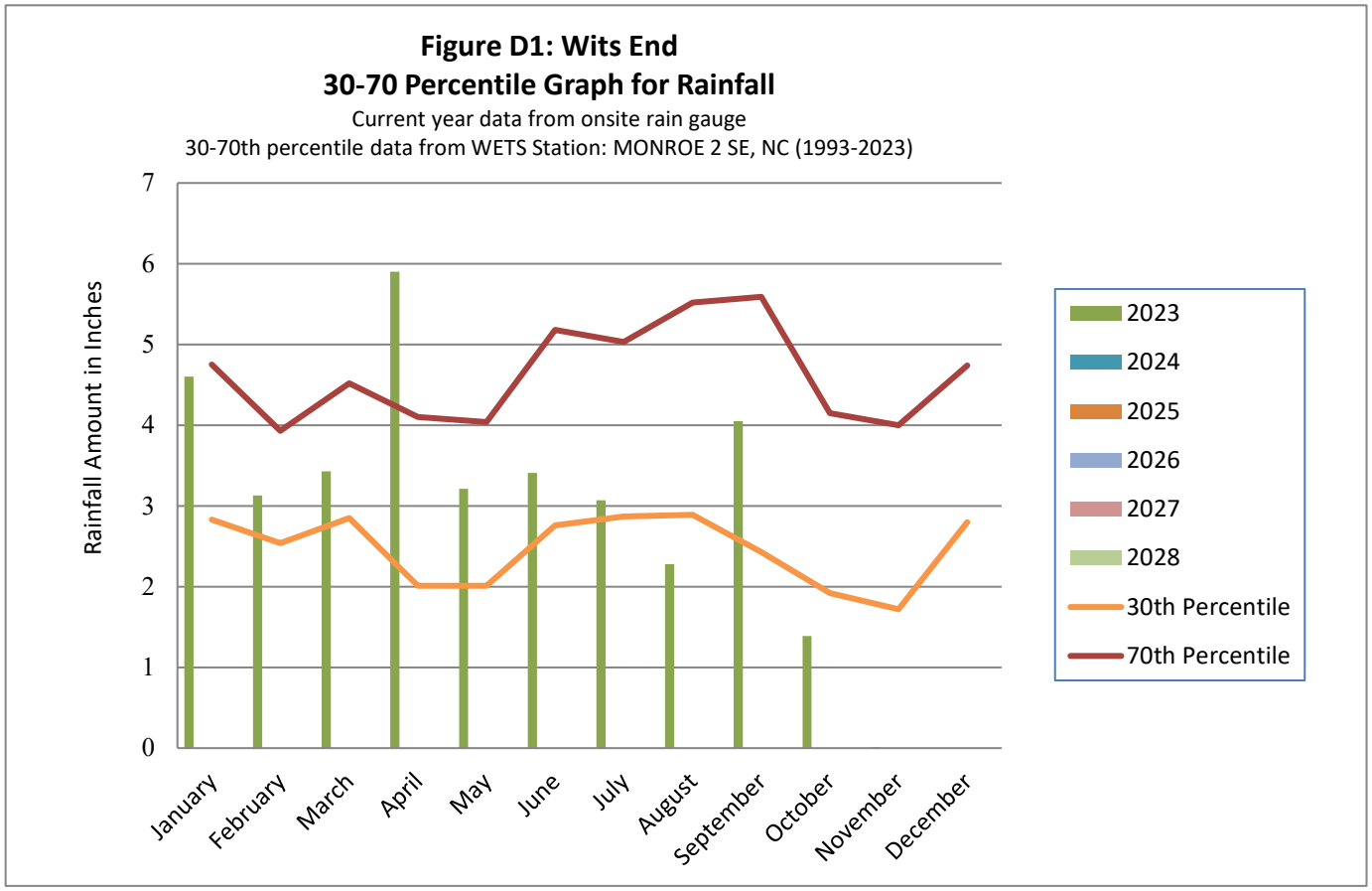
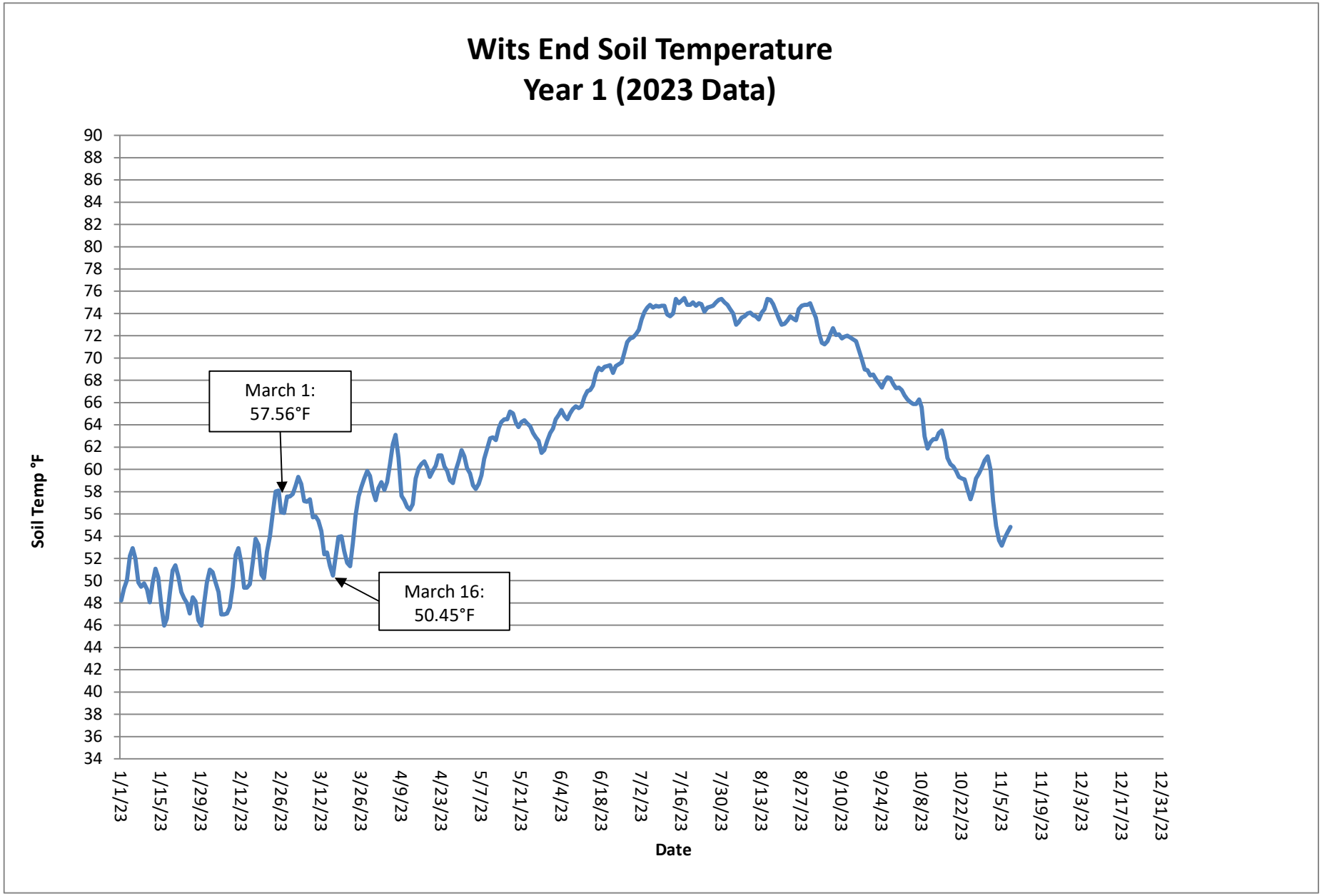


Figure D1: Wits End
30-70 Percentile Graph for Rainfall
Current year data from onsite rain gauge
30-70th percentile data from WETS Station: MONROE 2 SE, NC (1993-2023)
Rainfall Amount in Inches
0
1
2
3
4
5
6
7
January
February
March
April
May
June
July
August
September
October
November
December
2023
2024
2025
2026
2027
2028
30th Percentile
70th Percentile


Wits End Soil Temperature
Year 1 (2023 Data)
Soil Temp °F
90
88
86
84
82
80
78
76
74
72
70
68
66
64
62
60
58
56
54
52
50
48
46
44
42
40
38
36
34
March 1:
57.56°F
March 16:
50.45°F
1/1/23
1/15/23
1/29/23
2/12/23
2/26/23
3/12/23
3/26/23
4/9/23
4/23/23
5/7/23
5/21/23
6/4/23
6/18/23
7/2/23
7/16/23
7/30/23
8/13/23
8/27/23
9/10/23
9/24/23
10/8/23
10/22/23
11/5/23
11/19/23
12/3/23
12/17/23
12/31/23
Date

