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NORTH CAROLINA  
Environmental Quality

February 14, 2024

Sent via email: mdeangelo@res.us

Matthew Deangelo  
RES

Subject: DMS Comments on the MY3 2023 Draft Report  
Matthews Project ID # 100043, DMS Contract # 7419

Matthew,

DMS received the MY3 2023 draft report on 12/22/23 and a site visit was conducted on 01/30/24. DMS offers the following comments for the report period:

Report & Field Visit

1. In the MY4 draft report, please detail, and/or any correspondence with landowner on a resolution to avoid mowing/ encroachments in the future. We also recommend speaking to adjacent property owner.
2. During the site visit, three newly created beaver dams were observed downstream of the confluence.
3. CCVP – Please add a new layer to depict the areas with encroachment with a different symbology.
4. Privet was sparsely found at the downstream portion of project. Please continue treatment.

Digital Review

- No comments

Please incorporate the revisions and responses to comment letter, one (1) hardcopy, and one (1) pdf copy along with any updated digital files that may be needed based on the comments above. If you have any questions or wish to discuss these comments further, please contact me at any time. I can be reached at (919) 218-0012, or via email at [danielle.mir@deq.nc.gov](mailto:danielle.mir@deq.nc.gov)

Sincerely,

A handwritten signature in blue ink, appearing to read "Danielle Mir".

Danielle Mir  
Eastern Project Manager  
NCDEQ Division of Mitigation Services

cc: Ryan Medic



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February 28, 2024

Danielle Mir  
NC DEQ Division of Mitigation Services  
217 West Jones Street  
Raleigh, NC 27604

RE: Matthew MY3 Comments, Project ID #100043, DMS Contract #0007419

Listed below are comments provided by DMS on February 14, 2024 regarding the Matthew Stream and Wetland Mitigation Project Year 3 Monitoring Report and RES' responses.

**Comments:**

1. In the MY4 draft report, please detail, and/or any correspondence with landowner on a resolution to avoid mowing/ encroachments in the future. We also recommend speaking to adjacent property owner.

Noted. Subsequent communication with the landowner and adjacent property owners will be included in the MY4 draft report.

Also, RES has included another encroachment area polygon that was noted and identified by both RES and DMS during the site visit in February 2024. It is depicted in Figure 2 CCPV, and Sections 1.7.1, 1.7.5, and Table 6 have been revised accordingly, including updated bare area and encroachment area calculations.

2. During the site visit, three newly created beaver dams were observed downstream of the confluence.

The beavers, as well as their dams, will be removed during MY4. Such actions will be reported in the MY4 Monitoring Report.

3. CCVP – Please add a new layer to depict the areas with encroachment with a different symbology.

The CCPV has been revised accordingly to depict areas of encroachment with different symbology.

4. Privet was sparsely found at the downstream portion of project. Please continue treatment.

Treatment for privet will be continued into MY4. Such actions will be reported in the MY4 Monitoring Report.

**Digital Comments:**

- No comments

**Year 3 Final Monitoring Report**

**MATTHEW SITE**

NCDMS Project #100043 (Contract #7419)

USACE Action ID: SAW-2017-00055

DWR Project #2017-0624

Johnston County, North Carolina

Neuse River Basin

HUC 03020201



**Provided by:**



Resource Environmental Solutions, LLC  
*for Environmental Banc & Exchange, LLC*

**Provided for:**

NC Department of Environmental Quality  
Division of Mitigation Services

**February 2024**

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# 1 PROJECT SUMMARY

## 1.1 Project Location and Description

The Matthew Site ("Project") is located within a rural watershed in Johnston County, North Carolina approximately two miles south of Four Oaks. The Project lies within the Neuse River Basin, North Carolina United States Geological Survey (USGS) 8-digit Cataloguing Unit 03020201 and 14-digit hydrologic unit code (HUC) 03020201150020, a Targeted Local Watershed (TLW) and the Division of Water Resources (NCDWR) sub-basin 03-04-04 (Figure 1). The Project restores 3,230 linear feet (LF) and preserves 234 LF of streams as well as restores 12.102 acres and preserves 2.063 acres of wetland that provide water quality benefit for 1,460 acres of drainage area.

The Project area is comprised of a 19.19-acre easement involving two unnamed tributaries within the footprint of a breached pond that drain directly to Juniper Swamp, which eventually drains to Hannah Creek. The Project area also included riparian wetlands that were impounded and filled. The stream and wetland mitigation components are summarized in Table 1. The Project is accessible from state route NC-96. Coordinates for the Project areas are approximately 35.42503, -78.40849 at the NC Department of Transportation (DOT) culvert located just above the Project easement.

## 1.2 Project Goals and Objectives

Through the comprehensive analysis of the Project's maximum functional uplift using the Stream Functions Pyramid Framework and conclusions based on a Site Hydric Soils Detailed Study, specific, attainable goals and objectives were realized by the Project. These goals clearly address the degraded water quality and nutrient input from agricultural practices that were identified as major watershed stressors in the 2010 Neuse RBRP (amended August 2018). The Project addresses outlined RBRP Goal 2 list in the Mitigation Plan.

The Project goals are:

- Re-establish hydrology to a historical stream/wetland complex that has been impacted by agricultural impoundments for over 113 years.
- To transport water in a stable, non-erosive manner and maintain a stable water table in riparian floodplain wetlands that will also contribute to stream baseflow;
- Improve flood flow attenuation on site and downstream by allowing for overbank flows and connection to the floodplain;
- Create diverse bedforms and stable channels that achieve healthy dynamic equilibrium and provide suitable habitat for life
- Improve in-stream habitat;
- Limit sediment and nutrient inputs into the stream system;
- Re-establish, rehabilitate, and preserve wetlands;
- Restore, enhance, and preserve native wetland and riparian vegetation;
- Indirectly support the goals of the 2010 Neuse RBRP (amended August 2018) to improve water quality and to reduce sediment and nutrient loads; and

- To support the life histories of aquatic and riparian plants and animals through stream restoration activities

The Project objectives carried out to address the goals are:

- Designed and reconstructed stream channels sized to convey bankfull flows that maintain a stable dimension, profile, and planform;
- Added in-stream structures and bank stabilization measures to improve bedform diversity and protect restored streams;
- Installed habitat features such as brush toes, constructed riffles, woody materials, and pools of varying depths to restored streams;
- Removed dams, berms, fill material, spoil piles, and debris to restore wetland hydrology and maintain appropriate hydroperiod for Bibb soil series;
- Increased forested riparian buffers to at least 50 feet on both sides of the channel along the Project reaches with a hardwood riparian plant community;
- Installed approximately 937 linear feet of livestock exclusion fencing along the western easement boundary to ensure livestock will not have stream or wetland access;
- Treated exotic invasive species; and
- Established a permanent conservation easement on the Project that perpetually protects streams, wetlands, and their associated buffers.

### **1.3 Project Success Criteria**

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

#### ***1.3.1 Stream Restoration Success Criteria***

Four bankfull flow events must be documented within the seven-year monitoring period. The bankfull events must occur in separate years. Otherwise, the stream monitoring will continue until four bankfull events have been documented in separate years. Stage recorders were installed on RL1-A and RL2 to document bankfull events.

There should be little change in as-built cross sections. If changes do take place, they should be evaluated to determine if they represent a movement toward a less stable condition (for example down-cutting or erosion) or are minor changes that represent an increase in stability (for example settling, vegetative changes, deposition along the banks, or decrease in width/depth ratio). Cross sections shall be classified using the Rosgen stream classification method, and all monitored cross sections should fall within the quantitative parameters defined for channels of the design stream type. Bank height ratio shall not exceed 1.2, and the entrenchment ratio shall be above 2.2 within restored riffle cross sections (for C and E streams).

Digital images are used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of erosion control measures.

Longitudinal images should not indicate the absence of developing bars within the channel or an excessive increase in channel depth. Lateral images should not indicate excessive erosion or continuing degradation of the banks over time. A series of images over time should indicate successional maturation of riparian vegetation.

### *1.3.2 Wetland Hydrology Success Criteria*

The Natural Resources Conservation Service (NRCS) has a current WETs table (1989-2018) for Johnston County upon which to base a normal rainfall amount and average growing season. The closest comparable data station was determined to be the WETS station for Smithfield, NC. The growing season for Johnston County is 242 days long, extending from March 18 to November 15, and is based on a daily minimum temperature greater than 28 degrees Fahrenheit occurring in five of ten years.

Based upon field observation across the site, the NRCS mapping units show a good correlation to actual site conditions in areas of the site. Mitigation guidance for soils in the Coastal Plain suggests a hydroperiod for the Bibb soil of 12-16 percent of the growing season. The hydrology success criterion for the Site is to restore the water table so that it remains continuously within 12 inches of the soil surface for at least 12 percent of the growing season (approximately 29 days) at each groundwater gauge location.

### *1.3.3 Vegetation Success Criteria*

Specific and measurable success criteria for plant density within the riparian buffers on the Project follow IRT Guidance. The interim measures of vegetative success for the Project are the survival of at least 320 three-year old trees per acre at the end of Year 3, 260 trees per acre with an average height of seven feet at the end of Year 5, and the final vegetative success criteria is 210 trees per acre with an average height of 10 feet at the end of Year 7. Volunteer trees that are listed on the approved planting list will be counted, identified to species, and included in the yearly monitoring reports, and may be counted towards the success criteria of total planted stems after presence in the plot for two or more growing seasons. Moreover, any single species can only account for up to 50 percent of the required number of stems within any vegetation plot. Any stems in excess of 50 percent will be shown in the monitoring table but will not be used to demonstrate success.

## **1.4 Project Components**

Prior to restoration, the project streams and wetlands were significantly impacted by a large impoundment constructed over a hundred years ago. Improvements to the Project help meet the river basin needs expressed in the 2010 Neuse River Basin Restoration Priorities (RBRP).

Through stream and wetland restoration and preservation, the Project presents 3,253.400 Warm Stream Mitigation Units (SMU) and 7.207 Wetland Mitigation Units (WMU).



## Matthew Project Components Summary (Mitigation Plan)

Stream Mitigation			
Mitigation Approach	Linear Feet	Ratio	Warm SMU
Restoration	3,230	1:1	3,230.000
Preservation	234	10:1	23.400
Preservation (No Credit)	108	N/A	0.000
<b>Total</b>	<b>3,572</b>		<b>3,253.400</b>
Wetland Mitigation			
Mitigation Approach	Area (acres)	Ratio	WMU
Rehabilitation (Pond Conversion)	10.202	2:1	5.101
Re-establishment (Fill Removal)	1.900	1:1	1.900
Preservation	2.063	10:1	0.206
<b>Total</b>	<b>14.165</b>		<b>7.207</b>

## 1.5 Design and Approach

### 1.5.1 Streams

The Project includes Restoration and Preservation. Stream restoration incorporates the design of a single-thread meandering channel, with parameters based on data taken from reference site, published empirical relationships, regional curves developed from existing project streams, and NC Regional Curves. Analytical design techniques were also a crucial element of the project and were used to determine the design discharge and to verify the design as a whole.

The Project has been broken into the following design reaches:

**Reach RL1-A** – Priority I Restoration was performed along this reach for 2,438 linear feet both upstream and downstream of the dam. The upstream end is fed from three perched 54-inch crossline culverts under NC HWY 96, and construction activities included installing a plunge pool to stabilize the existing outfall. The conservation easement begins approximately 125 feet downstream of the culverts. This allows for DOT and public utilities to maintain the crossing and a buried water line, respectively. Additionally, the easement is setback from the road such that the adjacent landowner to the north may access and maintain the existing barn located approximately 25 to 40 feet from the channel.

Restoration activities included constructing a channel sized to provide frequent out of bank flows to allow improved floodplain and wetland connectivity. In-stream structures such as log vanes, log sills, brush toes and constructed riffles were installed for vertical and lateral stability and to improve bedform diversity. Additional work included removing the dam, existing pipes, a bridge, and riprap piles.

The restoration activities on the lower extent of Reach RL1-A impacted existing wetlands WE and WD before transitioning to reach RL1-B as preservation. However, the stream restoration results in net positive wetland area as surrounding riparian areas were restored as wetlands by raising

the channel bed elevation, thus raising groundwater elevation, and allowing for more frequent overbank events. Also, the surrounding wetland re-establishment involved with this Project, including removal of the upstream dam, spoil piles, and debris, as well as replanting a bottomland hardwood community, further improves existing wetlands.

**Reach RL1-B** – Preservation was performed for this reach downstream of RL1-A. This section begins where the channel has stabilized from the hurricane breach and continues flowing to the southwest beyond the Project. Preservation activities consisted of supplemental planting throughout the riparian buffer.

**Reach RL2** – Priority I Restoration was performed for this reach. Flowing out of a pond just north of the Project, the channel was constructed beginning at the existing pond outfall (24" CMP) and confluences with RL1-A near stationing 16+50. Restoration activities involved constructing a meandering channel sized to improve floodplain connectivity. In-stream structures such as log vanes, log sills, brush toes and constructed riffles were installed for stability and to improve bedform diversity.

### *1.5.2 Wetlands*

The Matthew Project offers a total ecosystem restoration opportunity. As such, the wetland restoration is closely tied to the stream restoration and pond dam removal. The Project provides 7.207 WMUs through a combination of wetland re-establishment, rehabilitation, and preservation.

Wetland rehabilitation via "pond conversion" was performed within the pond footprint, including wetland, WA, with a credit ratio of 2:1. The construction of the farm pond had altered surface drainage and even since the breach, was partially impounded and flow is constricted. The primary restoration activity was the removal of the pond dam and its associated large berm along the eastern edge. Additionally, stream restoration within this pond footprint re-established stable stream channels that maintain a constant surface-groundwater connection that provides retention and storage within the floodplain, and thus healthy wetland hydroperiods.

Wetland re-establishment via "fill removal," with a credit ratio of 1:1, was performed in the area below the dam that consists of hydric soils surrounding Wetlands WC, WD, and WE that lacked sufficient wetland hydrology. This re-established wetland area is referred to as "WF" (Wetland F). This area lacked hydrology due to the construction of the farm pond that had altered surface drainage and had created constricted flow, inhibiting normal flow volumes parallel to the stream both at the surface and within the subsurface. In addition, fill material from the construction of the pond had filled these pre-existing wetlands and buried hydric soils. Furthermore, a ditch from the old pond outlet along the western edge of the floodplain drained upland overland flow and seepage away from the natural floodplain. This wetland area was re-established by removing the dam, removing fill material below the dam, and aligning a stable stream channel via stream restoration efforts. Additional activities included the removal of dam material debris that was littered throughout the floodplain during the breach of Hurricane Matthew, followed by surface roughening and creation of shallow depressions throughout the area in order to mimic natural conditions and provide an appropriate landscape for diverse habitat.

Preservation with a 10:1 credit ratio was used for jurisdictional wetlands WB, WC, WD, and WE. Some of these areas that were impacted by stream restoration efforts were planted with supplemental, native hardwood trees.

The wetland restoration areas directly connect to the existing high-quality bottomland hardwood wetland preservation area. The resulting wetland functions as a large, contiguous bottomland hardwood wetland community.

## **1.6 Construction and As-Built Conditions**

Site construction was completed on January 4, 2021, and planting was completed on March 2, 2021. The Matthew Site was overall built to design plans and guidelines. Fencing was installed as proposed along the western edge of the easement. A rock swale was added to the left bank of the downstream end of RL1 to address runoff from the wetland and old channel area. There are no constructed depressions greater than 12 inches deep; however, there are some segments of abandoned channel that have settled and are more than 12 inches deep. The as-built wetlands were 0.03 acres smaller than design due to minor survey differences of the top of bank during as-built. The record drawings were included in the As-built Report.

A few planting plan changes occurred based on bare root availability at time of planting. Changes included replacing swamp tupelo (*Nyssa biflora*), Atlantic white cedar (*Chamaecyparis thyoides*), overcup oak (*Quercus lyrata*), and water tupelo (*Nyssa aquatica*) with water oak (*Quercus nigra*) and green ash (*Fraxinus pennsylvanica*). Minor monitoring device location changes were made during as-built installation, however, the quantities remained as proposed in the Mitigation Plan.

## **1.7 Year 3 Monitoring Performance (MY3)**

The Matthew Year 3 Monitoring activities were performed in May and October 2023. All MY3 data is presented below and in the appendices. The Project is on track to meeting vegetation and stream interim success criteria. The majority of wetlands are also on track to meeting success criteria; however, there are some wetland areas that are underperforming and will require further investigation.

### **1.7.1 Vegetation**

Monitoring of the ten permanent vegetation plots and four random vegetation plots was completed on October 11<sup>th</sup>, 2023. Vegetation data are in **Appendix C**, associated photos are in **Appendix B**, and plot locations are in **Appendix B**. MY3 monitoring data indicates that all plots are exceeding the interim success criteria of 320 planted stems per acre. Planted stem densities ranged from 607 to 1,578 planted stems per acre with a mean of 942 planted stems per acre across all plots. A total of 12 species were documented within the plots. Desirable volunteer species, including swamp tupelo (*Nyssa biflora*), hazel alder (*Alnus serrulata*), and tulip poplar (*Liriodendron tulipifera*), were documented in random vegetation plots and counted toward success because they are well-established and mature. Whereas other volunteer species such as eastern Baccharis (*Baccharis*), loblolly pine (*pinus taeda*), winged sumac (*Rhus copallinum*), and black

willow (*Salix nigra*) were documented but not counted toward success. The average stem height across all vegetation plots was 7.6 feet.

Visual assessment of vegetation outside of the monitoring plots indicates that the herbaceous vegetation is becoming well established throughout the project. Chinese privet remains under control with very little identified in MY3. However, loblolly pine is becoming more prominent in a localized area just downstream of the old pond dam and accounts for approximately 1.6 acres (see **Appendix B**). Currently, the pines are not out-competing planted, desirable trees, as the planted trees are still thriving; however, RES plans to proactively treat and/or thin the pines in 2024. Additionally, RES identified encroachments toward the top of the Project along both north and south boundaries. Adjacent landowners had mowed within the easement boundary in these instances, resulting in bare areas (maintained lawns). RES has already re-marked the easement boundaries and informed the landowners. The combined acreage of the areas equals approximately 0.42 acres. The affected areas will be replanted with containerized trees in before Spring 2024.

### *1.7.2 Stream Geomorphology*

Geomorphology data collection for MY3 was collected May 18<sup>th</sup> 2023. Summary tables and cross section plots are in **Appendix D**. Overall the current years cross sections closely match the baseline cross sections. The current conditions show that shear stress and velocities are equilibrated for all restoration reaches. All reaches were designed as gravel bed channels and remain classified as gravel bed channels post-construction.