Appendix E: Project Timeline and Contact Info

Table 14. Project Timeline
Table 15. Project Contacts

Table 14. Project Timeline

Activity or Deliverable	Data Collection Complete	Task Completion or Deliverable Submission
Project Instituted	NA	Aug-20
Mitigation Plan Approved	NA	28-Jul-21
Construction (Grading) Completed	NA	22-Jul-22
Planting Completed	NA	28-Jul-22
As-built Survey Completed	Jul-22	Jul-22
MY0 Stream Survey	1-Jun-22	NA
MY0 Vegetation Survey	15-Feb-23	NA
MY0 Baseline Report	Jun-22	Mar-23
Supplemental Planting (33.4 acres)	NA	23-Jan-23
Invasive Treatment: Chinese privet and fescue	NA	20-Feb-23
Invasive Treatment: Bamboo, Chinaberry, and Chinese privet	NA	27-Jun-23
Invasive Treatment: Chinaberry, Chinese privet, multiflora rose, and tree of heaven	NA	18-Sep-23
MY1 Stream Survey	2-Apr-23	NA
MY1 Vegetation Survey	2-Oct-23	NA
MY1 Monitoring Report	Nov-23	Feb-24
Adaptive Management Plan for Vegetation/Hydrology	NA	Q1 2024
MY2+ Monitoring Reports	On Schedule	On Schedule

Table 15. Project Contacts

Project Name/Number	
Provider	Restoration Systems, LLC 1101 Haynes Street, Suite 211 Raleigh, NC 27604
Mitigation Provider POC	Ray Holz 919-755-9490
Designer	Axiom Environmental, Inc. 218 Snow Ave Raleigh, NC 27603
Primary project design POC	Grant Lewis 919-215-1693
Construction Contractor	Land Mechanics Designs, Inc. 126 Circle G Lane Willow Spring, NC 27592 Charles Hill 919-639-6132

Appendix F: 2023 Adaptive Management Plan

2023 Adaptive Management Plan

Wits End Stream and Wetland Mitigation Site

Union County, North Carolina
Yadkin River Basin
Cataloging Unit 03040105

DMS Project No. 100164
Full Delivery Contract No. 7968
DMS RFQ No. 16-032819-YD05 (Date of Issue: May 9, 2019)
USACE Action ID No. SAW-2020-00455
DWR Project No. 20200369

Restoration Systems, LLC
1101 Haynes Street, Suite 211
Raleigh, North Carolina 27604
Contact: Raymond Holz
919-755-9490 (phone)
919-755-9492 (fax)

September 18, 2023

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Mitigation Plan – Project Success Criteria
Mitigation Plan – Monitoring Summary

1 INTRODUCTION

Wits End Stream and Wetland Mitigation Site (Site) is an NCDMS Full-Delivery site located in Union County at coordinates (34.9132, -80.4435). The project is currently in Year 1 of monitoring. The final mitigation plan is dated October 13, 2021, and the As-Built report is dated April 2023.

Upon the completion of the physical grading associated with Site restoration in July of 2022, Restoration Systems (Site Sponsor) and Axiom Environmental (Site Designer and Monitoring Contractor) began observing the anticipated drying of unconsolidated sediments associated with the pond, which was removed during construction. As summer months continued to dry, pond bed soils began to shrink, leading to cracking throughout most of the former pond bed.

A remnant seed stock of a native *Polygonum spp.* within the pond bed soils quickly took root over most of the exposed pond bed, providing root structure to the soils. Permanent seeding efforts completed as part of the planting plan took root around the fringe of the former pond and in shallower portions of the pond. Along with the Site as a whole, the pond was planted with bare roots in the spring of 2022 and winter of 2023.

Over the past 18-plus months, pond soil conditions and vegetative communities have separated into four distinct conditions. Below is a description of each type, which are shown in Figure 1. Pond bed cracking and vegetation condition observations were delineated and quantified for this AMP and future monitoring efforts.

Type 1.) No Physical Intervention: Along UT-2 and the left floodplain of Waxhaw Branch in the pond bed, both planted/seeded bare-roots/herbaceous species have established and appear to have stabilized the soil structure. 2023 herbaceous coverage is strong with good diversity, planted bare roots and natural recruits appear to have been established to a satisfactory degree to achieve success criteria, and soil cracking/structure is evolving appropriately. While remnant cracking signs are still visible, the area seems stable, and no physical intervention is being proposed.

Type 2.) The right floodplain of Waxhaw Branch has areas where soil shrinking resulted in severe soil cracking from the floodplain grade to the restrictive sub-soil layer. In these areas, the cracking is continuous down the valley, resulting in a drainage effect to proposed wetland areas and adjacent floodplains, exasperating the shrinking of area soils.

Type 3.) Two separate vegetation conditions exist Within the right floodplain area.
- 3A.) Areas where herbaceous vegetation was established in 2022 and returned in 2023 and
- 3B.) Areas where inundated floodplains/overbank flows of Waxhaw Branch prohibited the herbaceous development in 2023.

At the MY0 IRT Site visit, held July 18, 2023, RS and the IRT discussed the development of an AMP to address pond bed cracking and areas lacking herbaceous vegetation along the right floodplain of Waxhaw Branch (site visit notes are attached for reference). This AMP proposes a two-pronged approach to address soil structure/wetland hydrology and the establishment of appropriate tree and shrub species in the pond bed to meet Site goals and success criteria.

<u>AMP Approach:</u>

1.) Soil Structure/Wetland Hydrology – Right floodplain of Waxhaw Branch
<u>Action</u>: Installation of two log-constructed floodplain grade control structures to disrupt the free flow of subsurface hydrology through the cracked soils of the floodplain and placement of large-woody debris on the floodplain for added stability during overbank events.

<u>Desired Outcome</u>:
- The retention of water table hydrology – Allowing soil development to occur under normal conditions, possibly resulting in the reformation of historic soil structure and reduced soil cracking.

- Allowing sediment deposition to occur within the cracked floodplains from overbank flows, aiding in soil structure development.
- Additional water table hydrology for establishing desired tree and shrub species at success criteria densities.

2.) Vegetated Planting
RS has observed that where natural recruits have established in the pond bed, they are thriving. Additionally, observations of bare-root planting in severely cracked soil areas indicate that the physical planting of the bare-root is producing fracture lines in the cracked soil and, in some cases, cracking the soil, leading to air pruning of our bare roots and high mortality rates.

Action: Planting of both 3-4' live-stakes and broadcasting seeding the pond bed with mitigation plan approved tree species.

Desired Outcome:
- Establish live-stake shrub species to aid in planting diversity and assist with soil structure development.
- Seeding with desired tree species may allow them to establish based on site conditions and avoid the shock associated with bare-root planting.
- The two planting approaches proposed in this AMP, plus the previous two rounds of bare-root planting, will increase desired tree and shrub diversity and densities within the pond bed.

Details of this AMP approach are provided in Section 3 and graphically depicted in Figure 2.

1.1 Site Planting Effort

Planting of the Site occurred in stages as construction was completed and as evaluations were made regarding planted stem viability. Ample rain and cooler temperatures helped during the latter 2022 planting efforts. Before the May 2022 planting efforts, bare roots were kept in a refrigerated truck to prevent budburst, and live stakes were kept submerged in water. However, after an inspection in late 2022, it was determined that an additional planting effort would help ensure Site vegetative success. Table A details site planting efforts.

Table A. Wits End Planting Dates

Type / Date	Planting Location	Notes
Bare Root		
Thursday, April 7, 2022	- UT-1, UT-2, Waxhaw Branch (within the old pond bed down to the confluence with UT-3), UT-4 to the Waxhaw Branch floodplain	Temperature Range: 60°F - 80°F Week of Precipitation: +/- 1.46 inches
Tuesday, May 24, 2022	- UT-3, from its confluence of Waxhaw Branch to where UT-3 enters the Site, and the origin point of UT-3A - Streamside and wetland areas along Waxhaw Branch starting at the confluence of UT3 (the forested portion of Waxhaw Branch) down to Snyder Store Road (Site outfall)	Temperature Range: 62°F - 75°F The previous night, the Site received +/- 0.64 inches of rain, and a light drizzle occurred during the morning of May 24
Monday, January 23, 2023	- Sitewide	Temperature Range: 33°F - 54°F Previous day rain: +/- 0.82 inches

Table A. Wits End Planting Dates (continued)

1-gallon Containerized Planting		
Thursday, July 28, 2022	- Waxhaw Branch – old road access and construction area for Waxhaw Branch bridge. - UT-3 southern easement edge - 520 1-gal.	Temperature Range: 77°F - 96°F A trace amount of rainfall occurred on July 29
Live Stakes		
Monday, March 21, 2022	- Waxhaw Branch to the confluence with UT-2, UT-1, UT-2, and UT-4 down to Waxhaw Branch floodplain	Temperature Range: 38°F - 71°F Week of Precipitation: +/- 0.85 inches
Thursday, April 7, 2022	- Marsh treatment areas, Waxhaw Branch from UT-2 confluence down to UT-3 confluence	Temperature Range: 60°F – 80°F Week of Precipitation: +/- 1.46 inches
Sunday, May 15, 2022	- UT-3/3A to its confluence with Waxhaw Branch and down to Snyder Store Road (Site outfall)	Planting occurred in the morning, with temperatures ranging from 66°F to 82°F. +/- 0.25 inches of rain fell that afternoon after planting

2 MONITORING YEAR 0 – DATA ASSESSMENT REVIEW

MY0 (2023) monitoring and site visits were conducted between June 2022 and February 2023 to assess the condition of the project. Stream, wetland, and vegetation criteria for the Site follow the approved success criteria presented in the Mitigation Plan.

2.1 Stream Assessment

Morphological surveys for MY0 were conducted on June 2, 2022. All streams within the Site are stable and functioning as designed. No stream areas of concern were identified during MY0.

2.2 Hydrology Assessment

28 groundwater monitoring gauges were installed throughout the Site's wetlands. Hydrologic data will be collected and reported during MY1 (2023).

2.3 Vegetative Assessment

The MY0 vegetative survey was completed in February 2023. Vegetation monitoring resulted in a sitewide stem density average of 426 planted stems per acre permanent plot average (413 stems per acre/sitewide average), above the interim requirement of 320 stems per acre required at MY3. Additionally, 31 of the 37 fixed vegetation plots and 7 of the 12 temporary plots met the interim success criteria.

3 PROPOSED ADAPTIVE MANAGEMENT ACTIONS

This AMP proposes a two-pronged approach to address soil structure/wetland hydrology and the establishment of appropriate tree and shrub species within the former pond bed of Waxhaw Branch to meet Site goals and success criteria. Earthwork is proposed for the installation of two floodplain grade controls in key areas, minimizing ground disturbance to floodplains and proposed wetland areas, the turning of soils within a small area of the former pond bed currently devoid of vegetation and subject to soil cracking, and the placement of large woody debris on the floodplain. Planting and seeding activities are proposed over +/- 5.1 acres via live-stake planting and seeding of native, mitigation plan approved, tree and herbaceous species.

3.1 Floodplain Grade Control

There are two locations where the outer bends of Waxhaw Branch come within close proximity of the form pond boundary. At these locations, depicted in Figure 2, RS proposes installing log-constructed floodplain grade control (VGC) structures. These structures would tie into the stable, uncracked soils adjacent to the Waxhaw Branch channel and extend through the pond bed, tying into the uncracked soils beyond the former pond bed. Structures would be placed adjacent to rock riffles of Waxhaw Branch but would not connect directly to the stream – no stream impacts are associated with their installation.

The structures will be set so the top is level with the floodplain grade. The primary objective is to eliminate subsurface groundwater flow through the existing cracks and for sediment deposition to occur within the cracks, not on the floodplain itself. Rebar will anchor the footer log to the undisturbed subgrade and the top log to the footer log. Excavated soil will be replaced and compacted around the structures, and live stakes will be planted.

Cross Section of Proposed VGC Structure

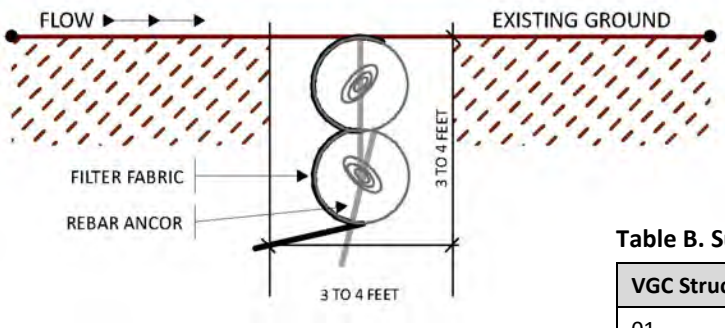

Table B. Summary of Proposed VGCs

VGC Structure No.	Length (ft.)	Disturbance (sq. ft.)
01	50	150
02	45	135

3.2 Soil Mixing

Within the area identified in Figure 1 as "AMP Type 3B - Severe Soil Cracking - Bare Soil: 0.427 Ac." RS proposes to turn the soil with a large tiller or excavator mechanically. While doing so, RS will incorporate large woody debris into this area to help with soil structure. This area is identified in Figure 2 as "Mechanical Soil Mixing - Severe Soil Cracking - Bare Soil: 0.427 Ac."

3.3 Live Stake Planting & Tree/Herbaceous Seeding

Proposed vegetation-based AMP practices are delineated in Figure 2 and consist of areas on the left and right floodplain of Waxhaw Branch, 3.006 and 2.050 acres, respectively. RS proposes vegetation-based AMP work via two approaches: 1.) planting of 3–4-foot live stakes, and 2.) broadcast seeding to native, Mitigation Plan approved tree and herbaceous species.

Vegetation Approach 1: Live stake planting, right floodplain of Waxhaw Branch, 3.006 acres

During the IRT Site visit in July, the use of live stakes for planting was discussed. The physical rooting of live stakes allows the plant stem additional opportunity to establish itself versus a bare root sapling's existing root structure, increasing the odds of survival. Live stakes have been used on previous NC mitigation projects to re-establish the soil structure of former pond bed soils. In addition, planting live stakes would allow RS the opportunity to improve woody species diversity was discussed. As such, RS proposes planting four (4) species via 3–4-foot live stakes at a density of 250 stems per acre – proposed species are detailed in Table C. Given that the depth of the restrictive soil layer is relatively shallow, 2-3 feet, RS felt that thicker, mid-length live stakes provide the greatest chance of establishment. The use of live stake poles, or 5+ foot live stake whips, was discussed with the IRT. RS may include black willow live stake poles in addition to the defined species below, but they will supplement the 3-4-foot live stakes and will not be the primary planting material. Live stakes will be planted at higher densities around the proposed VGC structures.

Table C. Live Stake Species & Quantity

Species	Common Name	#
Cephalanthus occidentalis	Button bush	200
Sambucus nigra	Elderberry	200
Salix nigra	Black willow	200
Salix sericea	Silky willow	200
		800

Vegetation Approach 2: Broadcast seeding of tree and herbaceous species, 5.1 Acres

Observations of the two-prior bare-root planting efforts within the cracked soil areas indicate the physical planting of the bare-root is producing fracture lines in the cracked soil and, in some cases, cracking the soil, leading to air pruning of our bare roots and high mortality rates. In addition, where natural recruits have established in the pond bed, they are thriving. As such, RS believes the most appropriate way to achieve site success criteria is to attempt a broadcast seeding of mitigation plan-approved tree species.

RS has talked with our Forestry Representative, Chad Casselman, Operations Manager at Native Forest Nursery, regarding this approach, including cold-stratifying seeds before broadcasting them to improve germination rates. Black Gum is the only species that would require true cold stratification. Cold stratification simulates the natural process by subjecting the seed to a cool (ideally 34 to 37 degrees Fahrenheit) moist environment. Other species would be kept in refrigerated storage until shipment/planting. In addition to the broadcasting to tree species, RS would seed the 5.1 acres with another application of the Mitigation Plan approved permanent seed mix. Tables D and E provide species lists and rates for both applications.

Table D. Broadcast Tree Species & Quantity

Species	Common Name	Seeds/lb	Germ. % *	Proposed lbs.	Total Seeds	Seeds/ac.
Nyssa sylvatica	Black gum	2,600	60-80	2	5,200	1,019
Quercus nigra	Water oak	300	60-80	17	5,100	1,000
Quercus phellos	Willow oak	400	70-90	13	5,200	1,019
Betula nigra	River birch	200,000	30-50	1	200,000	39,215

* Assuming a lower-than-average germination rate due to rodents eating seeds and less-than-ideal planting conditions, RS has based seeding rates on the low-end of the forestry-provided germination rates.