Visual assessment of the stream channel was performed to document signs of instability, such as eroding banks, structural instability, or excessive sedimentation. The channel is transporting sediment as designed and will continue to be monitored for aggradation and degradation. During the summer of 2023, aquatic vegetation, especially water primrose (*Ludwigia peploides*), was noted throughout much of the stream channels. However, by October 2023, tree growth over the monitoring year was exceptional and much of the channels are now becoming shaded, and the aquatic vegetation was notably reduced. RES is confident that this trend will continue, and that aquatic vegetation will not be a concern in future monitoring years.

### *1.7.3 Stream Hydrology*

Two stage recorders record bankfull events on reaches RL1-A and RL2. The stage recorder on RL1-A recorded seven bankfull events in MY3 with the highest reading being 0.7 feet above the top of bank. The stage recorder on RL2 recorded 25 bankfull events in MY3 with the highest reading being 1.89 feet above the top of bank. RES presumes that the offsite pond that feeds RL2 likely contributes to flashier flows and the resulting high number of bankfull events. However, plentiful flood events are likely beneficial, as they can potentially support hydrology to surrounding wetlands. Stage recorder locations can be found on **Figure 2**, photos are in **Appendix B**, and hydrology data are in **Appendix E**.

#### 1.7.4 Wetland Hydrology

There are 10 groundwater wells with automatic recording pressure transducers monitoring groundwater hydrology. Six wells are located within wetland rehabilitation areas, two are located within wetland re-establishment areas, and two are located within preservation areas serving as references. These are recording water table depths at a frequency of twice per day. Data recorded in MY3 demonstrates consecutive hydroperiods ranging from zero to 38 percent across all wells onsite. GW2, GW3, GW4, and GW7 fell short of the 12 percent success criteria with hydroperiods ranging from zero to two percent. These four groundwater wells have failed for the third consecutive year which may indicate a hydrology issue to areas surrounding these groundwater wells. These lower hydroperiods may be due to multiple factors:

- The significant drought of 2022 (occurring in MY2) produced a significant hydrology deficit at the Project. Then, in 2023 (MY3), drought conditions alleviated somewhat but there were still abnormally dry periods, including during the antecedent, dormant season. Ultimately, this means that hydrology may not have been able to recover back to normal. The majority of both the antecedent dormant season and the growing seasons for Johnston County were lower than average, falling within an abnormally dry period for the majority of the periods. More specifically, Johnston County experienced the following drought condition during the applicable monitoring period according to U.S. Drought Monitor:
  - o D0 – Abnormally Dry for 83% of growing season and 67% of antecedent dormant season

In addition, see **Appendix E** for all rain data.

- GW2, GW3, and GW4 are clustered in an area that may be located on a higher topographic feature. The entire wetland rehabilitation area is within the old pond bed, but the bed may have undulated in depth, with locally higher features (now ground surface).
  - o GW3 is located within inches of a fast-growing, now large, volunteer black willow tree. RES questions if the tree could have an affect on the integrity of the groundwater well or the local hydrology around the well.
- GW7 is located on the old dam footprint. Because there are obvious wetlands above and below the dam footprint, RES speculates that the intense soil compaction here is an adverse factor.

However, considering these factors, RES identified prevalent hydrophytic wetland vegetation around each of the groundwater wells, including rushes (*Juncus* spp.), sedges (*Carex* spp.) and tearthumb (*Persicaria sagittata*). Evidence of this vegetation can be seen in photos in **Appendix B**. With the past two years of below normal precipitation, it is difficult to draw conclusions for these wetland features, but RES fully recognizes there could be potential issues. RES has delineated a general area to investigate further and plans to install additional groundwater wells in and around the “investigation area” before the growing season of MY4. **Figure 3 in Appendix E** depicts the investigation area and proposed additional groundwater well locations. RES will include the data collected from the additional wells in MY4 and for the remainder of the monitoring period. All current wetland hydrology data can be found in **Appendix E**.

### 1.7.5 Encroachments

As mentioned earlier, RES identified encroachments toward the top of the Project along both north and south boundaries. Adjacent landowners had mowed within the easement boundary in both instances, resulting in bare areas (maintained lawns). In the instance along the southern boundary, an easement corner marker was relocated by the landowner as they wanted to maintain their lawn up to the edge of the old pond embankment. RES has since had a surveyor locate and re-mark the corner. In addition, RES has already re-marked the easement boundaries instances and informed the landowners. The combined acreage of the areas equals approximately 0.42 acres (**Figure 2, Appendix B**). The affected areas will be replanted with containerized trees before Spring 2024.

## 2 METHODS

Stream monitoring was conducted using a Topcon GTS-312 Total Station. Three-dimensional coordinates associated with cross-section data were collected in the field (NAD83 State Plane feet FIPS 3200). Morphological data were collected at 16 cross-sections. Survey data were imported into CAD, ArcGIS®, and Microsoft Excel® for data processing and analysis. The stage recorders include an automatic pressure transducer placed in PVC casing in a pool. The elevation of the bed and top of bank at each stage recorder are used to detect bankfull events.

Vegetation success is being monitored at 10 permanent vegetation plots and four random vegetation plots. Vegetation plot monitoring follows the CVS-EEP Level 2 Protocol for Recording Vegetation, version 4.2 (Lee et al. 2008) and includes analysis of species composition and density of planted species. Data are processed using the CVS data entry tool. In the field, the four corners of each plot were permanently marked with PVC at the origin and metal conduit at the other corners. Photos of each plot are taken from the origin each monitoring year. The random plots are collected in locations where there are no permanent vegetation plots. Random plots are typically collected in the form of 100 square meter belt transects with variable dimensions. Tree species and height are recorded for each planted stem and the transects are mapped, and new locations will be monitored in subsequent years.

Wetland hydrology is monitored to document success in wetland restoration areas where hydrology was affected. This is accomplished with eight automatic pressure transducer gauges (located in groundwater wells) that record daily groundwater levels. Eight have been installed within the wetland restoration crediting area and two within preservation areas to serve as reference wetlands. One automatic pressure transducer is installed above ground for use as a barometric reference. Gauges are downloaded quarterly and wetland hydroperiods are calculated during the growing season. Gauge installation followed current regulatory guidance. Visual observations of primary and secondary wetland hydrology indicators are also recorded during quarterly site visits. As mentioned earlier, soil was characterized at each groundwater well. In December 2021, soil borings were taken within three feet of each existing groundwater well and characterized in accordance with the Soil Characterization Data Forms provided in the USACE's *Technical Standard for Water-Table Monitoring of Potential Wetland Sites*, and includes parameters

of soil horizon depths, texture, colors, redoximorphic features, induration, and roots, as well as a photo of each soil profile (**Year 1 Monitoring Report, Appendix E**).

### 3 REFERENCES

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# **Appendix A**

## Background Tables

**Table 1. Matthew (100043) - Mitigation Assets and Components**

Project Segment	Existing Footage or Acreage	Mitigation Plan Footage or Acreage	Mitigation Category	Restoration Level	Priority Level	Mitigation Ratio (X:1)	Mitigation Plan Credits		As-Built Footage or Acreage	Comments
RL1-A	1767	2438	Warm	R	1	1.00000	2438.000		2438	Channel restoration, riparian planting, livestock exclusion
RL1-B	234	234	Warm	P	NA	10.00000	23.400		234	Supplemental planting, livestock exclusion
RL1-B	108	108	Warm	P	NA	NA	0.000		108	Channel within easement; however, no credit
RL2	949	792	Warm	R	1	1.00000	792.000		792	Channel restoration, riparian planting, livestock exclusion
WA	10.199	10.202	RR	RH		2.00000	5.101		10.204	Dam and berm removal, stream restoration, native planting
WB	0.429	0.429	RR	P		10.00000	0.043		0.429	Permanent conservation easement
WC	0.102	0.102	RR	P		10.00000	0.010		0.102	Permanent conservation easement
WD	0.808	0.807	RR	P		10.00000	0.081		0.786	Permanent conservation easement
WE	0.758	0.725	RR	P		10.00000	0.073		0.705	Permanent conservation easement
WF	0.000	1.900	RR	RE		1.00000	1.900		1.903	Dam, fill, spoil, and debris removal; stream restoration, native planting

**Project Credits**

Restoration Level	Stream			Riparian Wetland	Non-Rip Wetland	Coastal Marsh
	Warm	Cool	Cold			
Restoration	<b>3230.000</b>			<b>7.001</b>		
Re-establishment						
Rehabilitation						
Enhancement						
Enhancement I						
Enhancement II						
Creation						
Preservation	<b>23.400</b>			<b>0.206</b>		
<b>Total</b>	<b>3253.400</b>			<b>7.207</b>		

**Table 2. Project Activity and Reporting History  
Matthew Mitigation Site**

**Elapsed Time Since grading complete: 35 months**  
**Elapsed Time Since planting complete: 33 months**  
**Number of reporting Years<sup>1</sup>: 3**

<b>Activity or Deliverable</b>	<b>Data Collection Complete</b>	<b>Completion or Delivery</b>
Restoration Plan	NA	Sep-19
Final Design – Construction Plans	NA	Aug-20
Stream Construction	NA	04-Jan-21
Site Planting	NA	02-Mar-21
As-built (Year 0 Monitoring – baseline)	Mar-21	Jun-21
Year 1 Monitoring	Dec-21	Dec-21
Year 2 Monitoring	XS Survey: Jun-22 Veg. Plots: Oct-22	Dec-22
Encroachment Areas Identified and Re-marked	May-November-23	-
Year 3 Monitoring	XS Survey: May-23 Veg. Plots: Oct-23	Dec-23
Year 4 Monitoring		
Year 5 Monitoring		
Year 6 Monitoring		
Year 7 Monitoring		

<sup>1</sup> = The number of reports or data points produced excluding the baseline

**Table 3. Project Contacts Table  
Matthew Mitigation Site**

<b>Designer</b>	RES / 3600 Glenwood Ave., Suite 100, Raleigh, NC 27612
Primary project design POC	Frasier Mullen, PE
<b>Construction Contractor</b>	KBS Earthwork Inc. / 5616 Coble Church Rd., Julian, NC 27283
Construction contractor POC	Kory Strader
<b>Survey Contractor</b>	Matrix East, PLLC / 906 N. Queen St., Suite A, Kinston, NC 28501
Survey contractor POC	Chris Paderick, PLS
<b>Planting Contractor</b>	Shenandoah Habitats
Planting contractor POC	David Coleman
<b>Monitoring Performers</b>	RES / 3600 Glenwood Ave, Suite 100, Raleigh, NC 27612
Monitoring POC	Matt DeAngelo (757) 202-4471

**Table 4. Project Background Information**

Project Name	Matthew				
County	Johnston				
Project Area (acres)	19.19				
Project Coordinates (latitude and longitude)	Latitude: 35.42503 Longitude: -78.40849				
Planted Acreage (Acres of Woody Stems Planted)	16.4				

**Project Watershed Summary Information**

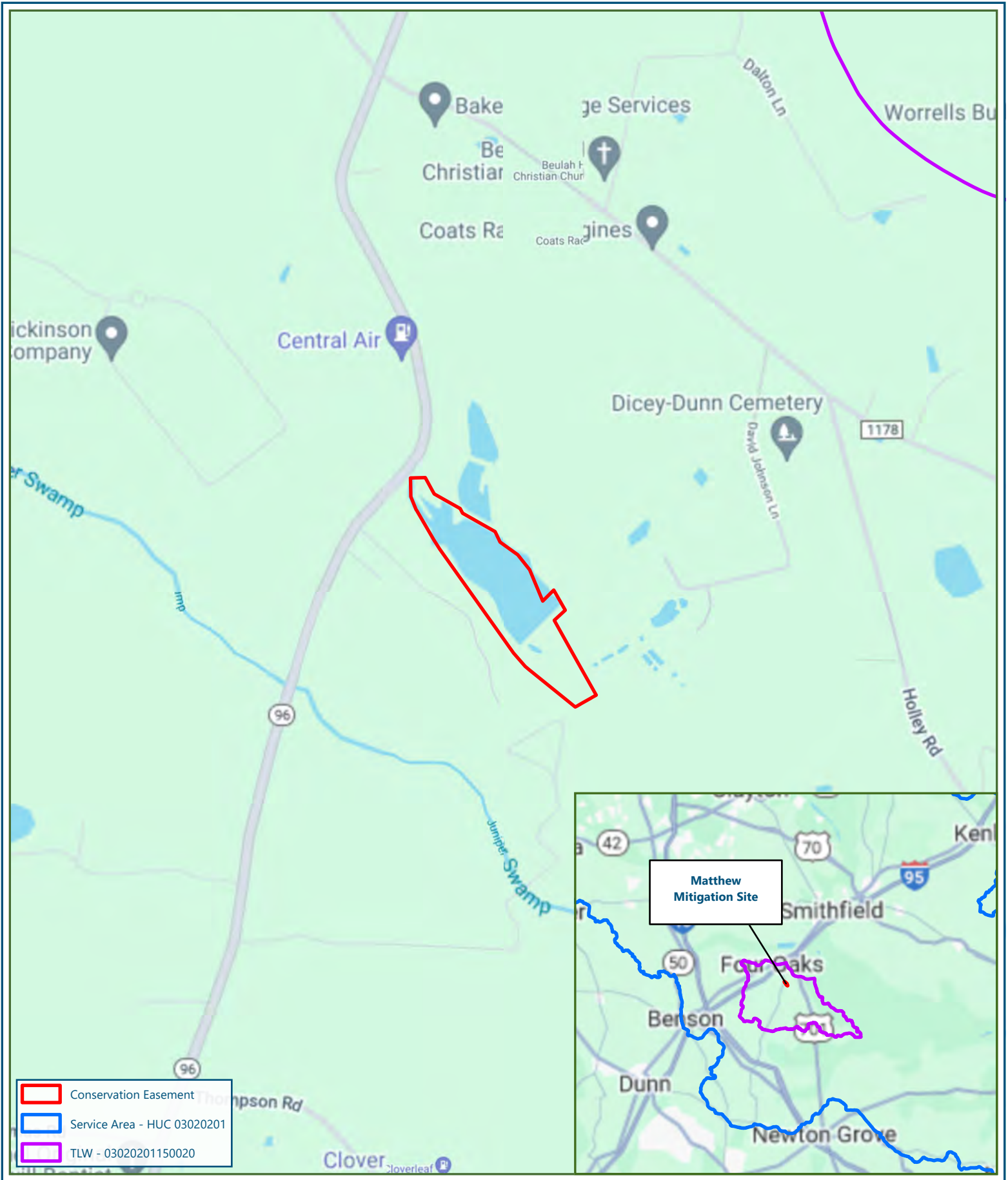
Level IV Ecoregion	65m - Rolling Coastal Plain				
River Basin	Neuse				
USGS Hydrologic Unit 8-digit	03020201	USGS Hydrologic Unit 14-digit	03020201150020		
DWR Sub-basin	03-04-04				
Project Drainage Area (Acres and Square Miles)	1,460 ac (2.28 sqmi)				
Project Drainage Area Percentage of Impervious Area	7%				

**Reach Summary Information**

Parameters	RL1-A	RL1-B	RL2		
Length of reach (linear feet)	1767	342	949		
Valley confinement (Confined, moderately confined, unconfined)	Unconfined	Unconfined	Unconfined		
Drainage area (Acres and Square Miles)	853 (1.33)	1460 (2.28)	490 (0.77)		
Perennial, Intermittent, Ephemeral	Perennial	Perennial	Perennial		
NCDWR Water Quality Classification	C; NSW	C; NSW	C; NSW		
Stream Classification (existing)	E5	E4	NA		
Stream Classification (proposed)	E4/E5	E4/E5	E4/E5		
Evolutionary trend (Simon)	III	IV/V	III		
FEMA classification	Zone AE	Zone Ae	Zone AE		

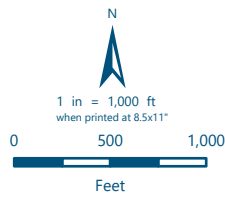
**Wetland Summary Information**

Parameters	WA	WB	WC	WD	WE
Size of Wetland (acres)	10.2	0.429	0.100	0.808	0.758
Wetland Type	RR	RR	RR	RR	RR
Mapped Soil Series	Water	Bibb	Bibb	Bibb	Bibb
Drainage Class	NA	PD	PD	PD	PD
Soil Hydric Status	NA	PH	PH	PH	PH
Source of Hydrology	GW, OL	GW, OL	GW, OL	GW, OL	GW, OL
Restoration or enhancement method	H, V	V	V	V	V



**Figure 1**  
**Site Location**

**Matthew**  
 Johnston County, North Carolina  
 78.4062°W 35.4222°N



Reference: This information is not to be used as final legal boundaries.  
Data Source: USGS, GoogleMaps  
Spatial Reference: NAD 1983 StatePlane North Carolina FIPS 3200



# **Appendix B**

## Visual Assessment Data

**Figure 2**  
Current Conditions Plan View

MY3 2023

**Matthew**

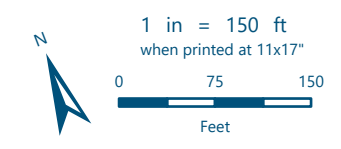
Johnston County, North Carolina  
78.4062°W 35.4222°N



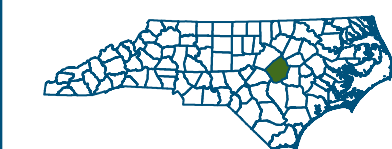
- Conservation Easement
- Encroachment
- Fixed Vegetation Plot
- > 320 stems/acre
- Random Vegetation Plots
- MY3 > 320 stems/acre
- MY2 Random Plot
- Wetland Mitigation Approach
- Rehabilitation (2:1)
- Re-establishment (1:1)
- Preservation
- Stream Mitigation Approach
- Restoration
- Preservation
- Restoration (No credit)
- Preservation (No credit)
- Cross Section
- Fence Installation
- Engineered Sediment Pack
- + Stage Recorder
- Ambient
- Wetland Gauges
- > 12% Hydroperiod
- < 5% Hydroperiod

**Vegetation Condition Assessment**

Invasive Species	Target Community		
	Present	Marginal	Absent
Absent			
Present			



Reference: This information is not to be used as final legal boundaries.  
Imagery Source: Google  
Spatial Reference: NAD 1983 StatePlane North Carolina FIPS 3200 Feet  
Date Exported: 2/28/2024





Visual Stream Stability Assessment

Reach RL1-A  
 Assessed Stream Length 2438  
 Assessed Bank Length 4876

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 <u>NOT</u> 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%
<b>Totals</b>					0	100%
Structure	Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	46	46		100%
	Bank Protection	Bank erosion within the structures extent of influence does <u>not</u> exceed 15%. (See guidance for this table in DMS monitoring guidance document)	36	36		100%

Visual Stream Stability Assessment

Reach RL2  
 Assessed Stream Length 792  
 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 <u>NOT</u> 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%
<b>Totals</b>					0	100%
Structure	Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	19	19		100%
	Bank Protection	Bank erosion within the structures extent of influence does <u>not</u> exceed 15%. (See guidance for this table in DMS monitoring guidance document)	17	17		100%

**Table 6**

**Vegetation Condition Assessment**

**Planted Acreage<sup>1</sup>**

**16.4**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
<b>1. Bare Areas</b>	Very limited cover of both woody and herbaceous material.	0.1 acres	Red Simple Hatch	3	0.42	2.6%
<b>2. Low Stem Density Areas</b>	Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria.	0.1 acres	Orange Simple Hatch	0	0.00	0.0%
<b>Total</b>				<b>3</b>	<b>0</b>	<b>2.6%</b>
<b>3. Areas of Poor Growth Rates or Vigor</b>	Areas with woody stems of a size class that are obviously small given the monitoring year.	0.25 acres	Orange Simple Hatch	0	0.00	0.0%
<b>Cumulative Total</b>				<b>3</b>	<b>0</b>	<b>2.6%</b>

**Easement Acreage<sup>2</sup>**

**19.19**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Easement Acreage
<b>4. Invasive Areas of Concern<sup>4</sup></b>	Areas or points (if too small to render as polygons at map scale).	1000 SF	Yellow Crosshatch	1	1.60	8.3%
<b>5. Easement Encroachment Areas<sup>3</sup></b>	Areas or points (if too small to render as polygons at map scale).	none	Red Simple Hatch	3	0.42	2.6%

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

**2** = The acreage within the easement boundaries.

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

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

**Matthew MY3 Vegetation Monitoring Plot Photos**



Vegetation Plot 1 (10/11/2023)



Vegetation Plot 2 (10/11/2023)



Vegetation Plot 3 (10/11/2023)



Vegetation Plot 4 (10/11/2023)



Vegetation Plot 5 (10/11/2023)



Vegetation Plot 6 (10/11/2023)



Vegetation Plot 7 (10/11/2023)



Vegetation Plot 8 (10/11/2023)



Vegetation Plot 9 (10/11/2023)



Vegetation Plot 10 (10/11/2023)

**Matthew MY3 Random Vegetation Monitoring Plot Photo**



Random Vegetation Plot 1 (10/11/2023)



Random Vegetation Plot 2 (10/11/2023)



Random Vegetation Plot 3 (10/11/2023)



Random Vegetation Plot 4 (10/11/2023)

**MY3 Matthew Monitoring Device Photos**



Stage Recorder RL1-A (10/11/2023)



Stage Recorder RL2 (10/11/2023)



Groundwater Well 1 (10/11/2023)



Groundwater Well 2 (10/11/2023)





Groundwater Well 3 (10/11/2023)



Groundwater Well 4 (10/11/2023)



Groundwater Well 5 (10/11/2023)



Groundwater Well 6 (10/11/2023)



Groundwater Well 7 (10/11/2023)



Groundwater Well 8 (10/11/2023)



Groundwater Well Ref 1 (10/11/2023)



Groundwater Well Ref 2 (10/11/2023)

**Matthew MY3 General Site Photos**



Plunge pool and boulder toe protection below NC-96 culvert on  
RL1-A (05/18/2023)



RL1-A (10/11/2023)



RL1-B (10/11/2023)



RL1-B (10/11/2023)



RL1-B (05/18/2023)



Plunge Pool at the top of RL2 (05/18/2023)



RL2 (05/18/2023)



RL2 (10/11/2023)



General Wetland/Vegetation Condition (10/11/2023)



General Wetland/Vegetation Condition (10/11/2023)



Dam Footprint (5/18/2023)



Encroachment Mowing – Southern Boundary (10/11/2023)



Markers added to Southern Encroachment (7/27/2023)



Markers added to Northern Encroachment (7/27/2023)

# **Appendix C**

## **Vegetation Plot Data**

**Table 7. Planted Species Summary**

Common Name	Scientific Name	Mit Plan %	As-Built %	Total Stems Planted
River Birch	<i>Betula nigra</i>	10	20	3,500
Swamp Chestnut Oak	<i>Quercus michauxii</i>	5	16	2,700
Buttonbush	<i>Cephalanthus occidentalis</i>	10	15	2,500
Sycamore	<i>Platanus occidentalis</i>	10	14	2,300
Willow Oak	<i>Quercus phellos</i>	10	12	2,200
Bald Cypress	<i>Taxodium distichum</i>	15	9	1,500
Water Oak	<i>Quercus nigra</i>	0	8	1,400
Green Ash	<i>Fraxinus pennsylvanica</i>	0	5	800
Swamp Tupelo	<i>Nyssa biflora</i>	10	0	0
Atlantic White Cedar	<i>Chamaecyparis thyoides</i>	10	0	0
Overcup Oak	<i>Quercus lyrata</i>	10	0	0
Laurel Oak	<i>Quercus laurifolia</i>	5	1	100
Water Tupelo	<i>Nyssa aquatica</i>	5	0	0
<b>Total</b>				17,000
<b>Planted Area</b>				16.4
<b>As-built Planted Stems/Acre</b>				1,037

**Table 8. Vegetation Plot Mitigation Success Summary**

Plot #	Planted Stems/Acres	Volunteer Stems/Acre	Total Stems/Acre	Success Criteria Met?	Average Planted Stem Height (ft)
1	850	121	971	Yes	5.1
2	607	162	769	Yes	6.4
3	850	324	1174	Yes	6.7
4	971	202	1174	Yes	11.7
5	890	81	971	Yes	9.6
6	931	81	1012	Yes	11.1
7	769	486	1255	Yes	9.5
8	688	40	728	Yes	7.9
9	931	1214	2145	Yes	5.5
10	728	1214	1942	Yes	7.5
R1	1578	0	1578	Yes	7.4
R2	809	0	809	Yes	13.7
R3	1538	0	1538	Yes	5.2
R4	1052	0	1052	Yes	2.0
<b>Project Avg</b>	<b>942</b>	<b>280</b>	<b>1223</b>	<b>Yes</b>	<b>7.6</b>





# **Appendix D**

## Stream Measurement and Geomorphology Data

**Table 10. Baseline Stream Data Summary  
Matthew Mitigation Site - Reach RL1-A**

Parameter	Gauge <sup>2</sup>	Regional Curve			Pre-Existing Condition						Reference Reach(es) Data						Design			Monitoring Baseline					
		LL	UL	Eq.	Min	Mean	Med	Max	SD <sup>5</sup>	n	Min	Mean	Med	Max	SD <sup>5</sup>	n	Min	Med	Max	Min	Mean	Med	Max	SD <sup>5</sup>	n
<b>Dimension and Substrate - Riffle Only</b>																									
Bankfull Width (ft)		---	---	---	8.0	8.2	8.2	8.4	--	2	11.5	---	---	---	---	1	11.0	12.2	13.3	8.8	10.8	11.0	12.1	1.3	6
Floodprone Width (ft)					0.0	>15	15.0	>30	--	2	>30	---	---	---	---	1	>30	>30	>30	>49.8	>49.9	>49.9	>50	0.1	6
Bankfull Mean Depth (ft)		---	---	---	1.1	1.4	1.4	1.6	--	2	1.3	---	---	---	---	1	1.2	1.3	1.3	-	-	-	-	-	-
<sup>1</sup> Bankfull Max Depth (ft)					1.4	2.2	2.2	2.9	--	2	1.9	---	---	---	---	1	1.5	1.6	1.7	1.3	1.7	1.7	2.0	0.3	6
Bankfull Cross Sectional Area (ft <sup>2</sup> )		---	---	---	8.5	10.9	10.9	13.2	--	2	15.2	---	---	---	---	1	13.1	15.5	17.9	8.6	12.5	12.2	16.6	3.4	6
Width/Depth Ratio					5.4	6.5	6.5	7.6	--	2	8.7	---	---	---	---	1	9.2	9.5	9.8	-	-	-	-	-	-
Entrenchment Ratio					2.2	2.2	2.2	2.2	--	2	2.2	---	---	---	---	1	2.2	2.2	2.2	1.3	1.7	1.7	2.0	0.3	6
<sup>1</sup> Bank Height Ratio					--	--	--	1.1	--	2	1.1	---	---	---	---	1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	6
<b>Profile</b>																									
Riffle Length (ft)					---	---	---	---	---	---	5	---	---	35	---	---	5.5	---	23	10	24	23	44	10	45
Riffle Slope (ft/ft)					---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.01	1.04044	0.73	4.04	0.88273	45
Pool Length (ft)					---	---	---	---	---	---	3	---	---	12	---	---	11	---	18	14	33	32	60	10	44
Pool Max depth (ft)					---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pool Spacing (ft)					---	---	---	---	---	---	11	---	---	35	---	---	39	---	59.5	26	57	56	91	16	44
<b>Pattern</b>																									
Channel Beltwidth (ft)					---	---	---	---	---	---	20	---	---	59	---	---	5.5	---	23	5.5	---	---	23	---	---
Radius of Curvature (ft)					---	---	---	---	---	---	11	---	---	26	---	---	---	---	---	---	---	---	---	---	---
Rc:Bankfull width (ft/ft)					---	---	---	---	---	---	0.9	---	---	2.1	---	---	11	---	18	11	---	---	18	---	---
Meander Wavelength (ft)					---	---	---	---	---	---	155	---	---	177	---	---	---	---	---	---	---	---	---	---	---
Meander Width Ratio					---	---	---	---	---	---	13	---	---	14.8	---	---	39	---	59.5	39	---	---	59.5	---	---
<b>Transport parameters</b>																									
Reach Shear Stress (competency) lb/ft <sup>2</sup>																									
Max part size (mm) mobilized at bankfull																									
Stream Power (transport capacity) W/m <sup>2</sup>																									
<b>Additional Reach Parameters</b>																									
Rosgen Classification																									
Bankfull Velocity (fps)		---	---	---																					
Bankfull Discharge (cfs)		---	---	---																					
Valley length (ft)																									
Channel Thalweg length (ft)																									
Sinuosity (ft)																									
Water Surface Slope (Channel) (ft/ft)																									
Channel slope (ft/ft)																									
<sup>3</sup> Bankfull Floodplain Area (acres)																									
<sup>4</sup> % of Reach with Eroding Banks																									
Channel Stability or Habitat Metric																									
Biological or Other																									

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

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

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

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

**Table 10. Baseline Stream Data Summary (continued)**  
**Matthew Mitigation Site - Reach RL2**

Parameter	Gauge <sup>2</sup>	Regional Curve			Pre-Existing Condition						Reference Reach(es) Data						Design			Monitoring Baseline						
		LL	UL	Eq.	Min	Mean	Med	Max	SD <sup>5</sup>	n	Min	Mean	Med	Max	SD <sup>5</sup>	n	Min	Med	Max	Min	Mean	Med	Max	SD <sup>5</sup>	n	
<b>Dimension and Substrate - Riffle Only</b>																										
Bankfull Width (ft)		---	---	---	---	---	---	---	---	---	11.5	---	---	---	---	1	---	9.2	--	8.3	8.8	8.8	9.3	0.5	2	
Floodprone Width (ft)					---	---	---	---	---	---	>30	---	---	---	---	1	---	>30	--	>49.8	>49.9	49.9	>50	0.1	2	
Bankfull Mean Depth (ft)		---	---	---	---	---	---	---	---	---	1.3	---	---	---	---	1	---	1.0	--	-	-	-	-	-	-	
<sup>1</sup> Bankfull Max Depth (ft)					---	---	---	---	---	---	1.9	---	---	---	---	1	---	1.3	--	1.3	1.4	1.4	1.4	0.1	2	
Bankfull Cross Sectional Area (ft <sup>2</sup> )		---	---	---	---	---	---	---	---	---	15.2	---	---	---	---	1	---	9.0	---	7.7	8.4	8.4	9.0	0.7	2	
Width/Depth Ratio					---	---	---	---	---	---	8.7	---	---	---	---	1	---	9.4	---	-	-	-	-	-	-	
Entrenchment Ratio					---	---	---	---	---	---	2.2	---	---	---	---	1	---	2.2	---	1.3	1.4	1.4	1.4	0.1	2	
<sup>1</sup> Bank Height Ratio					---	---	---	---	---	---	1.1	---	---	---	---	1	---	1.0	---	1.0	1.0	1.0	1.0	0.0	2	
<b>Profile</b>																										
Riffle Length (ft)					---	---	---	---	---	---	5	---	---	35	---	---	4	---	18	9	15	14	37	7	16	
Riffle Slope (ft/ft)					---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.01	1.98875	1.575	5.38	1.68443	16	
Pool Length (ft)					---	---	---	---	---	---	3	---	---	12	---	---	4	---	14	17	30	26	82	15	15	
Pool Max depth (ft)					---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
Pool Spacing (ft)					---	---	---	---	---	---	11	---	---	35	---	---	13	---	45	33	46	40	119	22	14	
<b>Pattern</b>																										
Channel Beltwidth (ft)					---	---	---	---	---	---	20	---	---	59	---	---	15	---	46	15	---	---	46	---	---	
Radius of Curvature (ft)					---	---	---	---	---	---	11	---	---	26	---	---	8	---	20	8	---	---	20	---	---	
Rc:Bankfull width (ft/ft)					---	---	---	---	---	---	0.9	---	---	2.1	---	---	0.9	---	2.1	0.9	---	---	2.1	---	---	
Meander Wavelength (ft)					---	---	---	---	---	---	155	---	---	177	---	---	120	---	137	120	---	---	137	---	---	
Meander Width Ratio					---	---	---	---	---	---	13	---	---	14.8	---	---	13	---	14.8	13	---	---	14.8	---	---	
<b>Transport parameters</b>																										
Reach Shear Stress (competency) lb/ft <sup>2</sup>																										
Max part size (mm) mobilized at bankfull																										
Stream Power (transport capacity) W/m <sup>2</sup>																										
<b>Additional Reach Parameters</b>																										
Rosgen Classification																										
Bankfull Velocity (fps)		---	---	---																						
Bankfull Discharge (cfs)		---	---	---																						
Valley length (ft)																										
Channel Thalweg length (ft)																										
Sinuosity (ft)																										
Water Surface Slope (Channel) (ft/ft)																										
Channel slope (ft/ft)																										
<sup>3</sup> Bankfull Floodplain Area (acres)																										
<sup>4</sup> % of Reach with Eroding Banks																										
Channel Stability or Habitat Metric																										
Biological or Other																										

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

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

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

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

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

**Project Name/Number: Matthew #100043**

	Cross Section 1 (Pool)							Cross Section 2 (Riffle)							Cross Section 3 (Riffle)							Cross Section 4 (Pool)							Cross Section 5 (Pool)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+
<b>Bankfull Elevation (ft) - Based on AB-XSA<sup>1</sup></b>	127.2	127.6	127.6	127.7				127.1	127.7	127.6	127.7				126.2	126.3	126.3	126.3				126.0	126.0	126.0	125.9				125.5	125.6	125.5	125.5			
Bankfull Width (ft) <sup>1</sup>	10.1	9.1	11.9	8.8				10.0	9.9	11.5	11.0				8.8	10.5	9.3	9.2				9.8	10.1	10.1	9.3				9.7	11.4	9.8	10.6			
Floodprone Width (ft) <sup>1</sup>	-	-	-	-				>49.9	>49.9	>49.9	>49.9				>50.0	>50	>49.8	>49.7				-	-	-	-				-	-	-	-			
Bankfull Max Depth (ft) <sup>2</sup>	1.5	1.2	1.2	1.3				1.3	1.2	1.4	1.4				1.6	1.6	1.6	1.5				2.0	2.2	2.2	2.3				2.9	2.8	3.0	2.9			
Low Bank Elevation (ft)	-	-	-	-				127.1	127.4	127.6	127.6				126.2	126.2	126.2	126.2				-	-	-	-				-	-	-	-			
Bankfull Cross Sectional Area (ft <sup>2</sup> ) <sup>2</sup>	9.0	7.4	7.8	7.4				8.6	6.1	8.0	7.5				9.9	9.3	9.3	9.1				12.1	12.3	12.8	13.4				15.3	14.7	16.5	15.9			
Bankfull Entrenchment Ratio <sup>1</sup>	-	-	-	-				>5.0	>5.0	>4.4	>4.5				>5.7	>4.8	>5.4	>5.4				-	-	-	-				-	-	-	-			
Bankfull Bank Height Ratio <sup>1</sup>	-	-	-	-				1.0	0.8	1.0	0.9				1.0	1.0	1.0	0.9				-	-	-	-				-	-	-	-			
	Cross Section 6 (Riffle)							Cross Section 7 (Riffle)							Cross Section 8 (Pool)							Cross Section 9 (Riffle)							Cross Section 10 (Pool)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+
<b>Bankfull Elevation (ft) - Based on AB-XSA<sup>1</sup></b>	125.4	125.6	125.4	125.4				124.0	124.1	124.0	124.0				123.4	123.2	123.2	123.2				123.5	123.5	123.6	123.5				122.9	122.9	123.0	122.8			
Bankfull Width (ft) <sup>1</sup>	8.9	8.8	9.5	8.8				11.9	12.8	13.1	12.4				11.2	11.3	11.0	10.4				12.0	13.1	13.0	11.7				13.4	13.5	14.1	13.3			
Floodprone Width (ft) <sup>1</sup>	>49.9	>50	>50	>49.9				>49.9	>49.9	>49.9	>49.9				-	-	-	-				>50	>49.9	>49.9	>50.1				-	-	-	-			
Bankfull Max Depth (ft) <sup>2</sup>	1.4	1.2	1.4	1.1				2.0	1.9	1.9	1.8				2.8	3.0	2.8	3.2				2.0	1.9	2.0	1.9				2.7	2.9	3.2	3.1			
Low Bank Elevation (ft)	125.4	125.2	125.1	125.1				124.0	124.0	124.0	123.9				-	-	-	-				123.5	123.4	123.6	123.4				-	-	-	-			
Bankfull Cross Sectional Area (ft <sup>2</sup> ) <sup>2</sup>	8.8	6.1	5.9	6.2				16.6	15.0	16.1	14.4				19.9	22.0	21.4	21.8				16.5	15.9	16.6	15.2				21.6	23.9	23.6	22.4			
Bankfull Entrenchment Ratio <sup>1</sup>	>5.6	>5.7	>5.2	>5.7				>4.2	>3.9	>3.8	>4.0				-	-	-	-				>4.2	>3.8	>3.8	>4.3				-	-	-	-			
Bankfull Bank Height Ratio <sup>1</sup>	1.0	0.8	0.8	0.8				1.0	0.9	1.0	0.9				-	-	-	-				1.0	1.0	1.0	0.9				-	-	-	-			
	Cross Section 11 (Pool)							Cross Section 12 (Riffle)							Cross Section 13 (Pool)							Cross Section 14 (Riffle)							Cross Section 15 (Riffle)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+
<b>Bankfull Elevation (ft) - Based on AB-XSA<sup>1</sup></b>	122.3	122.2	122.1	122.0				122.2	122.2	122.1	122.2				126.4	126.3	126.3	126.3				126.7	126.8	126.8	126.7				125.4	125.4	125.4	125.3			
Bankfull Width (ft) <sup>1</sup>	11.5	11.1	11.0	9.9				12.1	13.3	13.6	12.4				9.4	10.0	9.9	9.4				9.3	10.1	10.6	9.9				8.3	8.5	8.3	8.5			
Floodprone Width (ft) <sup>1</sup>	-	-	-	-				>49.8	>49.9	>49.9	>49.9				-	-	-	-				>49.8	>50	>49.9	>49.7				>50	>50	>49.9	>49.9			
Bankfull Max Depth (ft) <sup>2</sup>	3.2	3.2	3.1	3.1				1.7	1.8	1.7	1.6				2.3	2.5	2.1	2.2				1.4	1.3	1.2	1.2				1.3	1.4	1.3	1.4			
Low Bank Elevation (ft)	-	-	-	-				122.2	122.2	122.2	122.0				-	-	-	-				126.7	126.8	126.6	126.6				125.4	125.4	125.4	125.4			
Bankfull Cross Sectional Area (ft <sup>2</sup> ) <sup>2</sup>	19.8	21.8	21.6	20.6				14.4	14.6	14.7	12.3				13.9	16.1	14.1	13.6				9.0	9.0	8.0	8.4				7.7	8.5	8.1	8.4			
Bankfull Entrenchment Ratio <sup>1</sup>	-	-	-	-				>4.1	>3.7	>3.7	>4.0				-	-	-	-				>5.4	>4.9	>4.7	>5.0				>6.0	>5.9	>6.0	>5.4			
Bankfull Bank Height Ratio <sup>1</sup>	-	-	-	-				1.0	1.0	1.0	0.9				-	-	-	-				1.0	1.0	0.9	1.0				1.0	1.1	1.0	1.0			
	Cross Section 16 (Pool)																																		
	Base	MY1	MY2	MY3	MY5	MY7	MY+																												
<b>Bankfull Elevation (ft) - Based on AB-XSA<sup>1</sup></b>	125.2	125.3	125.3	125.3																															
Bankfull Width (ft) <sup>1</sup>	9.2	9.6	9.2	9.7																															
Floodprone Width (ft) <sup>1</sup>	-	-	-	-																															
Bankfull Max Depth (ft) <sup>2</sup>	2.4	2.1	2.0	2.1																															
Low Bank Elevation (ft)	-	-	-	-																															
Bankfull Cross Sectional Area (ft <sup>2</sup> ) <sup>2</sup>	12.6	11.3	11.1	11.8																															
Bankfull Entrenchment Ratio <sup>1</sup>	-	-	-	-																															
Bankfull Bank Height Ratio <sup>1</sup>	-	-	-	-																															