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Table E. Broadcast Herbaceous Seed Species & Quantity

Permanent Seed- Sitewide @ 2 lbs /acre					
Species	**%**	**Species**	**%**	**Species**	**%**
Yarrow *(Achillea millefolium)*	0.8	Garden tickseed *(Coreopsis tinctoria)*	4	Slender rush *(Juncus tenuis)*	0.5
Redtop *(Agrostis gigantea)*	15	Mexican aster *(Cosmos bipinnatus)*	1	Roundhead bushclover *(Lespedeza capitata)*	0.5
Winter bentgrass *(Agrostis hyemalis)*	5	Giant larkspur *(Consolida ajacis)*	2	Dense blazing star *(Liatris spicata)*	0.5
Autumn bentgrass (*Agrostis perennans)*	5	Showy tick-trefoil *(Desmodium canadense)*	1	Wild bergamot *(Monarda fistulosa)*	0.5
Creeping bentgrass *(Agrostis stolonifera)*	2	Purple coneflower *(Echinacea purpurea)*	5	Beaked panicgrass *(Panicum anceps)*	0.5
Blue wild indigo *(Baptisia australis)*	2	Virginia wildrye *(Elymus virginicus)*	5	Deer-tongue *(Panicum clandestinum)*	5
Fox sedge *(Carex vulpinoidea)*	1	Blue mistflower *(Eupatorium coelestinum)*	0.5	Foxglove beardtongue *(Penstemon digitalis)*	1
Partridge pea *(Chamaecrista fasciculata)*	1	Common boneset *(Eupatorium perfoliatum)*	0.5	Coneflower - Clasping *(Rudbeckia amplexicaulis)*	1
Sensitive partridge pea *(Chamaecrista nictitans)*	1	Blanket flower *(Gaillardia perennial)*	0.5	Black-eyed Susan, *(Rudbeckia hirta)*	3
Oxeye daisy *(Chrysanthemum leucanthemum)*	4.5	Narrowleaf sunflower *(Helianthus angustifolius)*	0.5	American senna *(Senna hebecarpa)*	0.5
Shasta daisy *(Chrysanthemum x superbum)*	3	Oxeye *(Heliopsis helianthoides)*	0.5	Purpletop *(Tridens flavus)*	18
Lanceleaf coreopsis *(Coreopsis lanceolata)*	4	Rose mallow *(Hibiscus moscheutos)*	5	American vervain *(Verbena hastata)*	1
Permanent Seed- Marsh Treatments, Pools, Seeps @ 5 lbs /acre					
Species	**%**	**Species**	**%**	**Species**	**%**
Switchgrass *(Panicum rigidulum)*	36	Greenish-white sedge *(Carex albolutescens)*	8	Hop sedge *(Carex lupulina)*	5
Bearded beggarticks *(Bidens aristosa)*	20	Virginia wildrye *(Elymus virginicus)*	6	Fox sedge *(Carex vulpinoidea)*	2
Narrowleaf sunflower *(Helianthus angustifolius)*	18	Soft rush *(Juncus effusus)*	5		

4 PROPOSED ADAPTIVE MANAGEMENT MONITORING

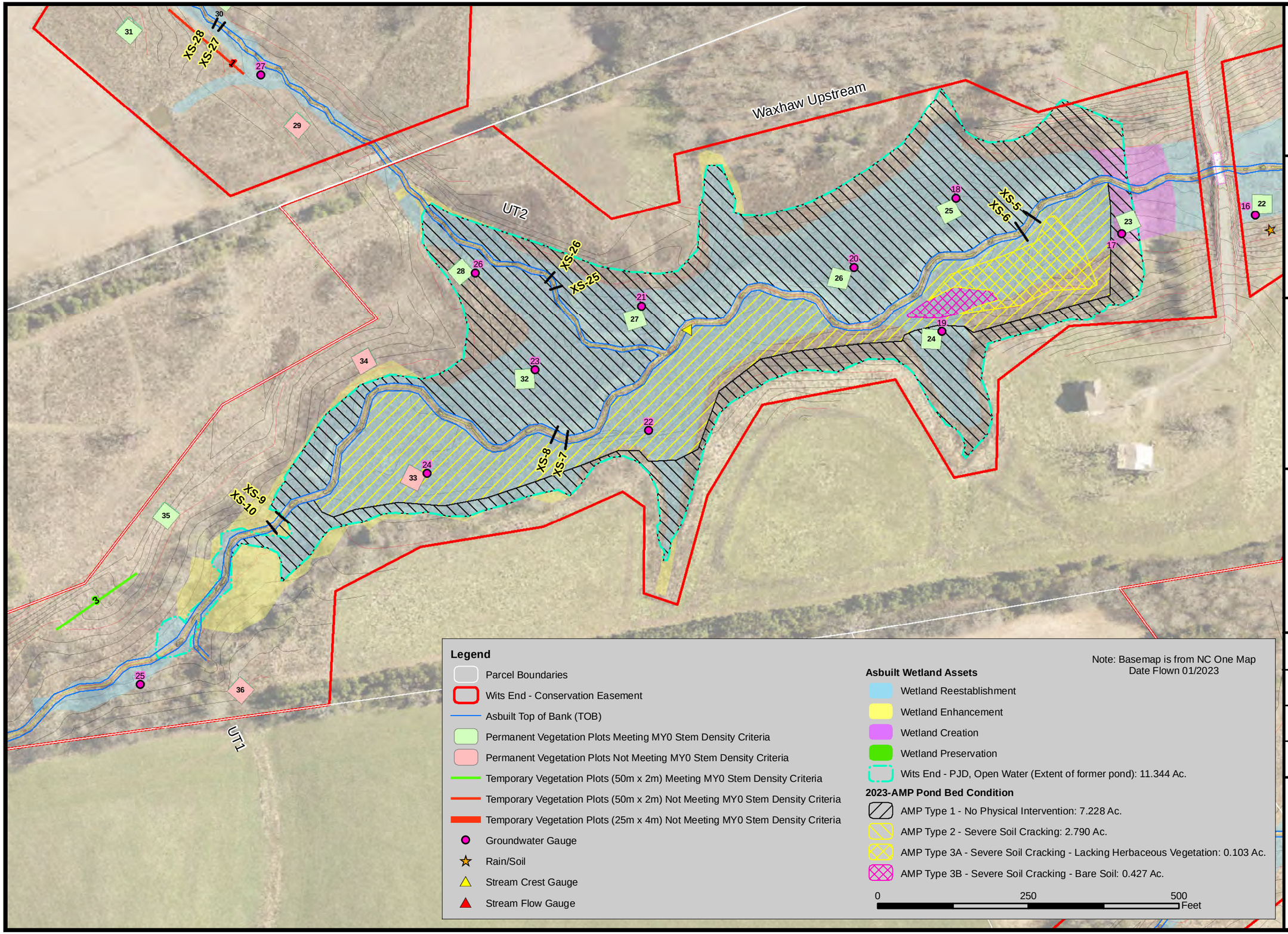
Upon completion of the AMP, RS will provide an AMP Implementation Memo to DMS and the IRT detailing the completed efforts with photo documentation. As a baseline, RS will conduct random vegetation transects as defined in the approved Mitigation Plan within the vegetation AMP zones in the spring of 2024 (MY2). RS will repeat these transects in the fall of 2024 and include the results in the MY2 (2024) monitoring report. Given that the Site is currently in MY1, RS does not propose additional monitoring protocols. RS will continue delineating and monitoring pond bed cracking and report the results in the yearly monitoring reports and future Current Condition Plan View figures.