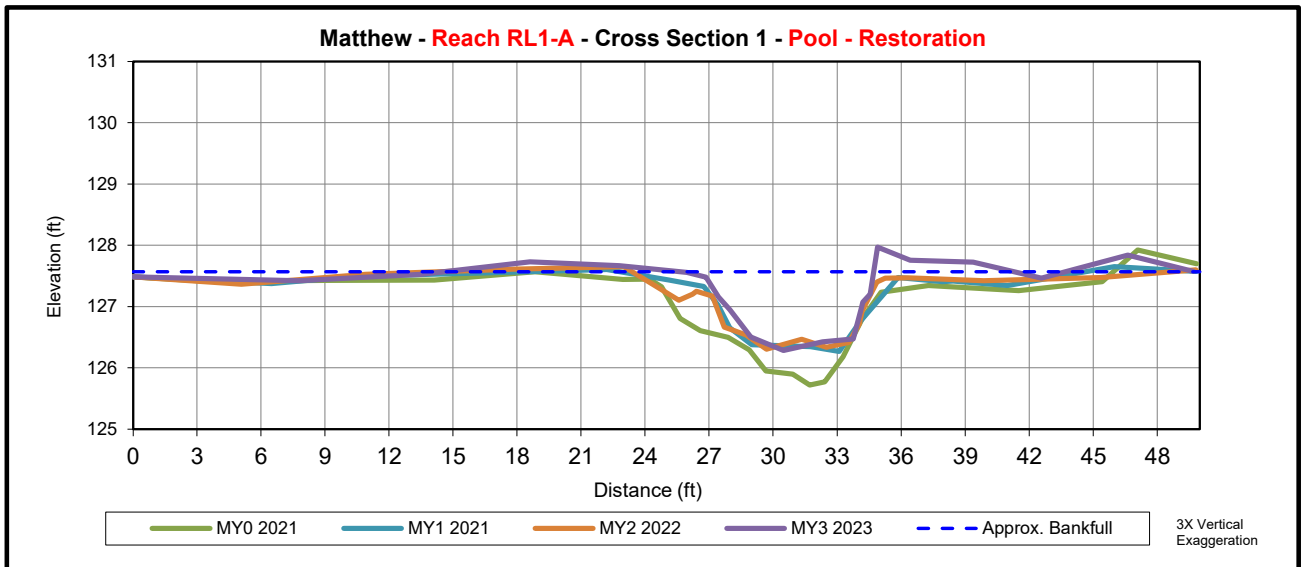
1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation  
 2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation



Upstream



Downstream



	Cross Section 1 (Pool)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+
<b>Bankfull Elevation (ft) - Based on AB-XSA<sup>1</sup></b>	127.2	127.6	127.6	127.7			
Bankfull Width (ft) <sup>1</sup>	10.1	9.1	11.9	8.8			
Floodprone Width (ft) <sup>1</sup>	-	-	-	-			
Bankfull Max Depth (ft) <sup>2</sup>	1.5	1.2	1.2	1.3			
Low Bank Elevation (ft)	-	-	-	-			
Bankfull Cross Sectional Area (ft <sup>2</sup> ) <sup>2</sup>	9.0	7.4	7.8	7.4			
Bankfull Entrenchment Ratio <sup>1</sup>	-	-	-	-			
Bankfull Bank Height Ratio <sup>1</sup>	-	-	-	-			

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

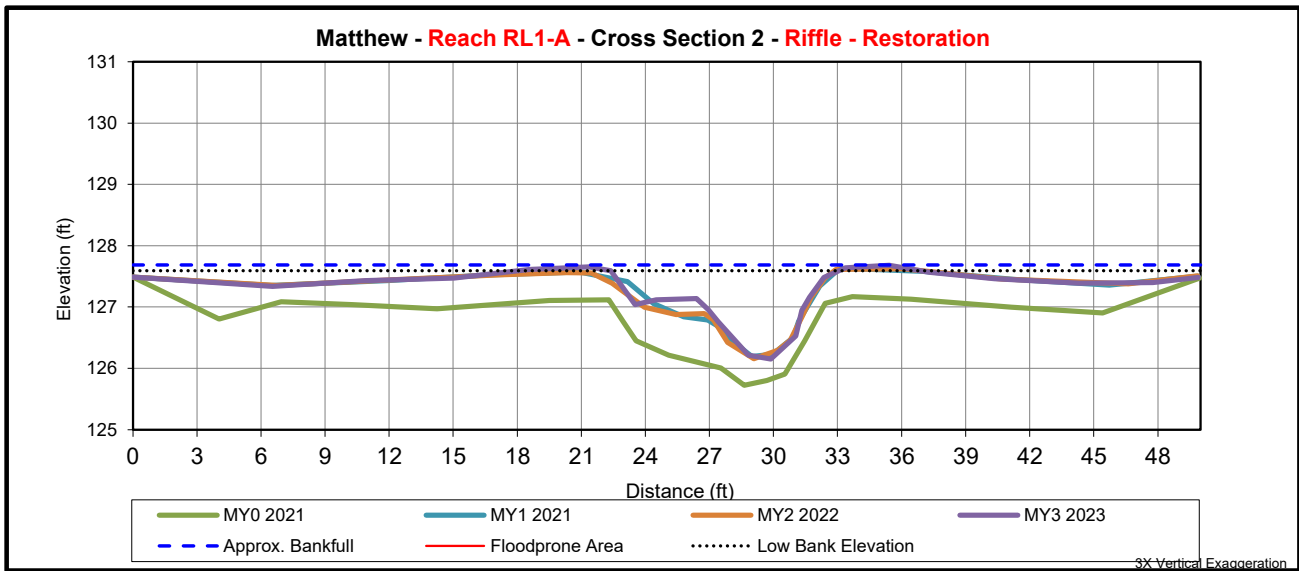
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation



Upstream



Downstream



	Cross Section 2 (Riffle)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+
<b>Bankfull Elevation (ft) - Based on AB-XSA<sup>1</sup></b>	127.1	127.7	127.6	127.7			
Bankfull Width (ft) <sup>1</sup>	10.0	9.9	11.5	11.0			
Floodprone Width (ft) <sup>1</sup>	>49.9	>49.9	>49.9	>49.9			
Bankfull Max Depth (ft) <sup>2</sup>	1.3	1.2	1.4	1.4			
Low Bank Elevation (ft)	127.1	127.4	127.6	127.6			
Bankfull Cross Sectional Area (ft <sup>2</sup> ) <sup>2</sup>	8.6	6.1	8.0	7.5			
Bankfull Entrenchment Ratio <sup>1</sup>	>5.0	>5.0	>4.4	>4.5			
Bankfull Bank Height Ratio <sup>1</sup>	1.0	0.8	1.0	0.9			

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

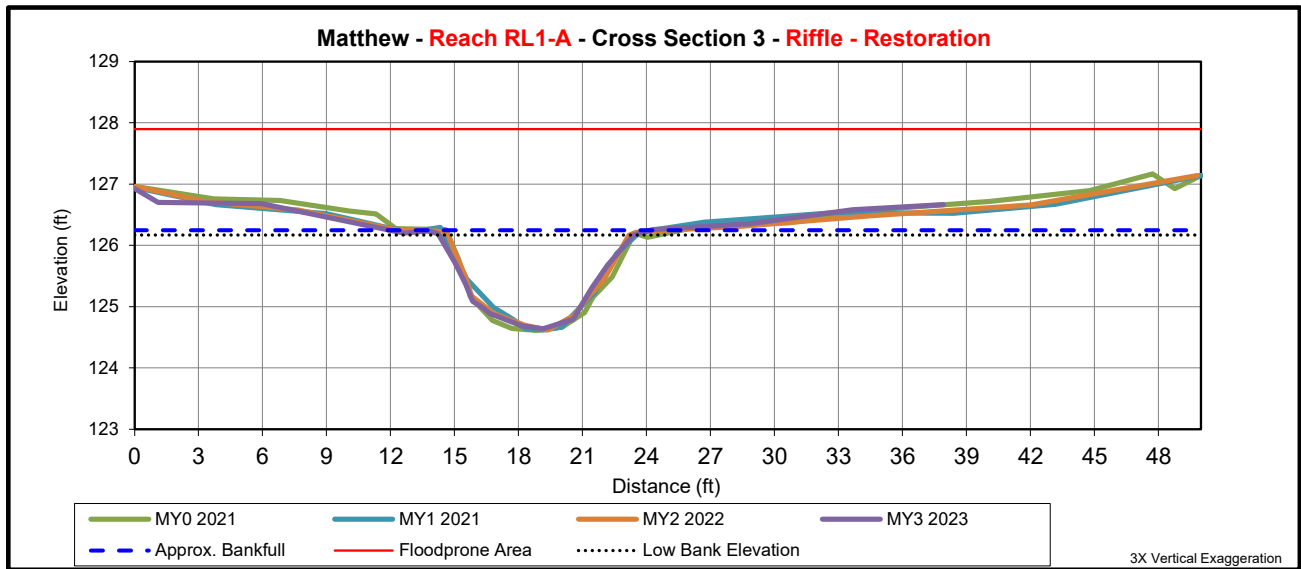
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation



Upstream



Downstream



	Cross Section 3 (Riffle)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+
<b>Bankfull Elevation (ft) - Based on AB-XSA<sup>1</sup></b>	126.2	126.3	126.3	126.3			
Bankfull Width (ft) <sup>1</sup>	8.8	10.5	9.3	9.2			
Floodprone Width (ft) <sup>1</sup>	>50.0	>50	>49.8	>49.7			
Bankfull Max Depth (ft) <sup>2</sup>	1.6	1.6	1.6	1.5			
Low Bank Elevation (ft)	126.2	126.2	126.2	126.2			
Bankfull Cross Sectional Area (ft <sup>2</sup> ) <sup>2</sup>	9.9	9.3	9.3	9.1			
Bankfull Entrenchment Ratio <sup>1</sup>	>5.7	>4.8	>5.4	>5.4			
Bankfull Bank Height Ratio <sup>1</sup>	1.0	1.0	1.0	0.9			

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

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

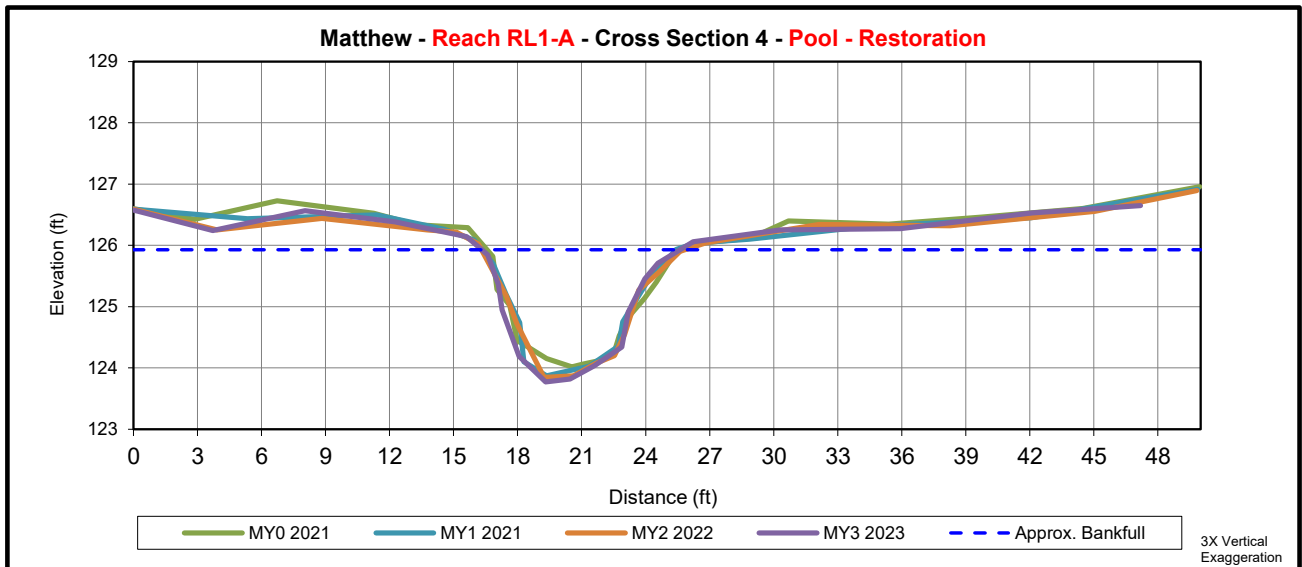




Upstream



Downstream



	<b>Cross Section 4 (Pool)</b>						
	Base	MY1	MY2	MY3	MY5	MY7	MY+
<b>Bankfull Elevation (ft) - Based on AB-XSA<sup>1</sup></b>	126.0	126.0	126.0	125.9			
Bankfull Width (ft) <sup>1</sup>	9.8	10.1	10.1	9.3			
Floodprone Width (ft) <sup>1</sup>	-	-	-	-			
Bankfull Max Depth (ft) <sup>2</sup>	2.0	2.2	2.2	2.3			
Low Bank Elevation (ft)	-	-	-	-			
Bankfull Cross Sectional Area (ft <sup>2</sup> ) <sup>2</sup>	12.1	12.3	12.8	13.4			
Bankfull Entrenchment Ratio <sup>1</sup>	-	-	-	-			
Bankfull Bank Height Ratio <sup>1</sup>	-	-	-	-			

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

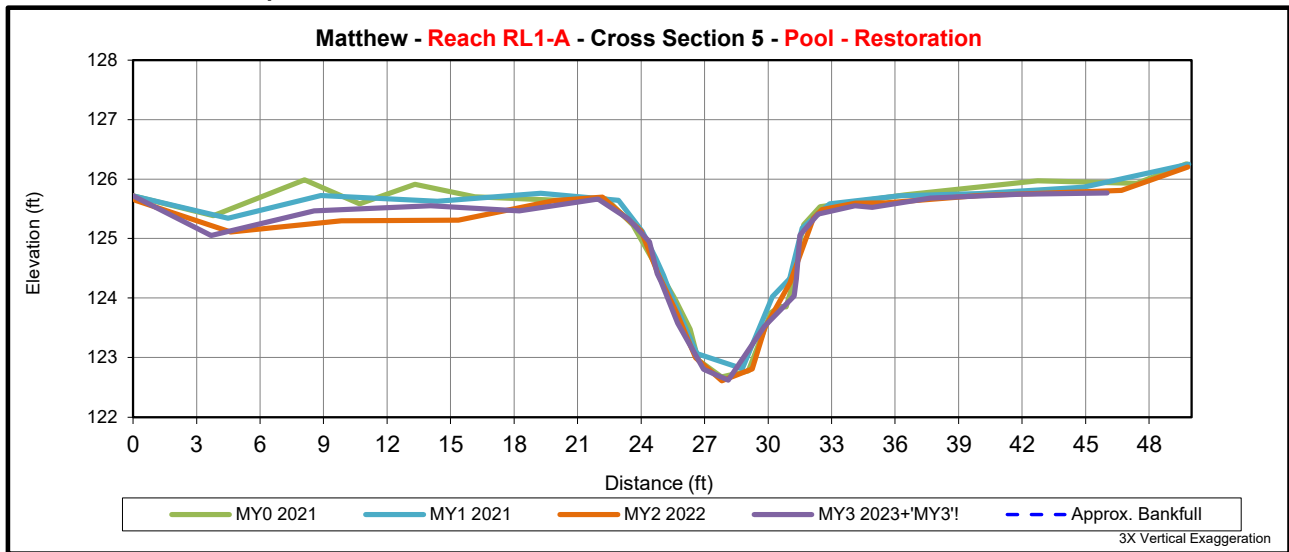
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation



Upstream



Downstream



	<b>Cross Section 5 (Pool)</b>						
	Base	MY1	MY2	MY3	MY5	MY7	MY+
<b>Bankfull Elevation (ft) - Based on AB-XSA<sup>1</sup></b>	125.5	125.6	125.5	125.5			
Bankfull Width (ft) <sup>1</sup>	9.7	11.4	9.8	10.6			
Floodprone Width (ft) <sup>1</sup>	-	-	-	-			
Bankfull Max Depth (ft) <sup>2</sup>	2.9	2.8	3.0	2.9			
Low Bank Elevation (ft)	-	-	-	-			
Bankfull Cross Sectional Area (ft <sup>2</sup> ) <sup>2</sup>	15.3	14.7	16.5	15.9			
Bankfull Entrenchment Ratio <sup>1</sup>	-	-	-	-			
Bankfull Bank Height Ratio <sup>1</sup>	-	-	-	-			

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

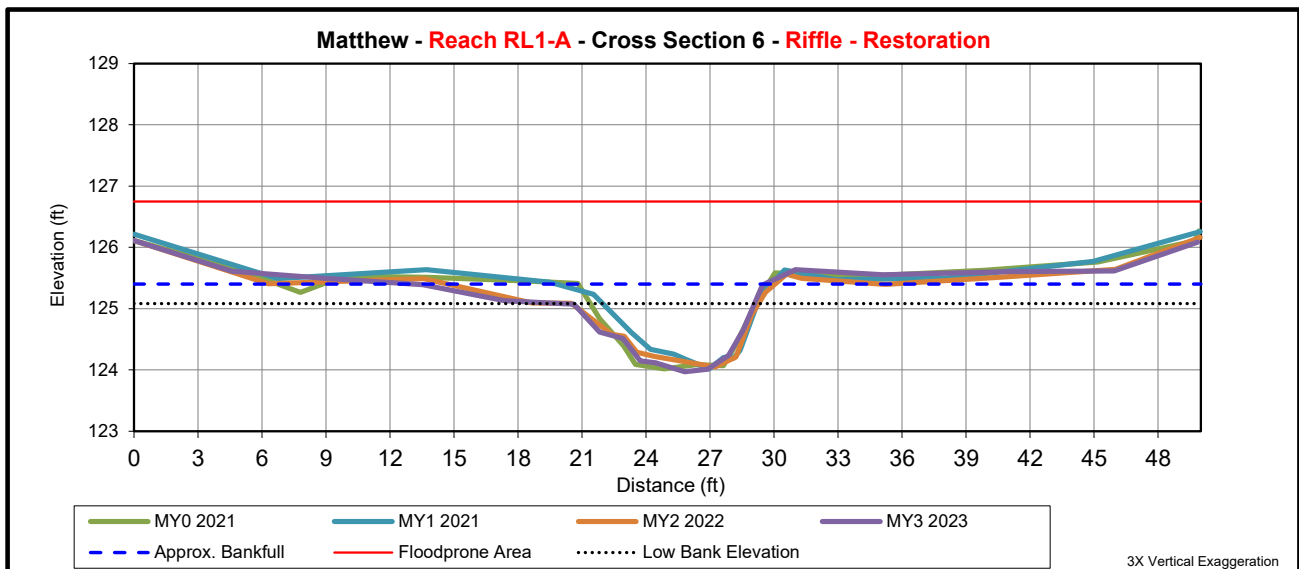
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation



Upstream



Downstream



	Cross Section 6 (Riffle)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+
<b>Bankfull Elevation (ft) - Based on AB-XSA<sup>1</sup></b>	125.4	125.6	125.4	125.4			
Bankfull Width (ft) <sup>1</sup>	8.9	8.8	9.5	8.8			
Floodprone Width (ft) <sup>1</sup>	>49.9	>50	>50	>49.9			
Bankfull Max Depth (ft) <sup>2</sup>	1.4	1.2	1.4	1.1			
Low Bank Elevation (ft)	125.4	125.2	125.1	125.1			
Bankfull Cross Sectional Area (ft <sup>2</sup> ) <sup>2</sup>	8.8	6.1	5.9	6.2			
Bankfull Entrenchment Ratio <sup>1</sup>	>5.6	>5.7	>5.2	>5.7			
Bankfull Bank Height Ratio <sup>1</sup>	1.0	0.8	0.8	0.8			

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

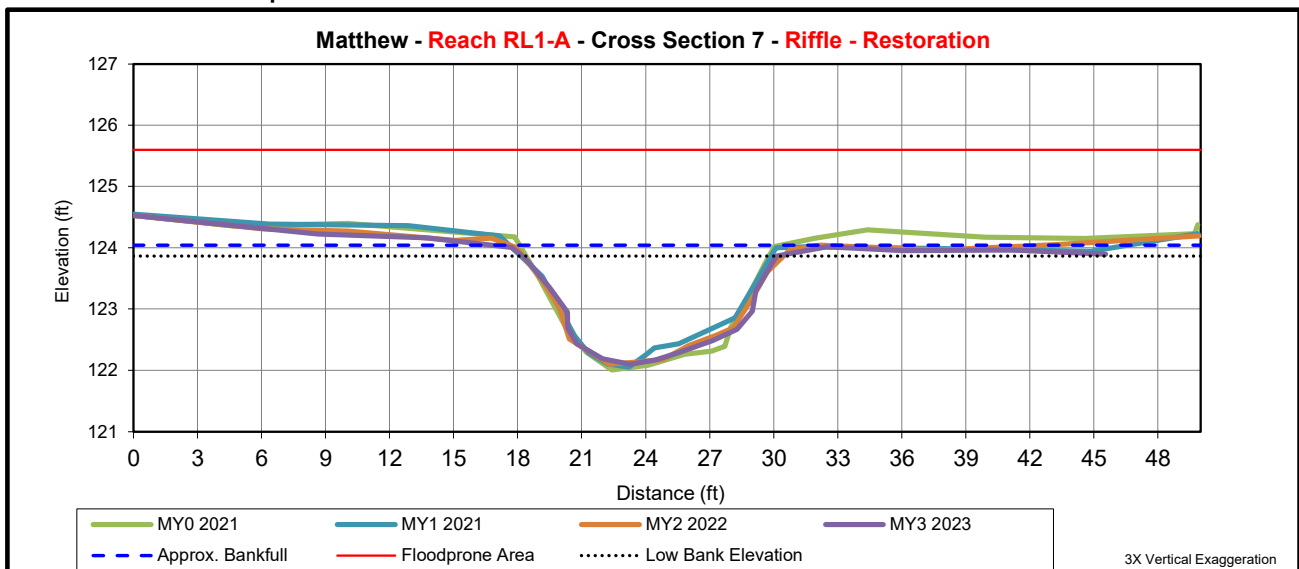
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation



Upstream



Downstream



	Cross Section 7 (Riffle)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+
<b>Bankfull Elevation (ft) - Based on AB-XSA<sup>1</sup></b>	124.0	124.1	124.0	124.0			
Bankfull Width (ft) <sup>1</sup>	11.9	12.8	13.1	12.4			
Floodprone Width (ft) <sup>1</sup>	>49.9	>49.9	>49.9	>49.9			
Bankfull Max Depth (ft) <sup>2</sup>	2.0	1.9	1.9	1.8			
Low Bank Elevation (ft)	124.0	124.0	124.0	123.9			
Bankfull Cross Sectional Area (ft <sup>2</sup> ) <sup>2</sup>	16.6	15.0	16.1	14.4			
Bankfull Entrenchment Ratio <sup>1</sup>	>4.2	>3.9	>3.8	>4.0			
Bankfull Bank Height Ratio <sup>1</sup>	1.0	0.9	1.0	0.9			

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

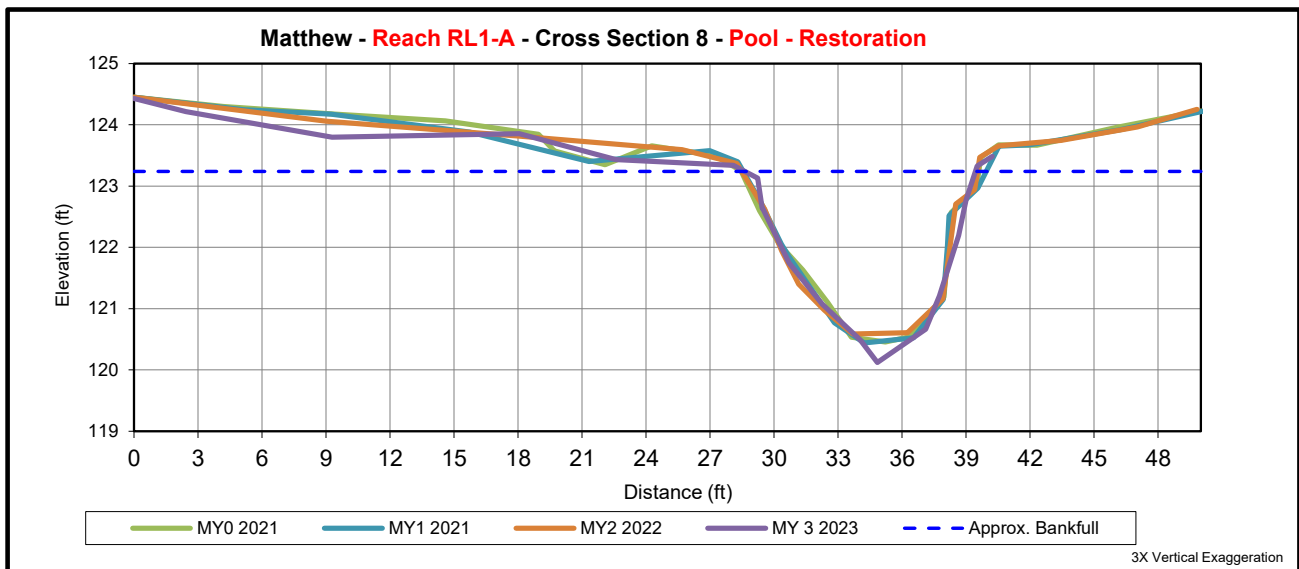
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation



Upstream



Downstream



	Cross Section 8 (Pool)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+
<b>Bankfull Elevation (ft) - Based on AB-XSA<sup>1</sup></b>	123.4	123.2	123.2	123.2			
Bankfull Width (ft) <sup>1</sup>	11.2	11.3	11.0	10.4			
Floodprone Width (ft) <sup>1</sup>	-	-	-	-			
Bankfull Max Depth (ft) <sup>2</sup>	2.8	3.0	2.8	3.2			
Low Bank Elevation (ft)	-	-	-	-			
Bankfull Cross Sectional Area (ft <sup>2</sup> ) <sup>2</sup>	19.9	22.0	21.4	21.8			
Bankfull Entrenchment Ratio <sup>1</sup>	-	-	-	-			
Bankfull Bank Height Ratio <sup>1</sup>	-	-	-	-			

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

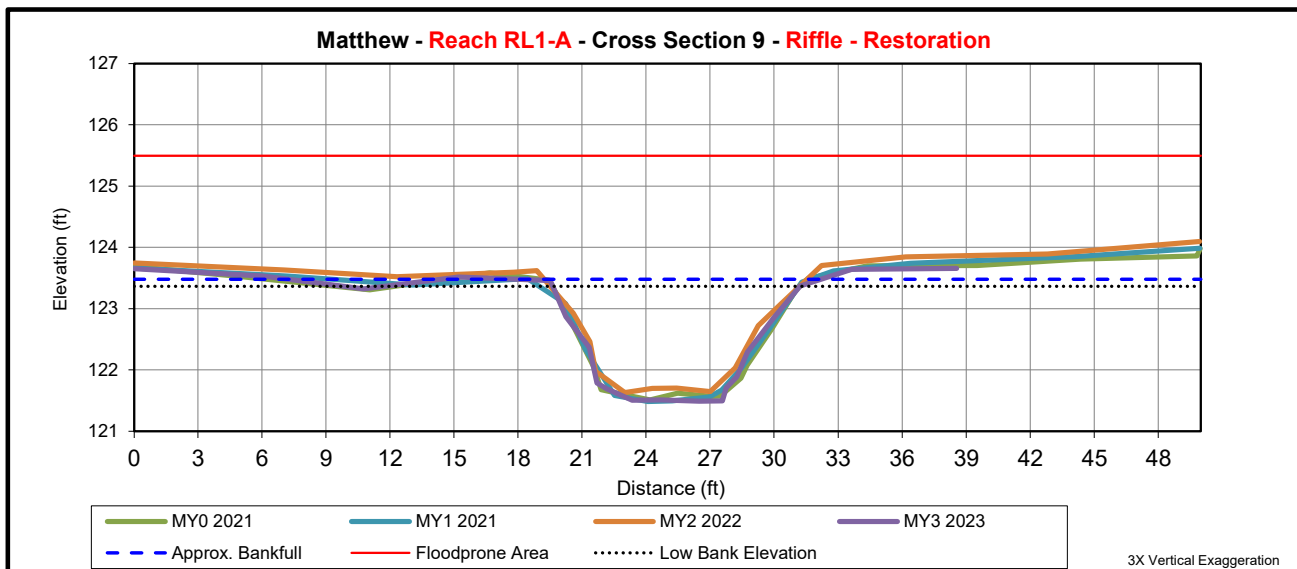
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation



Upstream



Downstream



	Cross Section 9 (Riffle)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+
<b>Bankfull Elevation (ft) - Based on AB-XSA<sup>1</sup></b>	123.5	123.5	123.6	123.5			
Bankfull Width (ft) <sup>1</sup>	12.0	13.1	13.0	11.7			
Floodprone Width (ft) <sup>1</sup>	>50	>49.9	>49.9	>50.1			
Bankfull Max Depth (ft) <sup>2</sup>	2.0	1.9	2.0	1.9			
Low Bank Elevation (ft)	123.5	123.4	123.6	123.4			
Bankfull Cross Sectional Area (ft <sup>2</sup> ) <sup>2</sup>	16.5	15.9	16.6	15.2			
Bankfull Entrenchment Ratio <sup>1</sup>	>4.2	>3.8	>3.8	>4.3			
Bankfull Bank Height Ratio <sup>1</sup>	1.0	1.0	1.0	0.9			

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

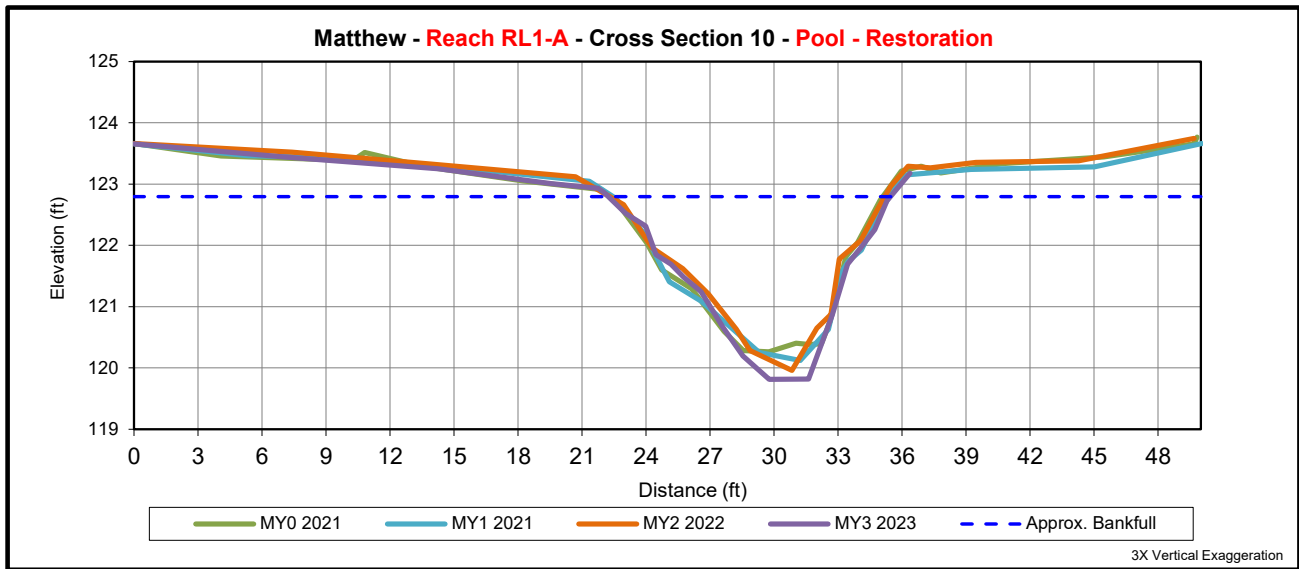
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation



Upstream



Downstream



	Cross Section 10 (Pool)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+
<b>Bankfull Elevation (ft) - Based on AB-XSA<sup>1</sup></b>	122.9	122.9	123.0	122.8			
Bankfull Width (ft) <sup>1</sup>	13.4	13.5	14.1	13.3			
Floodprone Width (ft) <sup>1</sup>	-	-	-	-			
Bankfull Max Depth (ft) <sup>2</sup>	2.7	2.9	3.2	3.1			
Low Bank Elevation (ft)	-	-	-	-			
Bankfull Cross Sectional Area (ft <sup>2</sup> ) <sup>2</sup>	21.6	23.9	23.6	22.4			
Bankfull Entrenchment Ratio <sup>1</sup>	-	-	-	-			
Bankfull Bank Height Ratio <sup>1</sup>	-	-	-	-			