2023 Adaptive Management Plan

Wits End Stream and Wetland Mitigation Site

APPENDIX ITEMS

Figure 1 – Overview Map
Figure 2 – AMP Map
Photo Log
MY0/1 – IRT Site Visit Notes
Mitigation Plan – Project Success Criteria
Mitigation Plan – Monitoring Summary



RESTORATION SYSTEMS | LLC

Prepared for:

NC DEQ
Division of Enviromental Quality

Division of Mitigation Services

Project:

WITS END

Union County, NC

Title:

2023-MY1 AMP

FIGURE 01 OVERVIEW

Drawn by: RJH

Date: SEPTEMBER 2023

Scale: 1:1,800

Project No.: 20-011

FIGURE

1

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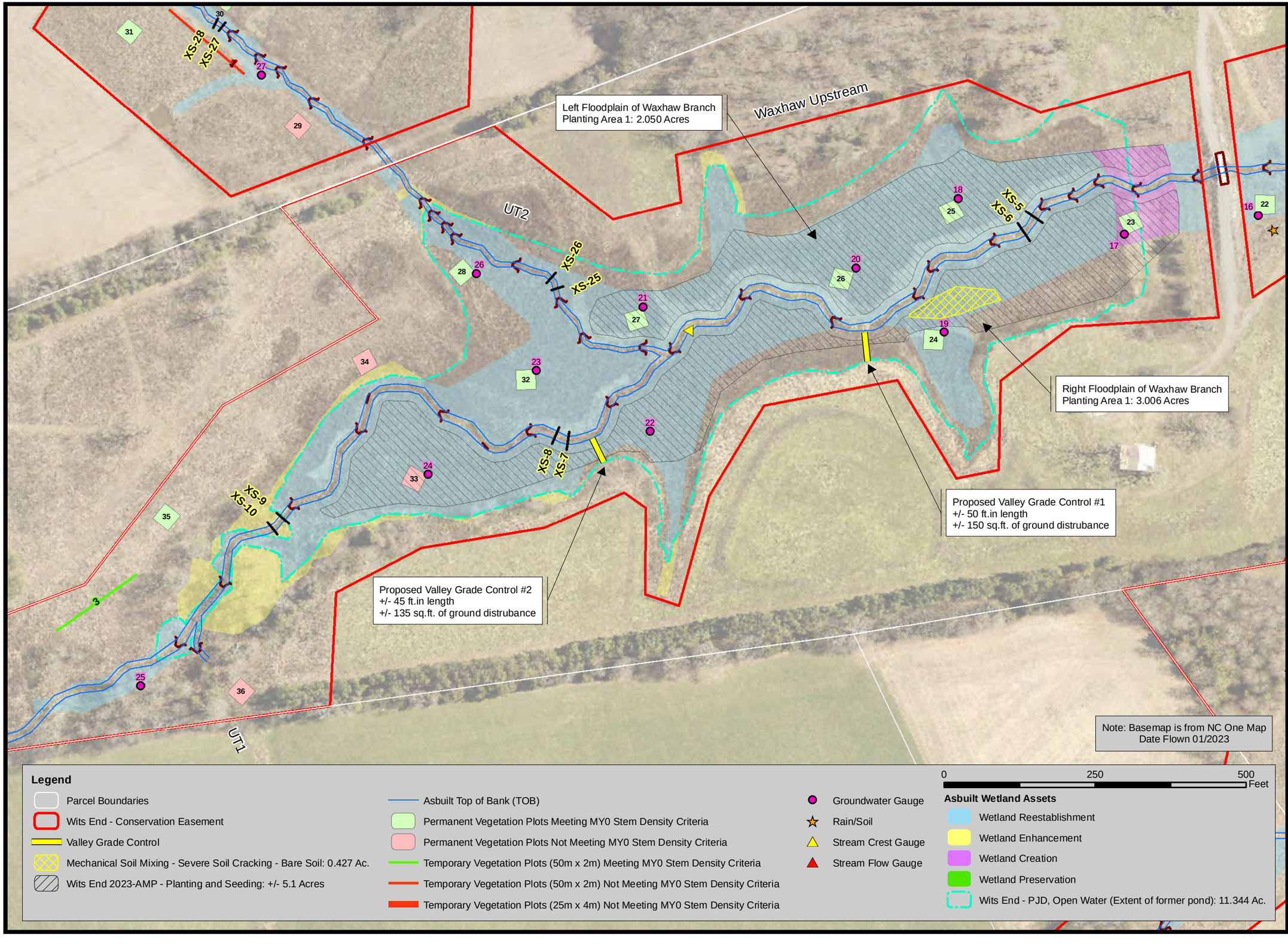


RESTORATION SYSTEMS | LLC

Prepared for:

NC DEQ
Division of Enviromental Quality

Division of Mitigation Services

Project:

WITS END

Union County, NC

Title:

2023-MY1 AMP

FIGURE 02 PROPOSED WORK

Drawn by: RJH

Date: SEPTEMBER 2023

Scale: 1:1,800

Project No.: 20-011

FIGURE

2

N

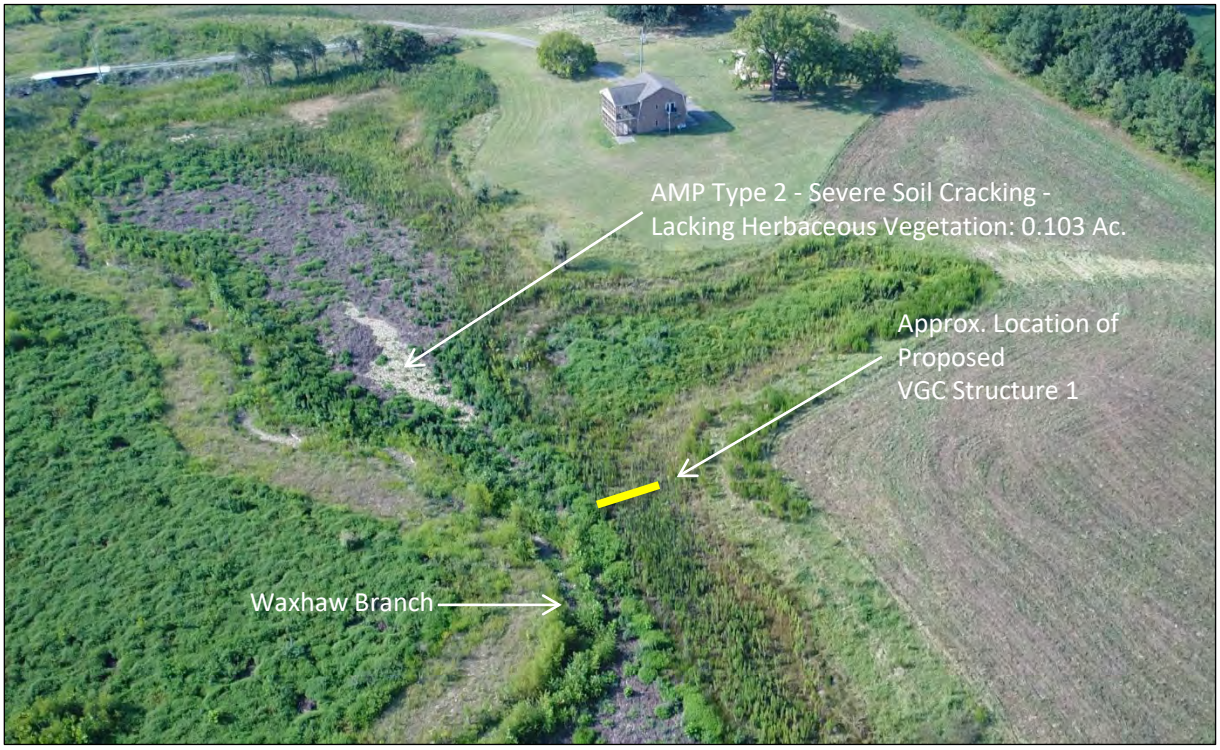


Photo 1: Looking south, downstream along Waxhaw Branch

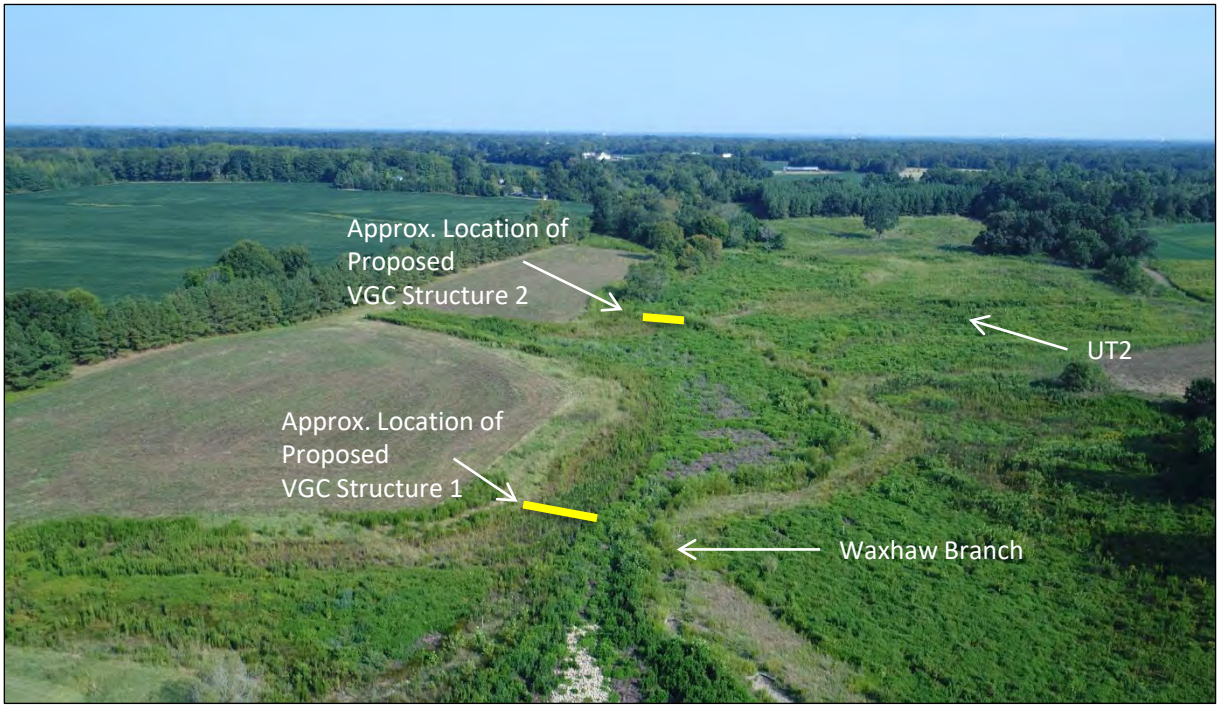
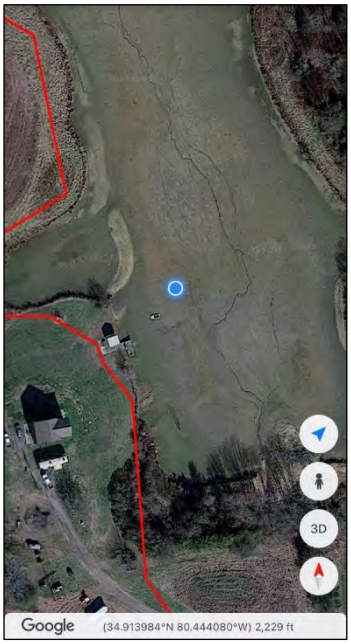


Photo 2: Looking north, upstream along Waxhaw Branch



Detail Area 1: AMP Type 3B - Severe Soil Cracking - Bare Soil

Photo 3: Soil cracking – mid-Summer conditions

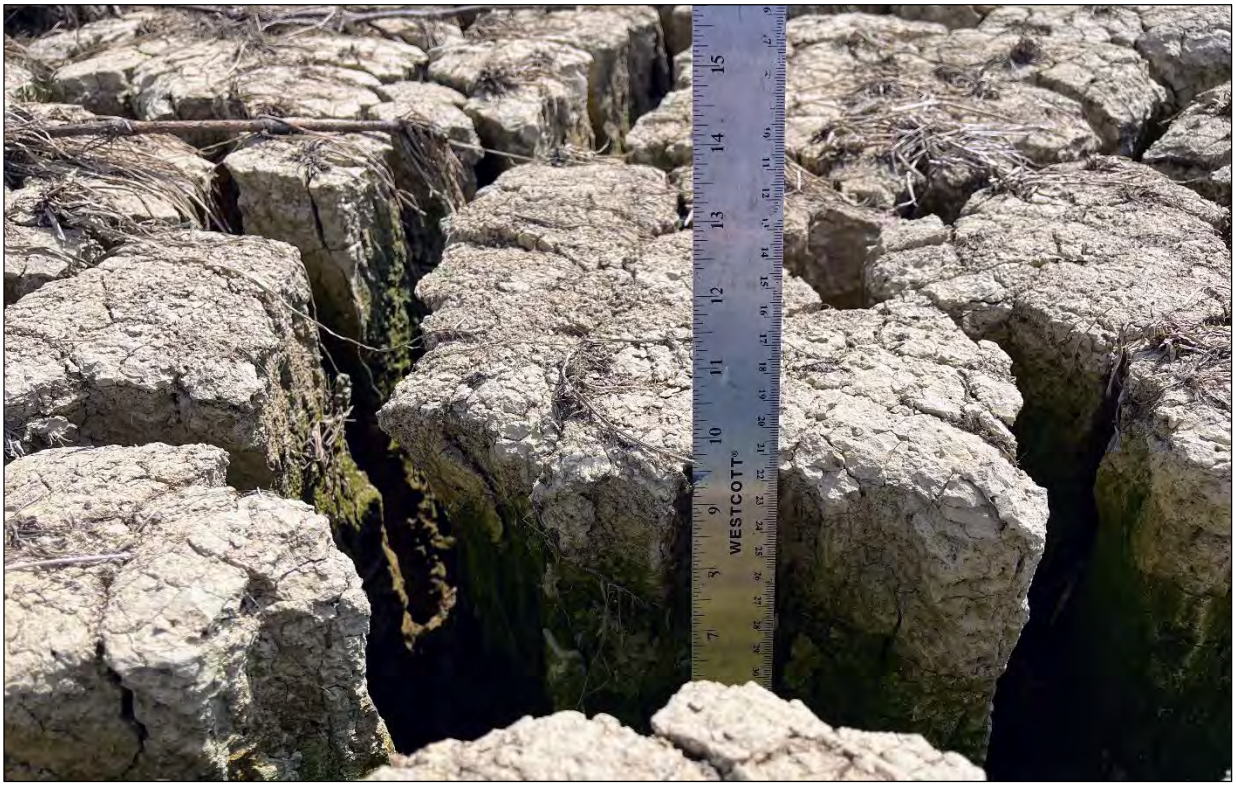
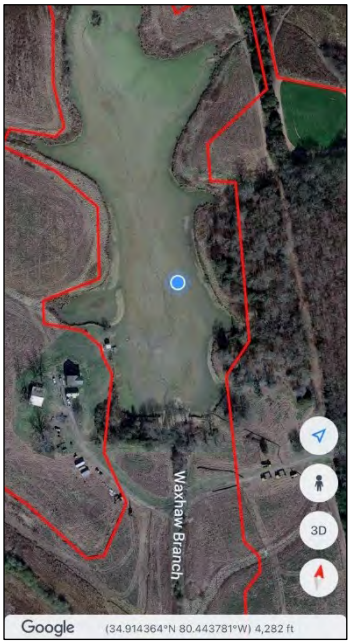


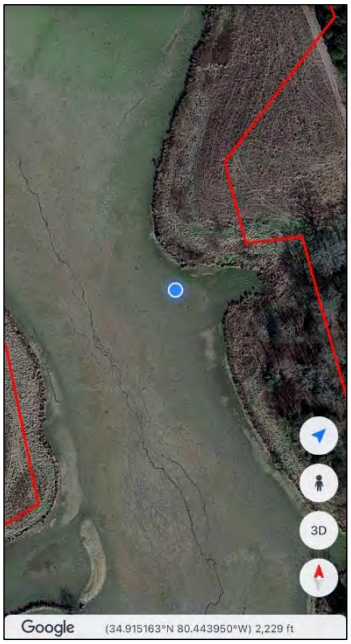
Photo 4: Depth to un-cracked sub-grade/soil



Detail Area 2: AMP Type 1 - No Physical Intervention

Photo 5: Soil cracking – mid-Summer conditions

Photo 6: Vegetation conditions



Detail Area 3: AMP Type 1 - No Physical Intervention

Photo 5: Soil cracking – mid-Summer conditions

Photo 6: Photo 6: Vegetation conditions

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July 24, 2023

Matthew Reid
Project Manager
Division of Mitigation Services
Sent via email to: matthew.reid@deq.nc.gov

Subject: Wits End, MY0/MY1 (2023) IRT Site Visit Notes
DMS Project No. 100164
USACE Action ID No. SAW-2020-00455 & DWR Project No. 20200369

On July 18, 2023, Restoration Systems (RS) held an on-site meeting with regulatory agencies to review and discuss the Wits End Mitigation Site (Site). Below is a list of attendees and site visit notes.

Attendees:

USACE:
- Steven Kichefski
- Erin Davis

NC DWR:
- Maria Polizzi
- Mac Haupt

NC DMS:
- Matthew Reid

Restoration Systems:
- Raymond Holz
- Alex Baldwin
- Josh Merritt

Axiom Environmental:
- Grant Lewis

Site Visit Notes:

General

- A review of the Wits End Mitigation Plan Addendum/Modification was conducted before the walkthrough began. Each item in the addendum was discussed, and the as-built Record Drawings were reviewed to inform the IRT of the requested changes.

- Erin Davis noted the Site's permanent seed mix included Roundhead Lespedeza (*Lespedeza capitata*), or Bush Clover/Round-headed Bush Clover, which is native to the north/southeastern USA (https://plants.ces.ncsu.edu/plants/lespedeza-capitata/).