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

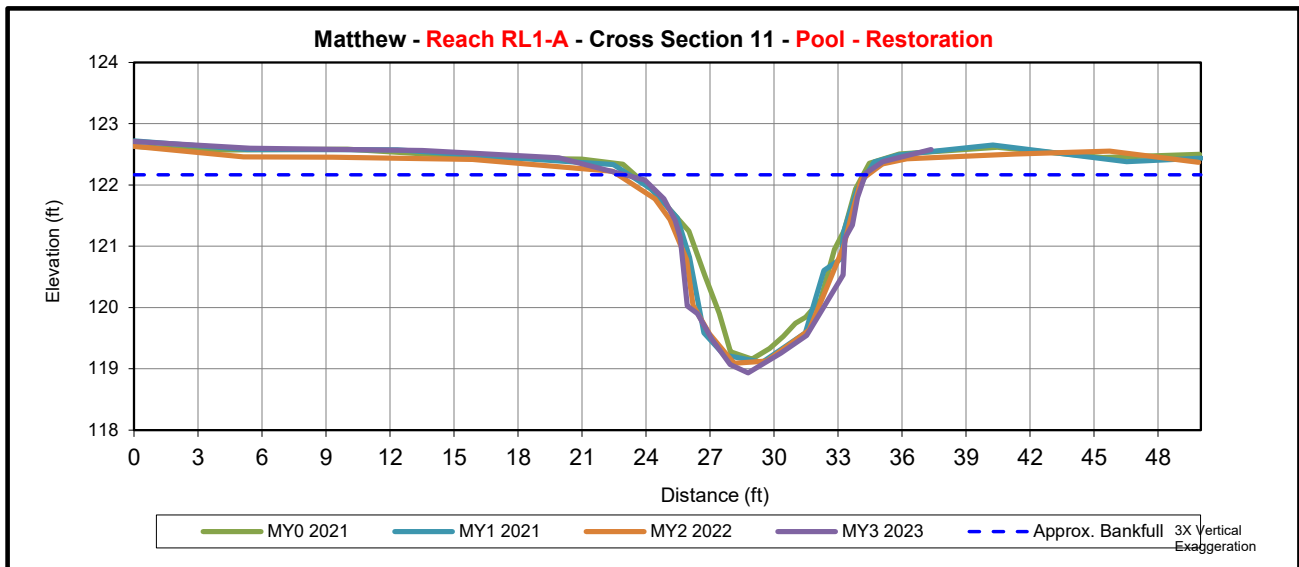
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation



Upstream



Downstream



	<b>Cross Section 11 (Pool)</b>						
	Base	MY1	MY2	MY3	MY5	MY7	MY+
<b>Bankfull Elevation (ft) - Based on AB-XSA</b> <sup>1</sup>	122.3	122.2	122.1	122.0			
Bankfull Width (ft) <sup>1</sup>	11.5	11.1	11.0	9.9			
Floodprone Width (ft) <sup>1</sup>	-	-	-	-			
Bankfull Max Depth (ft) <sup>2</sup>	3.2	3.2	3.1	3.1			
Low Bank Elevation (ft)	-	-	-	-			
Bankfull Cross Sectional Area (ft <sup>2</sup> ) <sup>2</sup>	19.8	21.8	21.6	20.6			
Bankfull Entrenchment Ratio <sup>1</sup>	-	-	-	-			
Bankfull Bank Height Ratio <sup>1</sup>	-	-	-	-			

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

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

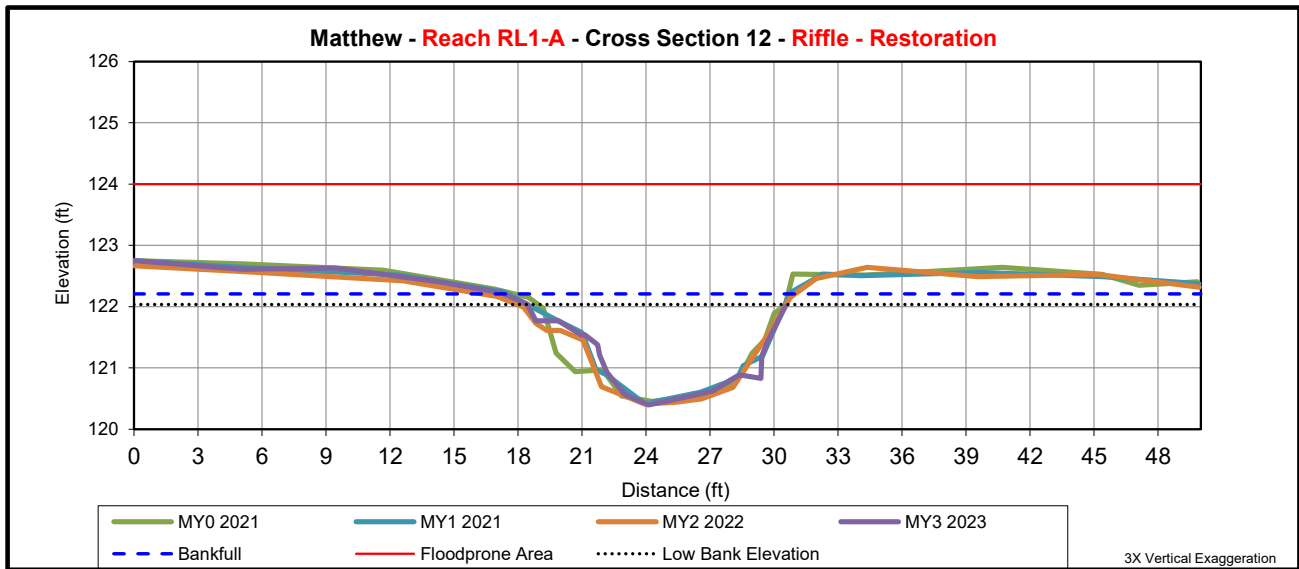




Upstream



Downstream



	Cross Section 12 (Riffle)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+
<b>Bankfull Elevation (ft) - Based on AB-XSA<sup>1</sup></b>	122.2	122.2	122.1	122.2			
Bankfull Width (ft) <sup>1</sup>	12.1	13.3	13.6	12.4			
Floodprone Width (ft) <sup>1</sup>	>49.8	>49.9	>49.9	>49.9			
Bankfull Max Depth (ft) <sup>2</sup>	1.7	1.8	1.7	1.6			
Low Bank Elevation (ft)	122.2	122.2	122.2	122.0			
Bankfull Cross Sectional Area (ft <sup>2</sup> ) <sup>2</sup>	14.4	14.6	14.7	12.3			
Bankfull Entrenchment Ratio <sup>1</sup>	>4.1	>3.7	>3.7	>4.0			
Bankfull Bank Height Ratio <sup>1</sup>	1.0	1.0	1.0	0.9			

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

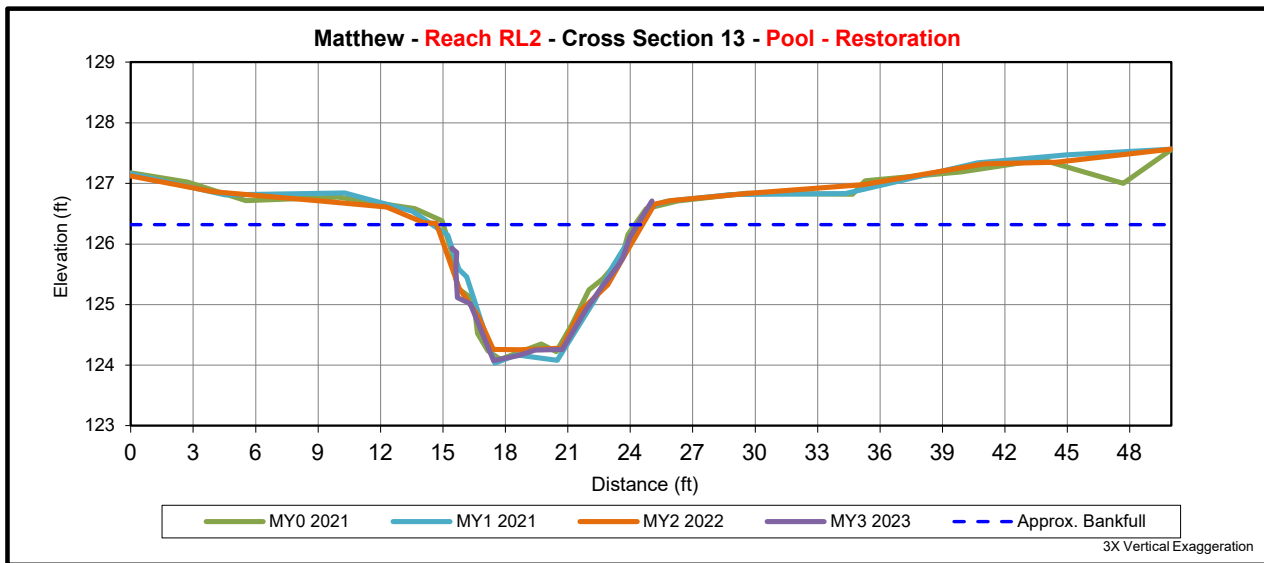
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation



Upstream



Downstream



	<b>Cross Section 13 (Pool)</b>						
	Base	MY1	MY2	MY3	MY5	MY7	MY+
<b>Bankfull Elevation (ft) - Based on AB-XSA<sup>1</sup></b>	126.4	126.3	126.3	126.3			
Bankfull Width (ft) <sup>1</sup>	9.4	10.0	9.9	9.4			
Floodprone Width (ft) <sup>1</sup>	-	-	-	-			
Bankfull Max Depth (ft) <sup>2</sup>	2.3	2.5	2.1	2.2			
Low Bank Elevation (ft)	-	-	-	-			
Bankfull Cross Sectional Area (ft <sup>2</sup> ) <sup>2</sup>	13.9	16.1	14.1	13.6			
Bankfull Entrenchment Ratio <sup>1</sup>	-	-	-	-			
Bankfull Bank Height Ratio <sup>1</sup>	-	-	-	-			

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

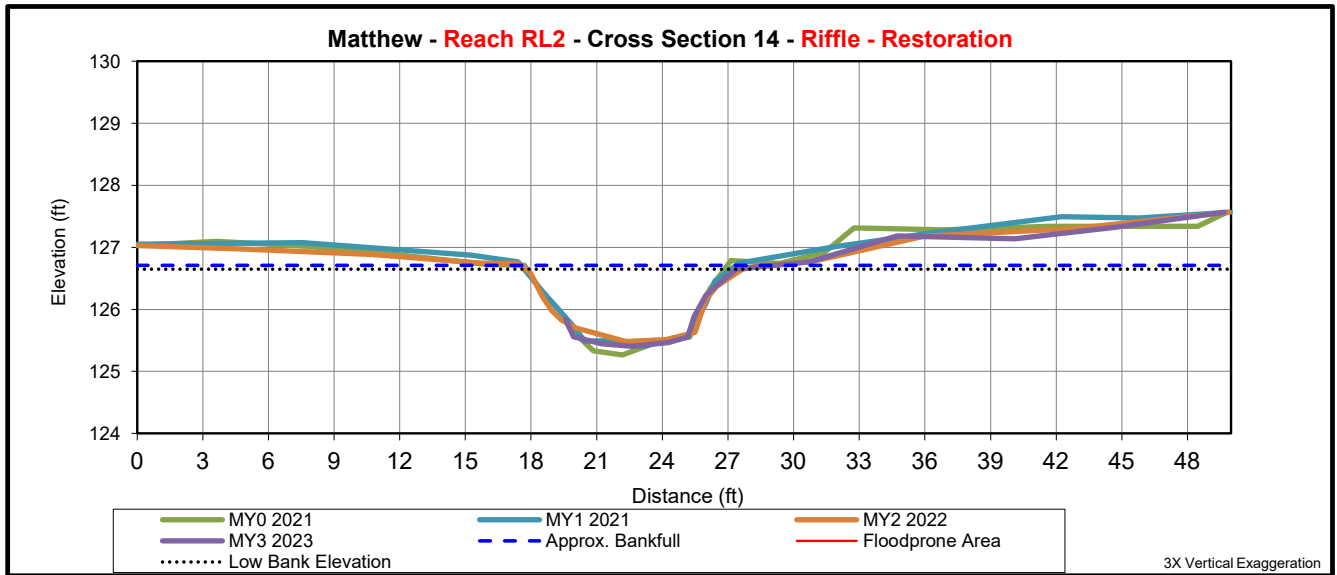
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation



Upstream



Downstream



	Cross Section 14 (Riffle)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+
<b>Bankfull Elevation (ft) - Based on AB-XSA<sup>1</sup></b>	126.7	126.8	126.8	126.7			
Bankfull Width (ft) <sup>1</sup>	9.3	10.1	10.6	9.9			
Floodprone Width (ft) <sup>1</sup>	>49.8	>50	>49.9	>49.7			
Bankfull Max Depth (ft) <sup>2</sup>	1.4	1.3	1.2	1.2			
Low Bank Elevation (ft)	126.7	126.8	126.6	126.6			
Bankfull Cross Sectional Area (ft <sup>2</sup> ) <sup>2</sup>	9.0	9.0	8.0	8.4			
Bankfull Entrenchment Ratio <sup>1</sup>	>5.4	>4.9	>4.7	>5.0			
Bankfull Bank Height Ratio <sup>1</sup>	1.0	1.0	0.9	1.0			

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

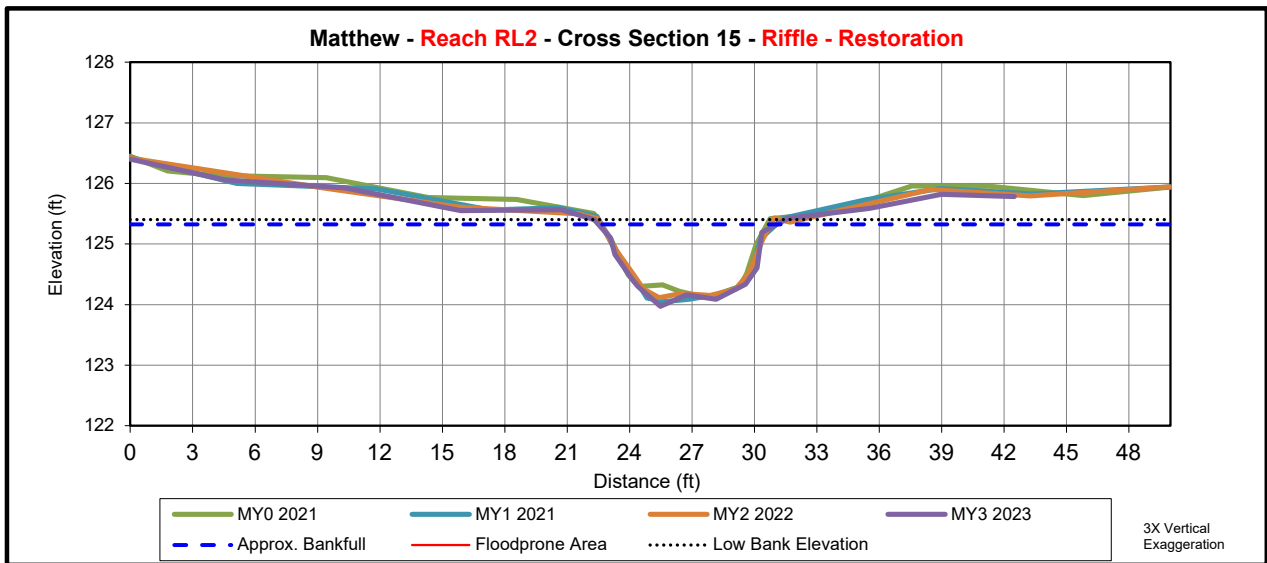
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation



Upstream



Downstream



	<b>Cross Section 15 (Rifle)</b>						
	Base	MY1	MY2	MY3	MY5	MY7	MY+
<b>Bankfull Elevation (ft) - Based on AB-XSA<sup>1</sup></b>	125.4	125.4	125.4	125.3			
Bankfull Width (ft) <sup>1</sup>	8.3	8.5	8.3	8.5			
Floodprone Width (ft) <sup>1</sup>	>50	>50	>49.9	>49.9			
Bankfull Max Depth (ft) <sup>2</sup>	1.3	1.4	1.3	1.4			
Low Bank Elevation (ft)	125.4	125.4	125.4	125.4			
Bankfull Cross Sectional Area (ft <sup>2</sup> ) <sup>2</sup>	7.7	8.5	8.1	8.4			
Bankfull Entrenchment Ratio <sup>1</sup>	>6.0	>5.9	>6.0	>5.4			
Bankfull Bank Height Ratio <sup>1</sup>	1.0	1.1	1.0	1.0			

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

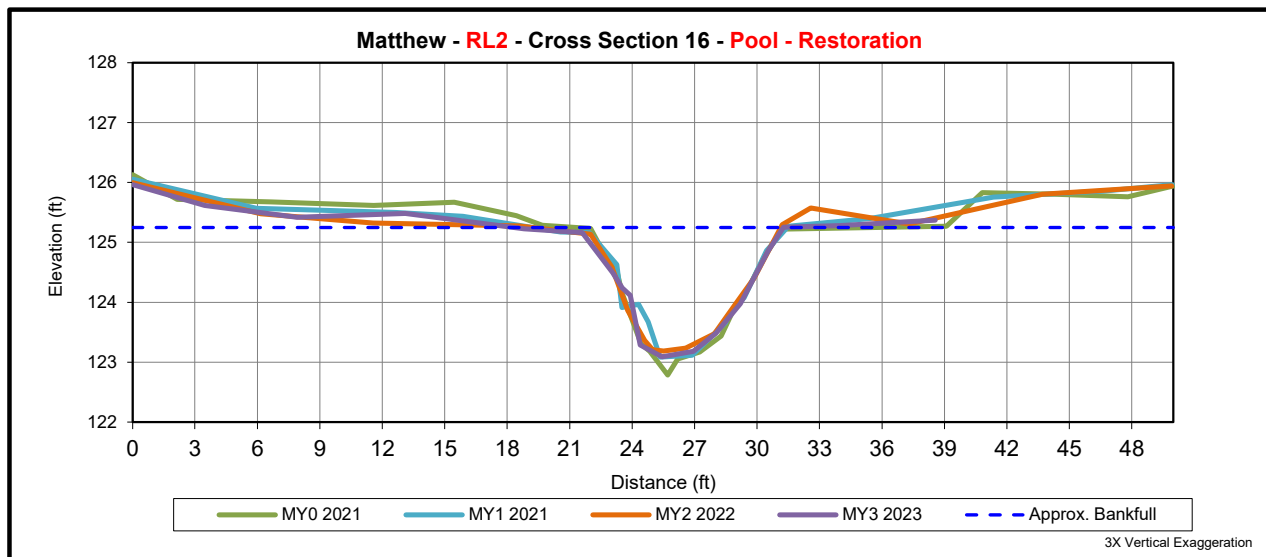
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation



Upstream



Downstream



	Cross Section 16 (Pool)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+
<b>Bankfull Elevation (ft) - Based on AB-XSA<sup>1</sup></b>	125.2	125.3	125.3	125.3			
Bankfull Width (ft) <sup>1</sup>	9.2	9.6	9.2	9.7			
Floodprone Width (ft) <sup>1</sup>	-	-	-	-			
Bankfull Max Depth (ft) <sup>2</sup>	2.4	2.1	2.0	2.1			
Low Bank Elevation (ft)	-	-	-	-			
Bankfull Cross Sectional Area (ft <sup>2</sup> ) <sup>2</sup>	12.6	11.3	11.1	11.8			
Bankfull Entrenchment Ratio <sup>1</sup>	-	-	-	-			
Bankfull Bank Height Ratio <sup>1</sup>	-	-	-	-			

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

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

**Appendix E**  
Hydrology Data  
&  
Soil Characterization

**Table 12a. 2023 Rainfall Summary**

Month	Average	Normal Limits		Project Location Precipitation*
		30 Percent	70 Percent	
November	3.24	1.87	3.94	3.70
December	3.28	2.24	3.91	4.70
January	3.37	2.39	3.99	3.96
February	3.25	2.10	3.92	3.20
March	4.23	3.10	4.98	2.91
April	3.71	2.38	4.47	4.83
May	4.25	2.93	5.06	2.67
June	4.60	2.99	5.54	5.74
July	5.56	4.24	6.47	4.14
August	5.10	3.61	6.04	10.74
September	5.02	2.98	6.09	3.32
October	3.32	2.21	3.98	0.74
November	3.24	1.87	3.94	2.13
December	3.28	2.24	3.91	-
Total Annual **	48.93	44.37	52.62	44.39
Above Normal Limits	Below Normal Limits			

WETS Station: Smithfield, NC. Approximately 7.44 miles from the site.