  RS reviewed the planted seed mixed, and Roundhead Lespedeza was planted as indicated in the MY0 Report. It accounted for 0.50% of the Site's permanent seed mix and should not be misinterpreted with RS seeding the highly invasive Chinese Lespedeza (*Lespedeza cuneata*). During the site visit/walk-through, there was no observance of a monoculture that had formed. Roundhead Lespedeza is well-suited for clay, loam (silt), sand, and shallow rocky soils, which comprise most of the Site. RS will continue to watch for the development of Roundhead Lespedeza monocultures at the site. However, given the low-percentage Roundhead Lespedeza planted and the Site's current herbaceous condition, RS does not expect monocultures to develop.

- The group discussed the as-built stream profile through the former pond, which indicates the channel was constructed lower than designed. Permanent stream cross-sections through this reach show the channel was constructed properly, with an appropriate relationship between the channel's bankfull and the restored floodplain. Survey rod discrepancies are assumed to be the cause, as no other profile issues were observed in the as-built drawings. RS will continue to monitor this reach of Waxhaw Branch for any downcutting or subsidence of the channel.

- Eastern Cottonwood – The IRT verbally agreed that it was okay to count Eastern Cottonwood on-site as a volunteer species towards Site vegetative performance standards during future monitoring years. Moving forward, Eastern Cottonwood will be recorded as an "Approved Post Mit Plan" species and capped at 10% for any one fix or random vegetation monitoring plot. RS will need to keep an eye on Eastern Cottonwood monoculture development, as areas of dense recruits were observed during the visit, particularly around the confluence of UT3 and UT3A.

- RS must watch for monoculture development of Eastern Cottonwood, Red Maple, Sweet Gum, Green Ash, and pine throughout the Site. If by MY3 (2025) development of monocultures exists that our out-competing planted tree species, RS may have to thin/remove the species referenced above.

- Missing flow gauges – In discussions with the Axiom Environmental monitoring crew, flow gauges were present at the Site in early July. The group observed missing flow gauges along UT3 and UT4 during the visit. These gauges are believed to have been washed away during heavy rains/flows. New gauges have been ordered and will be installed as soon as possible.

- The IRT requested winter-time photos of the Site moving forward.

- The IRT indicated they would like to visit the site before the MY3 (2025) credit release meeting, which would be between January and March of 2026.

- In the near future, RS will submit an Adaptive Management Plan to the IRT to address pond bed cracking/subsurface flow within the wetland areas along the right floodplain of Waxhaw Branch within the former pond.

Waxhaw Branch/Old Pond Bed

- The IRT requested RS map and plot pond bed cracking and bare areas on the CCPV moving forward.

- Waxhaw Branch – RS discussed the construction process of Waxhaw Branch through the old pond bed. The IRT requested that RS closely watch wetland development where pond-bed soils were removed and replaced during construction, as wetlands may not develop within the +/- 15-foot corridor along Waxhaw Branch. The subject area is proposed for wetland credit but may need to be modified/removed depending on wetland development.

- The IRT was pleased to see the general coverage of wetland monitoring gauges throughout the Site. However, it was noted that as wetland development continues, gauge placement may need to be altered to monitor the Site's wetlands appropriately, as wetlands are likely to contract/expand from those proposed in the Mitigation Plan.

UT2

- The IRT walked the lower portion of UT2 from its confluence with Waxhaw Branch in the old pond bed to BMP/wetland draw located off the right bank of UT2 above the constructed ford crossing.
    - In general, significantly less pond bed cracking/soil structure issues were observed along U2 in the old pond bed.
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    - The BMP was holding water, and RS discussed that no rock was used at the outfall of the BMP, and instead, woody debris and live stakes were used to stabilize the outfall. Woody debris was present, and live stakes were established.

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Wits End Mitigation Plan – Project Success Criteria

Streams
• All streams must maintain an Ordinary High-Water Mark (OHWM), per RGL 05-05. • Continuous surface flow in each intermittent tributary should occur each year for at least 30 consecutive days. • Bank height ratio (BHR) cannot exceed 1.2 at any measured cross-section over the monitoring period. • BHR at any measure riffle cross-section should not change by more than 10% from baseline condition during any single monitoring year. • 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 & Soils
• During average climatic conditions, saturation or inundation within the upper 12 inches of the soil surface for 8 percent of the growing season*. • Soil profile descriptions must meet one of the hydric soil indicators identified in the Field Indicators of Hydric Soils in the United States, Version 8.2 (USDA 2018) in monitoring years 4 and 7.
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 at year 7. • 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. • Any single species can only account for up to 50% of the required number of stems within any vegetation plot.

* The growing season is defined as March 1 to November 14, with the March 1 start date to be confirmed by documentation of soil temperature greater than 41°F at 12 inches below the surface and bud burst of two or more different non-evergreen vascular plant species (Section 8.1, Mitigation Plan).

Wits End Mitigation Plan – 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 28 cross-sections on restored channels	Graphic and tabular data.
Channel Stability	Visual Assessments	Yearly	All restored stream channels	Areas of concern depicted on the 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 the monitoring period	5 surface water gauges on UT 2, 3A, 3, 4, and 5	Surface water data for each monitoring period
Bankfull Events	Continuous monitoring surface water gauges and/or trail camera	Continuous recording through the monitoring period	3 crest gauges (pressure transducers on Waxhaw Br up-and downstream, and UT 3	Surface water data for each monitoring period
	Visual/Physical Evidence	Continuous through the monitoring period	Visual monitoring and photographic evidence as needed	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)	Pre-construction, Years 3, 5, and 7 during the "index period" referenced in *Small Streams Biocriteria Development* (NCDWQ 2009)	2 stations (on Waxhaw Br upstream and UT 3 downstream); however, the exact locations will be determined at the time pre-construction benthics are collected	Results will be presented on a site-by-site basis. They will include a list of taxa collected, an enumeration of *Ephemeroptera, Plecoptera, Tricopetera* taxa, and Biotic Index values. *
Wetland Parameters				
Parameter	**Method**	**Schedule/Frequency**	**Number/Extent**	**Data Collected/Reported**
Wetland Restoration	Groundwater gauges	Years 1, 2, 3, 4, 5, 6, and 7 throughout the year, with the modified growing season** as defined in the approved Site mitigation plan	27 gauges spread throughout restored wetlands	Soil temperature and bud burst of two woody species at the beginning of each monitoring period to verify the start of the modified growing season, groundwater and rain data for each monitoring period
	Soil profile descriptions	As-built and Years 3, 5, and 7	27 soil profile descriptions, one at each groundwater gauge	Soil profile descriptions completed to assess the development of hydric soil morphologic features
Vegetation Parameters				
Parameter	**Method**	**Schedule/Frequency**	**Number/Extent**	**Data Collected/Reported**
Vegetation establishment and vigor	Permanent vegetation plots 0.0247 acres (100 square meters) in size	As-built, Years 1, 2, 3, 5, and 7	37 plots spread across the Site	Species, height, planted vs. volunteer, stems/acre
	Annual random vegetation plots, 0.0247 acres (100 square meters) in size	As-built, Years 1, 2, 3, 5, and 7	12 plots randomly selected each year	Species and height

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

** The growing season is defined as March 1 to November 14, with the March 1 start date to be confirmed by documentation of soil temperature greater than 41°F at 12 inches below the surface and bud burst of two or more different non-evergreen vascular plant species (Section 8.1, Mitigation Plan

Appendix G: Project Notes

- DMS Boundary Inspection Report – MY0 with Response to Comments (June 9, 2023)
- IRT MY0/MY1 Site Visit Notes (July 24, 2023)

ROY COOPER
Governor
ELIZABETH S. BISER
Secretary
MARC RECKTENWALD
Director

NORTH CAROLINA
Environmental Quality

June 9, 2023

Matthew Reid
Project Manager
NCDEQ - Division of Mitigation Services
Asheville Regional Office
2090 U.S. 70 Highway
Swannanoa, NC 28778-8211

Subject: Boundary Inspection Report – MY0
Wits End, Union County, NC; DMS ID No. 100164

Matthew,

The MY0 boundary inspection was conducted by DMS on June 7, 2023. The inspection was conducted in accordance with the DMS Property Checklist which included an office review and a site visit to document site conditions. The entire easement boundary was inspected during the site visit to validate easement integrity and identify any potential issues on the site. This report summarizes the inspection results.

Office Review:

- Inconsistencies between features shown on the plat and the as-built required field verification to determine the status of mapped trails, ditches, power lines, internal fencing, ponds and infrastructure. Many of these items needed to be labeled as "to be removed", "removed" or similar to provide clarity during document review.