\*Project Location Precipitation is a location-weighted average of surrounding gauged data retrieved by the USACE Antecedent Precipitation Tool. Gauges used include Benson 7.5 ESE, Clayton 5.5 S, Clayton 5.7 SSE, Clayton 6.8 ESE, Clayton WTP, Four Oaks 5.7 NW, Selma 2.3 N, Smithfield 2.8 SE, and Smithfield

\*\*Total Annual represents the average total precipitation, annually, as calculated by the 30-year period.

**Table 12b. Drought Summary**

<b>MY2 Johnston County Drought Outlook</b>			
	<b>D0 - Abnormally Dry</b>	<b>D1 - Moderate Drought</b>	<b>D2 - Severe Drought</b>
<b>(Antecedent) Dormant Season (9/28/2021 - 3/17/2022)</b>			
Total weeks	25	25	25
Drought weeks	19	9	5
Percent	76%	36%	20%
<b>Growing Season (3/18/2022 - 11/15/2022)</b>			
Total weeks	35	35	35
Drought weeks	18	0	0
Percent	51%	0%	0%
<b>Total Period (9/28/2021 - 11/15/2022)</b>			
Total weeks	60	60	60
Drought weeks	49	31	19
Percent	82%	52%	32%

\* Indicates number of weeks that some or all of Johnston County was in a drought according to USDM

<b>MY3 Johnston County Drought Outlook</b>			
	<b>D0 - Abnormally Dry</b>	<b>D1 - Moderate Drought</b>	<b>D2 - Severe Drought</b>
<b>(Antecedent) Dormant Season (11/15/2022 - 3/17/2023)</b>			
Total weeks	18	18	18
Drought weeks*	12	0	0
Percent	67%	0%	0%
<b>Growing Season (3/18/2023 - 11/15/2023)</b>			
Total weeks	36	36	36
Drought weeks*	30	0	0
Percent	83%	0%	0%
<b>Total Period (11/15/2022 - 11/27/2023)</b>			
Total weeks	54	54	54
Drought weeks*	31	0	0
Percent	57%	0%	0%

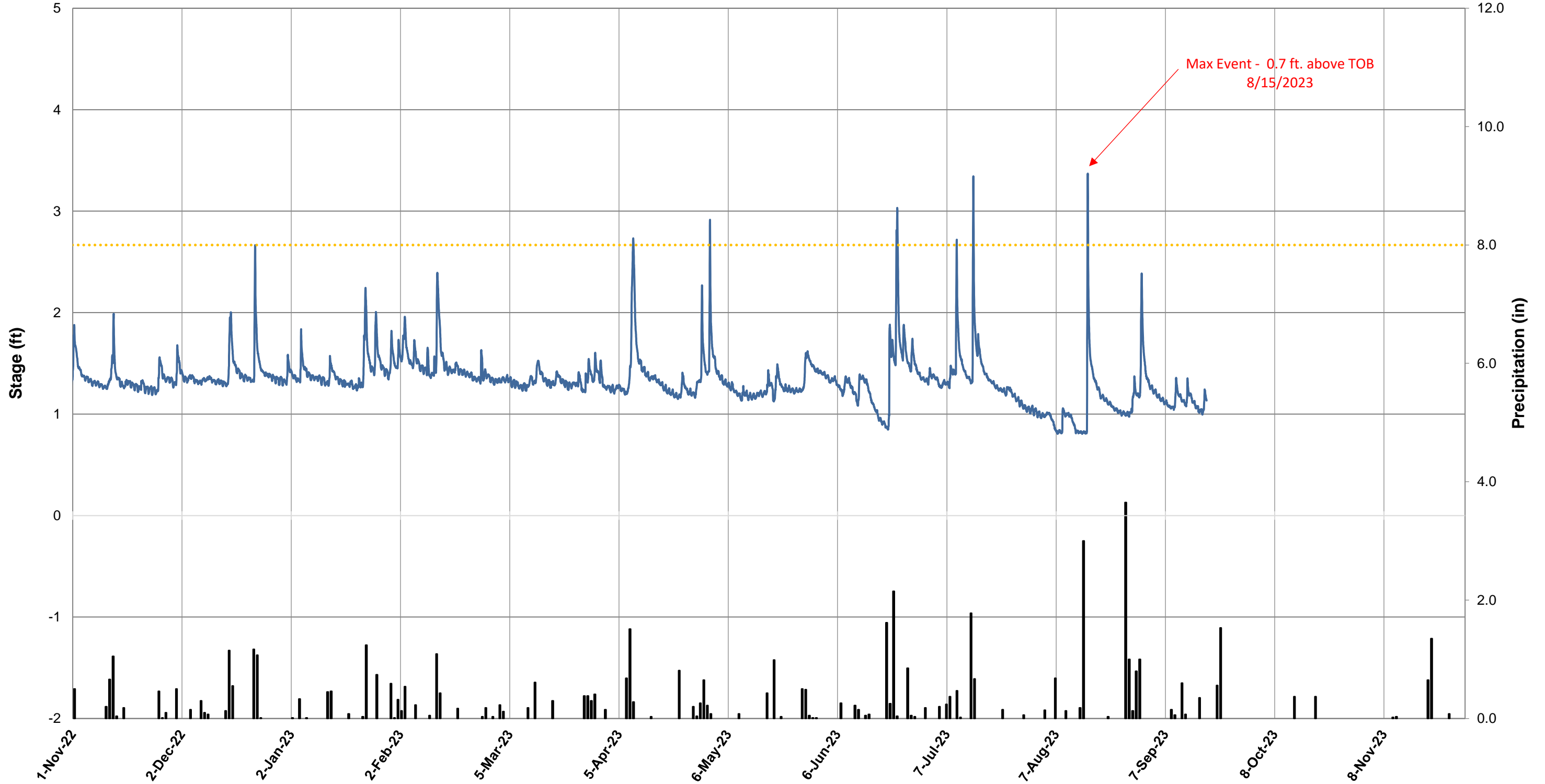
\* Indicates number of weeks that some or all of Johnston County was in a drought according to USDM



**Table 13. Documentation of Geomorphically Significant Flow Events**

<b>Year</b>	<b>Number of Bankfull Events</b>	<b>Maximum Bankfull Height (ft)</b>	<b>Date of Maximum Bankfull Event</b>
Stage Recorder RL1-A			
MY1 2021	15	2.11	7/20/2021
MY2 2022	6	1.28	8/23/2022
MY3 2023	7	0.7	8/15/2023
Stage Recorder RL2			
MY1 2021	11	2.78	7/20/2021
MY2 2022	11	2.64	7/8/2022
MY3 2023	25	1.89	7/14/2023

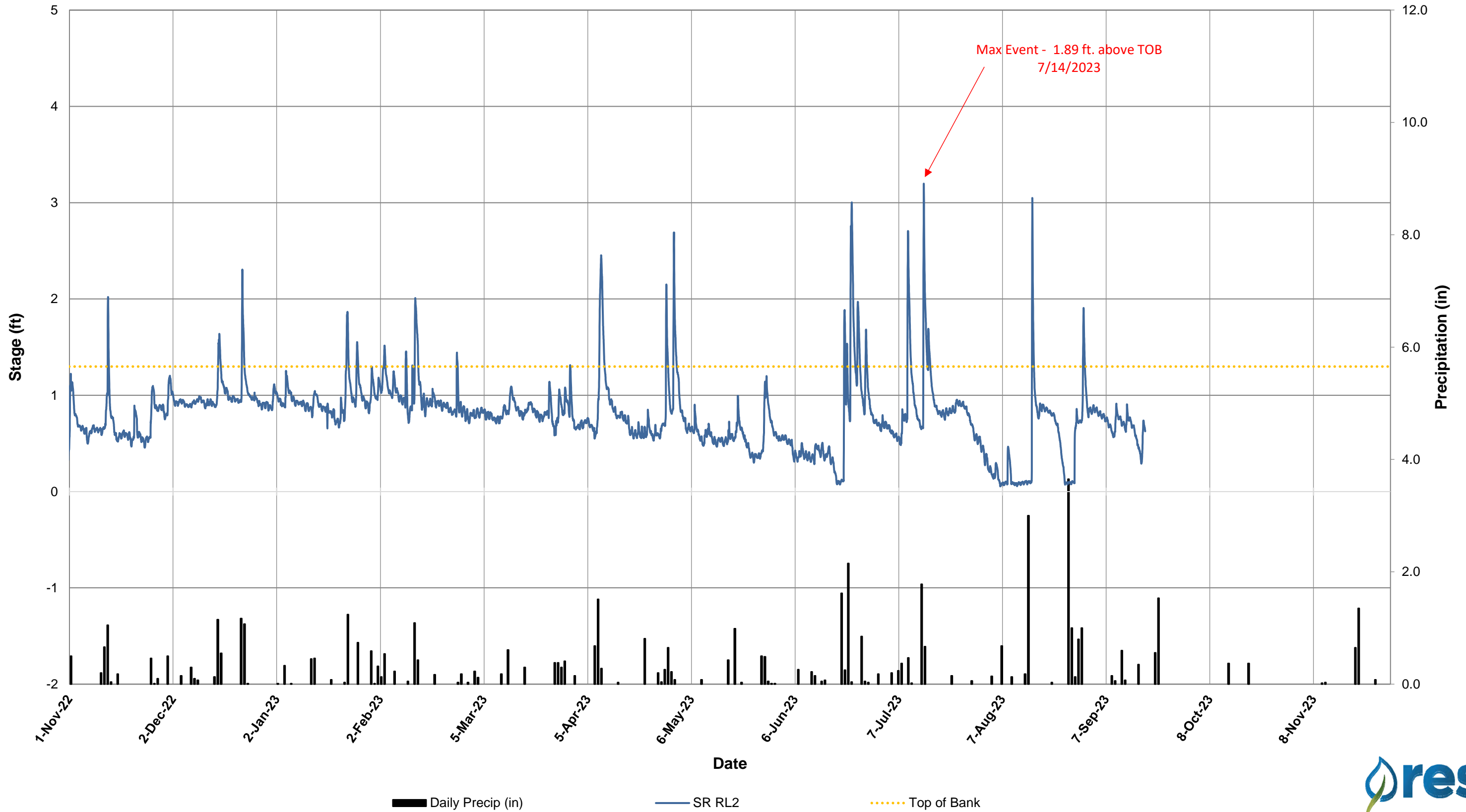
# MY3 Matthew RL1-A Stage Recorder Graph



■ Daily Precip (in)      — SR RL1-A      ..... Top of Bank



# MY3 Matthew RL2 Stage Recorder Graph



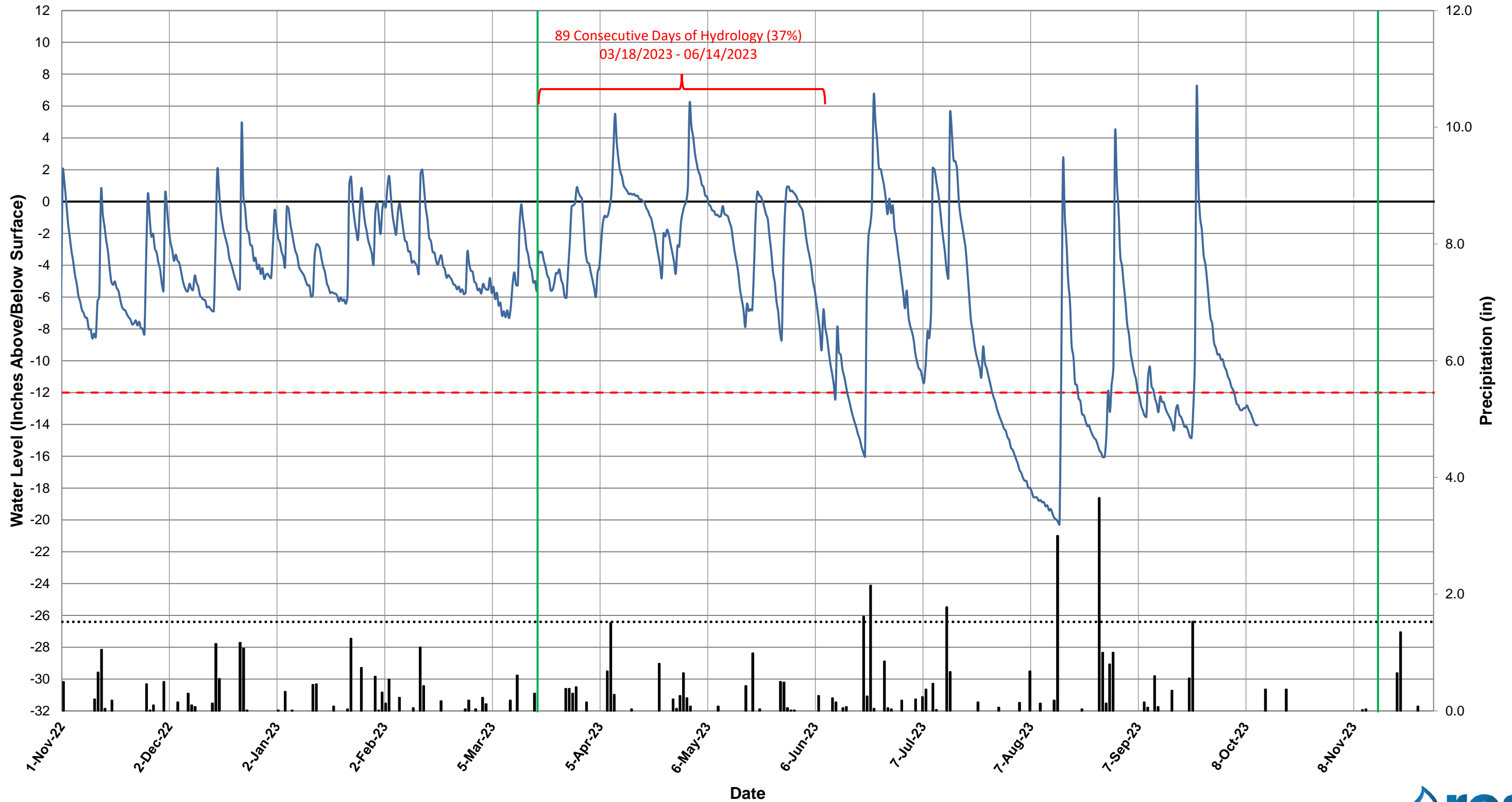
**Table 14. 2023 Max Hydroperiod**

2023 Max Hydroperiod (Growing Season 18-Mar through 15-Nov, 242 days)					
Well ID	Consecutive		Cumulative		Occurrences
	Days	Hydroperiod (%)	Days	Hydroperiod (%)	
<b>GW1</b>	89	37	153	63	6
<b>GW2</b>	1	0	3	1	5
<b>GW3</b>	5	2	26	11	19
<b>GW4</b>	3	1	11	4	8
<b>GW5</b>	34	14	71	29	10
<b>GW6</b>	33	13	101	42	13
<b>GW7</b>	4	2	22	9	10
<b>GW8</b>	30	12	76	31	13
<b>REF GW1</b>	92	38	174	72	7
<b>REF GW2</b>	57	23	112	46	7
<5%	6-11%	>12%			

**Table 15. Summary of Groundwater Monitoring Results**

Summary of Groundwater Monitoring Results									
Matthew									
Well ID	Wetland ID	Ground Elevation (ft)	Hydroperiod (%)						
			Year 1 (2021)	Year 2 (2022)	Year 3 (2023)	Year 4 (2024)	Year 5 (2025)	Year 6 (2026)	Year 7 (2027)
<b>GW1</b>	WA	126.92	39	19	37				
<b>GW2</b>	WA	127.43	1	0	0				
<b>GW3</b>	WA	126.70	2	1	2				
<b>GW4</b>	WA	126.31	2	1	1				
<b>GW5</b>	WA	124.95	25	11	14				
<b>GW6</b>	WA	123.89	14	7	13				
<b>GW7</b>	WF	123.88	6	1	2				
<b>GW8</b>	WF	123.58	7	12	12				
<b>REF GW1</b>	WE	N/A	67	19	38				
<b>REF GW2</b>	WB	N/A	36	25	23				
<5%	6-11%	>12%							