Field Inspection:

- Row crop encroachment into the easement was identified along six field boundaries.
- Several monument caps were missing/loose and caps #53 and 85 were not stamped. The caps on corners 20 & 31 could not be correctly attached due to a size mismatch with the expanded rebar.
- Several corner monuments were too high above ground surface along active crop field boundaries creating the risk for agricultural equipment damage to the monuments.
- Multiple corners were missing posts and/or signs.
- Easement signs in wooded areas were not co-located with the corner monuments and were positioned too far from the corners.
- Incorrect fasteners/methods were used to attach signs to trees. Nails were driven nearly flush to the trees at multiple locations which doesn't permit room for tree growth.
- GPS mapped placemarks 5, 8, 9 & 34 did not align with the digital boundary shape.

Action Items

- Secure the easement boundary against encroachment. Install any supplemental markings necessary and initiate communications with the landowner to prevent ongoing encroachment.
- Correct all marking/monumentation issues including replacement/installation of missing posts, caps and signs.
- Upgrade any fasteners that are not appropriately installed and consider blazing trees.
- Inspect the entire easement boundary and markings during the boundary repair effort, identify any deficiencies not listed in this report and make all necessary corrections.
- Check the boundary alignment at noted placemarks for accuracy. If mapping issues are verified the easement boundary documents will need to be updated.

Let me know if you have any questions or need additional information.

Sincerely,
Kelly Phillips

Property Specialist
NCDEQ-DMS
610 East Center Avenue, Suite 301
Mooresville, NC 28115
Cell: (919) 723-7565

cc: R:\EEP PROJECT LIBRARY FILES\PROJECT DELIVERABLES(REPORTS)\FD PROJECTS\Wit's End (#100164)\4_T2_Cons_Ease\DMS Easement Inspections\MY0

Restoration Systems, LLC
1101 Haynes St. Suite 211
Raleigh, North Carolina
Ph: (919) 755-9490
Fx: (919) 755-9492

Response to DMS As-Built Boundary Inspection Comments

Wits End, Project ID #100164, DMS Contract #7968
USACE Action ID No. SAW-2020-00455
DWR Project No. 2020-0369
Yadkin River Basin 03040105, Union County
DMS Reviewers: Kelly Phillips

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

Boundary Inspection Action Items:

1. Secure the easement boundary against encroachment. Install any supplemental markings necessary and initiate communications with the landowner to prevent ongoing encroachment.
   RS has engaged with the farmer and reiterated the location of the easement and that no encroachment of any kind is permissible. RS has also implemented additional measures to identify the easement boundary including supplemental posts with signage and horse tape.

2. Correct all marking/monumentation issues including replacement/installation of missing posts, caps and signs.
   RS had the surveyor replace the missing and unmarked caps. RS has replaced/installed missing posts and signs that were noted in the google earth file that accompanied the boundary inspection report.

3. Upgrade any fasteners that are not appropriately installed and consider blazing trees.
   Signage attached to trees has been upgraded to include additional fasteners, and trees have been blazed.

4. Inspect the entire easement boundary and markings during the boundary repair effort, identify any deficiencies not listed in this report and make all necessary corrections.
   The entire boundary was inspected during the above-mentioned work and no other deficiencies were identified.

5. Check the boundary alignment at noted placemarks for accuracy. If mapping issues are verified the easement boundary documents will need to be updated.
   The boundary alignment was checked at noted placemarks for accuracy and no mapping issues were observed. The encroachment areas make it appear the boundary alignment is incorrect, but upon checking the survey PLAT and having the surveyors locate the missing markers the boundary alignment has been verified.

Restoration Systems, LLC
1101 Haynes St. Suite 211
Raleigh, North Carolina
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July 24, 2023

Matthew Reid
Project Manager
Division of Mitigation Services
Sent via email to: matthew.reid@deq.nc.gov

Subject: Wits End, MY0/MY1 (2023) IRT Site Visit Notes
DMS Project No. 100164
USACE Action ID No. SAW-2020-00455 & DWR Project No. 20200369

On July 18, 2023, Restoration Systems (RS) held an on-site meeting with regulatory agencies to review and discuss the Wits End Mitigation Site (Site). Below is a list of attendees and site visit notes.

Attendees:

USACE:
- Steven Kichefski
- Erin Davis

NC DWR:
- Maria Polizzi
- Mac Haupt

NC DMS:
- Matthew Reid

Restoration Systems:
- Raymond Holz
- Alex Baldwin
- Josh Merritt

Axiom Environmental:
- Grant Lewis

Site Visit Notes:

General

- A review of the Wits End Mitigation Plan Addendum/Modification was conducted before the walkthrough began. Each item in the addendum was discussed, and the as-built Record Drawings were reviewed to inform the IRT of the requested changes.

- Erin Davis noted the Site's permanent seed mix included Roundhead Lespedeza (*Lespedeza capitata*), or Bush Clover/Round-headed Bush Clover, which is native to the north/southeastern USA (https://plants.ces.ncsu.edu/plants/lespedeza-capitata/).

  RS reviewed the planted seed mixed, and Roundhead Lespedeza was planted as indicated in the MY0 Report. It accounted for 0.50% of the Site's permanent seed mix and should not be misinterpreted with RS seeding the highly invasive Chinese Lespedeza (*Lespedeza cuneata*). During the site visit/walk-through, there was no observance of a monoculture that had formed. Roundhead Lespedeza is well-suited for clay, loam (silt), sand, and shallow rocky soils, which comprise most of the Site. RS will continue to watch for the development of Roundhead Lespedeza monocultures at the site. However, given the low-percentage Roundhead Lespedeza planted and the Site's current herbaceous condition, RS does not expect monocultures to develop.

- The group discussed the as-built stream profile through the former pond, which indicates the channel was constructed lower than designed. Permanent stream cross-sections through this reach show the channel was constructed properly, with an appropriate relationship between the channel's bankfull and the restored floodplain. Survey rod discrepancies are assumed to be the cause, as no other profile issues were observed in the as-built drawings. RS will continue to monitor this reach of Waxhaw Branch for any downcutting or subsidence of the channel.

- Eastern Cottonwood – The IRT verbally agreed that it was okay to count Eastern Cottonwood on-site as a volunteer species towards Site vegetative performance standards during future monitoring years. Moving forward, Eastern Cottonwood will be recorded as an "Approved Post Mit Plan" species and capped at 10% for any one fix or random vegetation monitoring plot. RS will need to keep an eye on Eastern Cottonwood monoculture development, as areas of dense recruits were observed during the visit, particularly around the confluence of UT3 and UT3A.

- RS must watch for monoculture development of Eastern Cottonwood, Red Maple, Sweet Gum, Green Ash, and pine throughout the Site. If by MY3 (2025) development of monocultures exists that our out-competing planted tree species, RS may have to thin/remove the species referenced above.

- Missing flow gauges – In discussions with the Axiom Environmental monitoring crew, flow gauges were present at the Site in early July. The group observed missing flow gauges along UT3 and UT4 during the visit. These gauges are believed to have been washed away during heavy rains/flows. New gauges have been ordered and will be installed as soon as possible.

- The IRT requested winter-time photos of the Site moving forward.

- The IRT indicated they would like to visit the site before the MY3 (2025) credit release meeting, which would be between January and March of 2026.

- In the near future, RS will submit an Adaptive Management Plan to the IRT to address pond bed cracking/subsurface flow within the wetland areas along the right floodplain of Waxhaw Branch within the former pond.

Waxhaw Branch/Old Pond Bed

- The IRT requested RS map and plot pond bed cracking and bare areas on the CCPV moving forward.

- Waxhaw Branch – RS discussed the construction process of Waxhaw Branch through the old pond bed. The IRT requested that RS closely watch wetland development where pond-bed soils were removed and replaced during construction, as wetlands may not develop within the +/- 15-foot corridor along Waxhaw Branch. The subject area is proposed for wetland credit but may need to be modified/removed depending on wetland development.

- The IRT was pleased to see the general coverage of wetland monitoring gauges throughout the Site. However, it was noted that as wetland development continues, gauge placement may need to be altered to monitor the Site's wetlands appropriately, as wetlands are likely to contract/expand from those proposed in the Mitigation Plan.

UT2

- The IRT walked the lower portion of UT2 from its confluence with Waxhaw Branch in the old pond bed to BMP/wetland draw located off the right bank of UT2 above the constructed ford crossing.
    - In general, significantly less pond bed cracking/soil structure issues were observed along U2 in the old pond bed.
    - The ford crossing was stable and well-vegetated upstream and downstream.
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