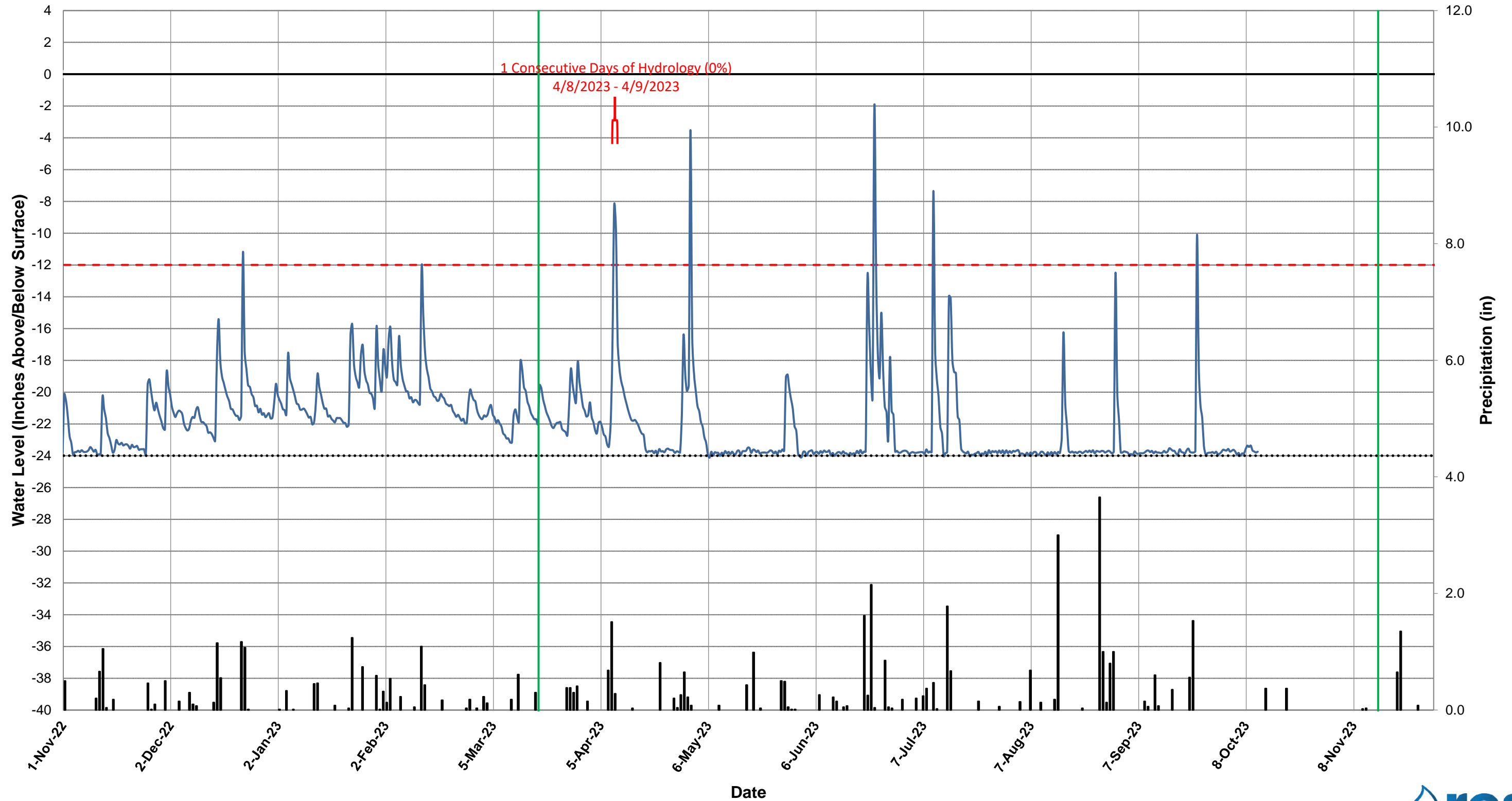
# 2023 Matthew GW1



■ Daily Precip (in)    — GW1    — Growing Season Start    — Growing Season End    ..... Logger Depth



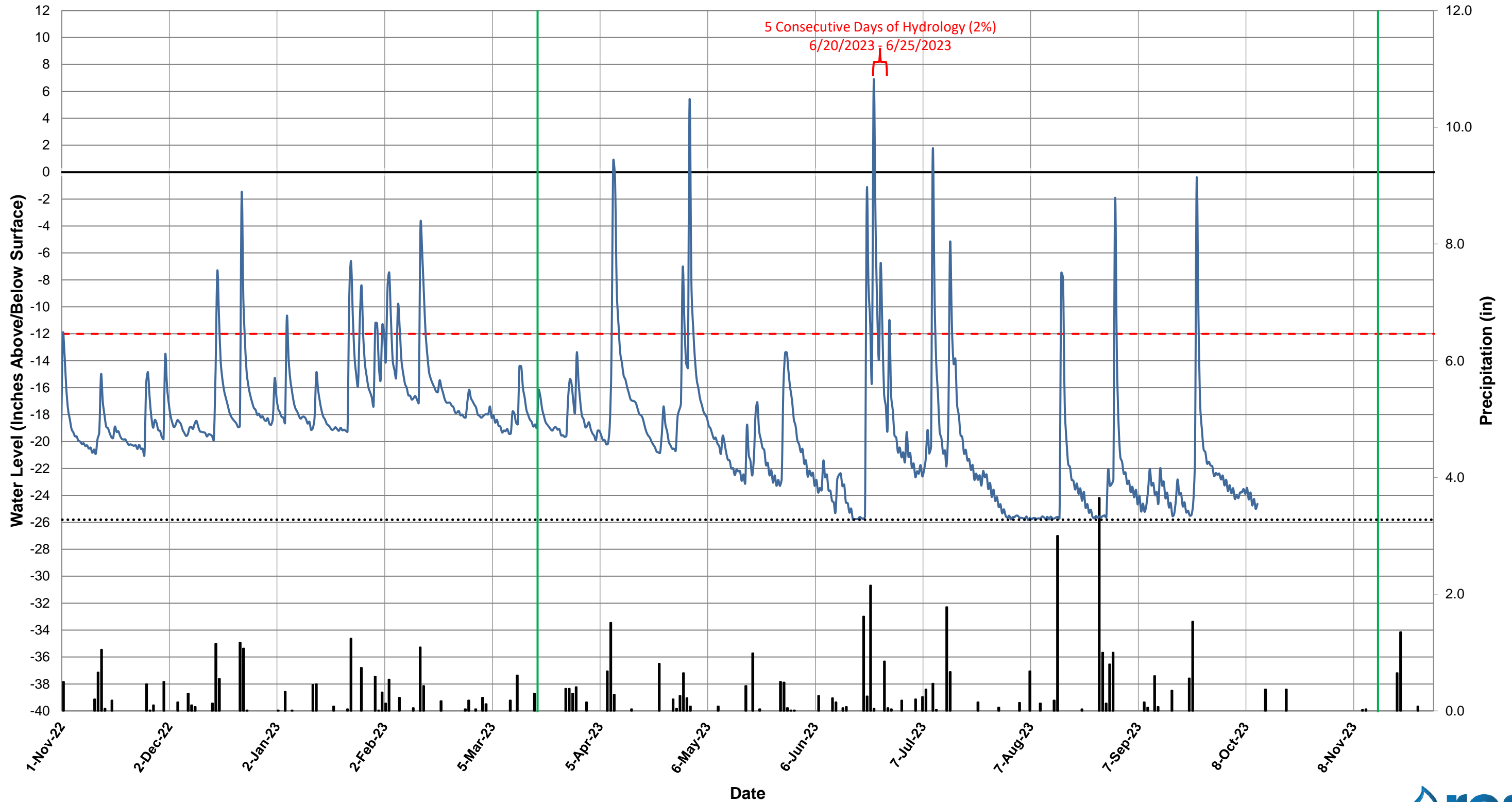
# 2023 Matthew GW2



■ Daily Precip (in)    — GW2    — Growing Season Start    — Growing Season End    ..... Logger Depth



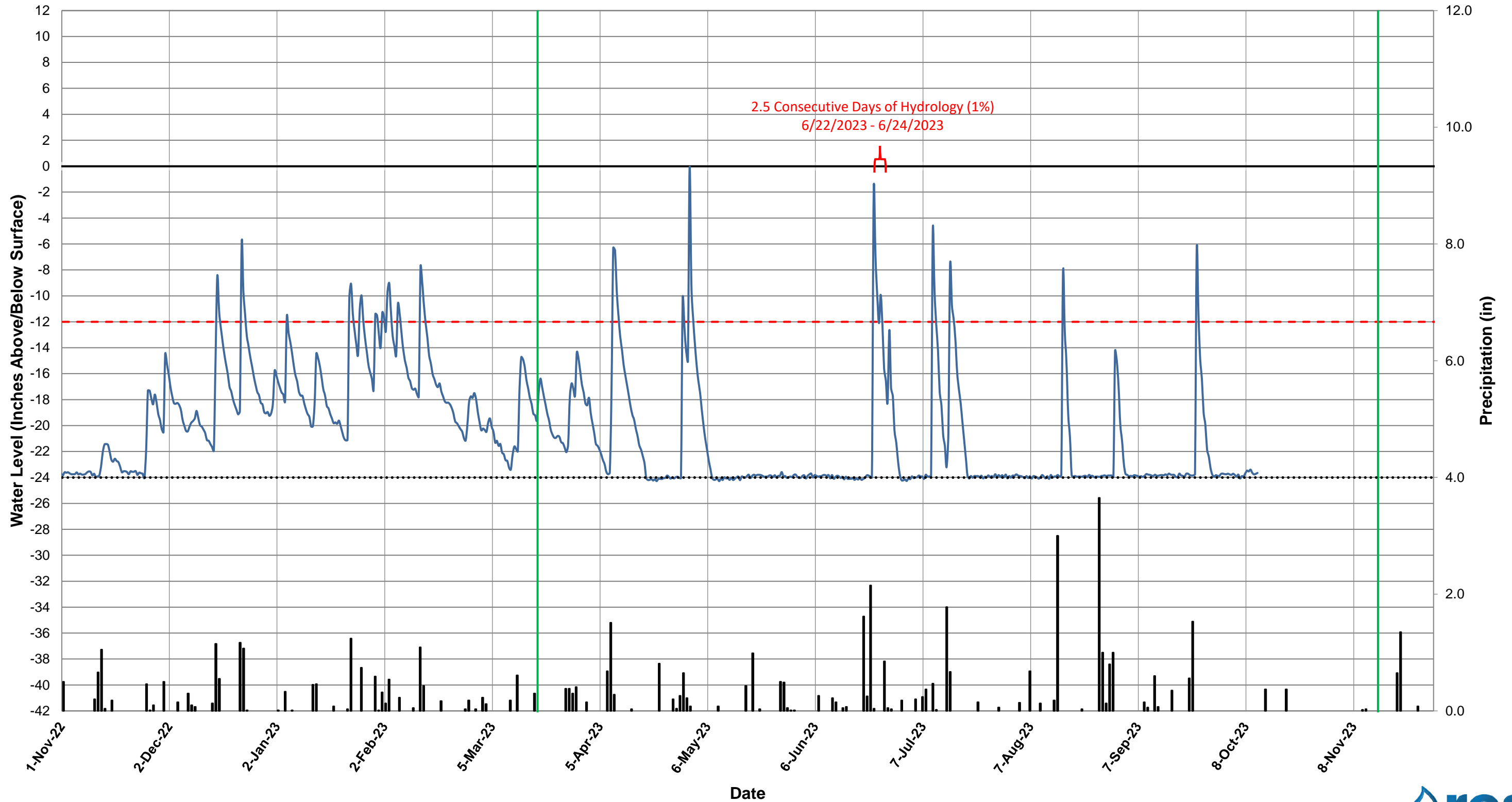
# 2023 Matthew GW3



■ Daily Precip (in)    — GW3    — Growing Season Start    — Growing Season End    ..... Logger Depth



# 2023 Matthew GW4

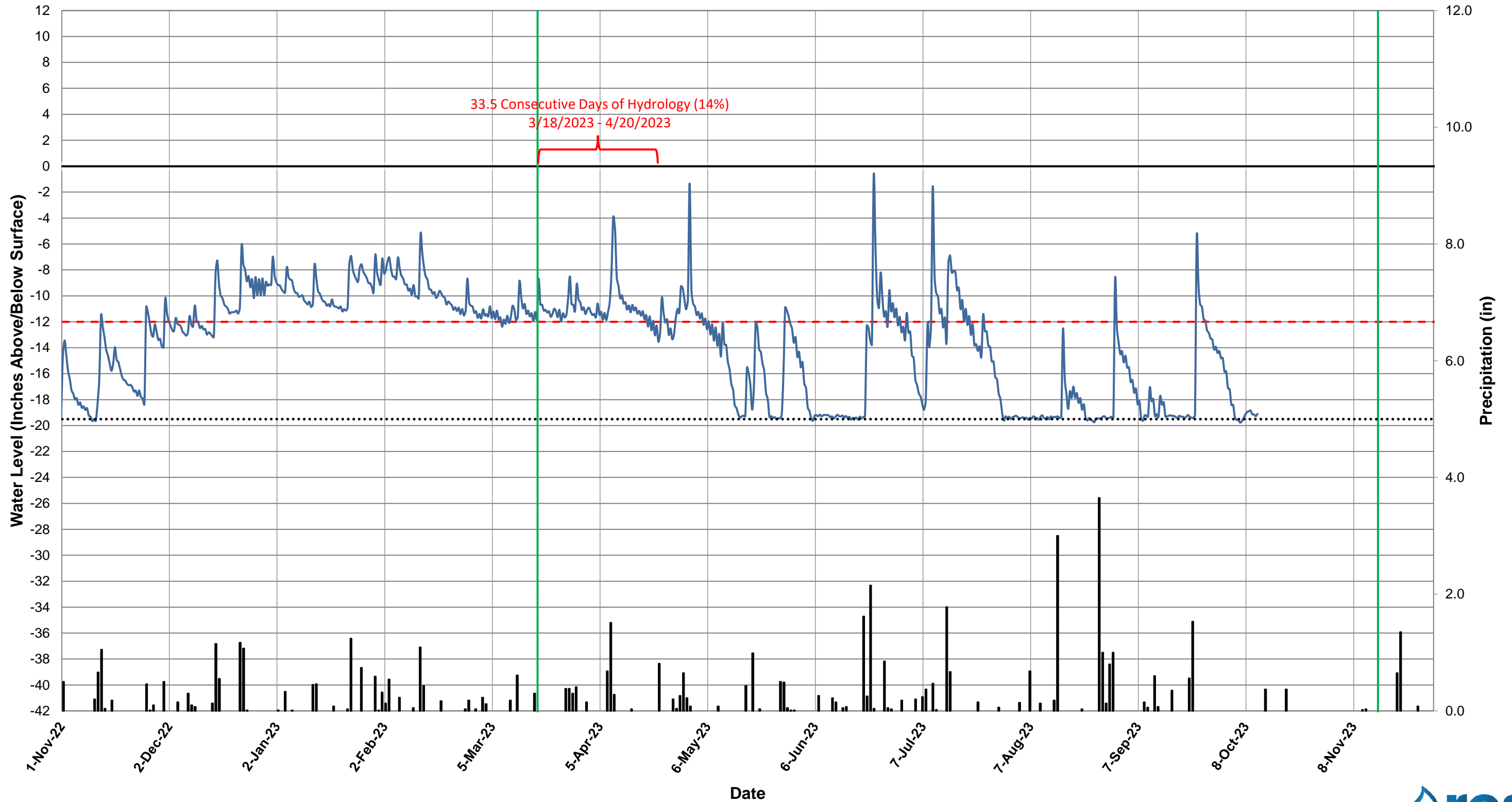


■ Daily Precip (in)    — GW4    — Growing Season Start    — Growing Season End    ..... Logger Depth





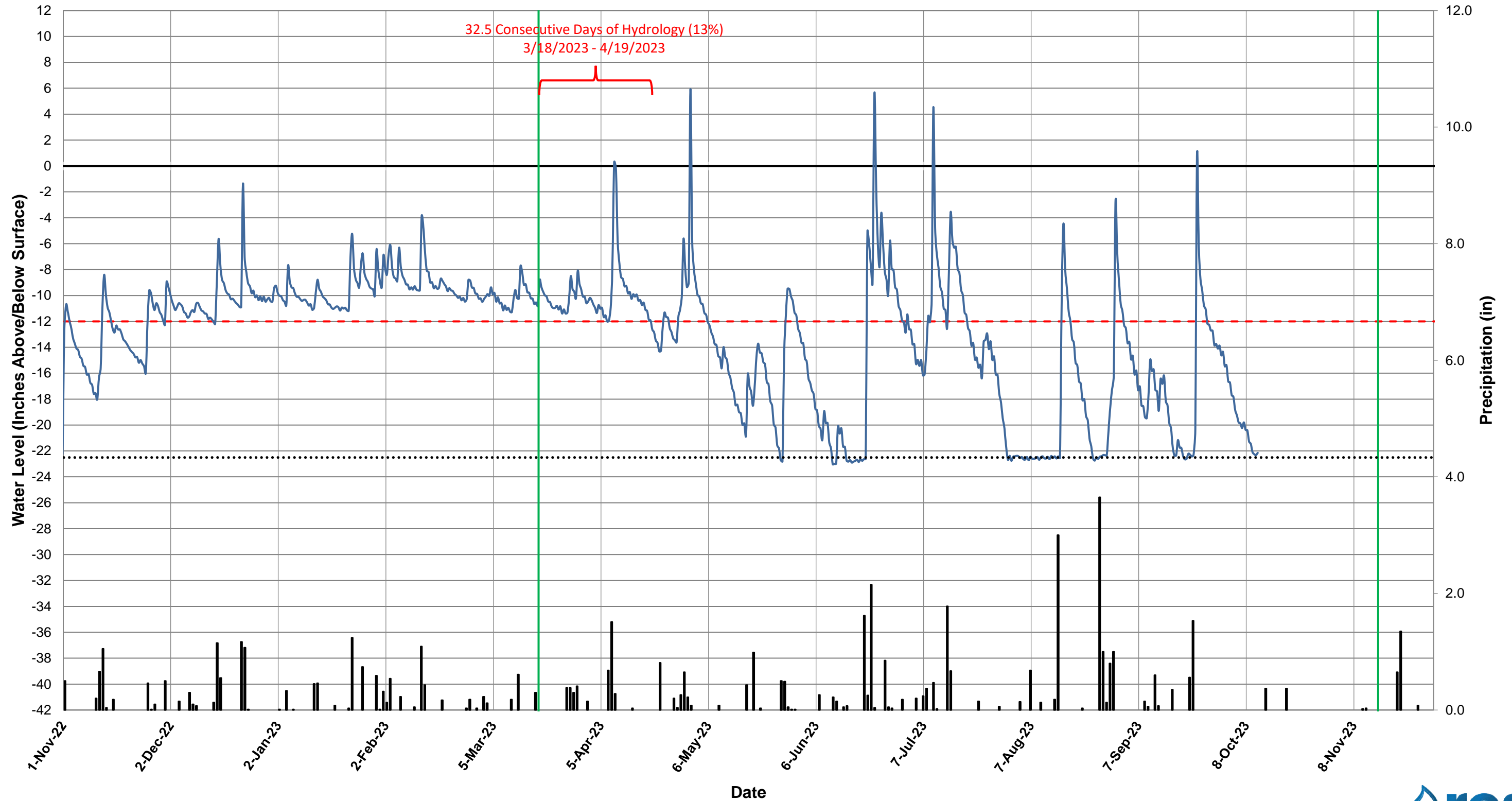
# 2023 Matthew GW5



■ Daily Precip (in)    — GW5    — Growing Season Start    — Growing Season End    ..... Logger Depth



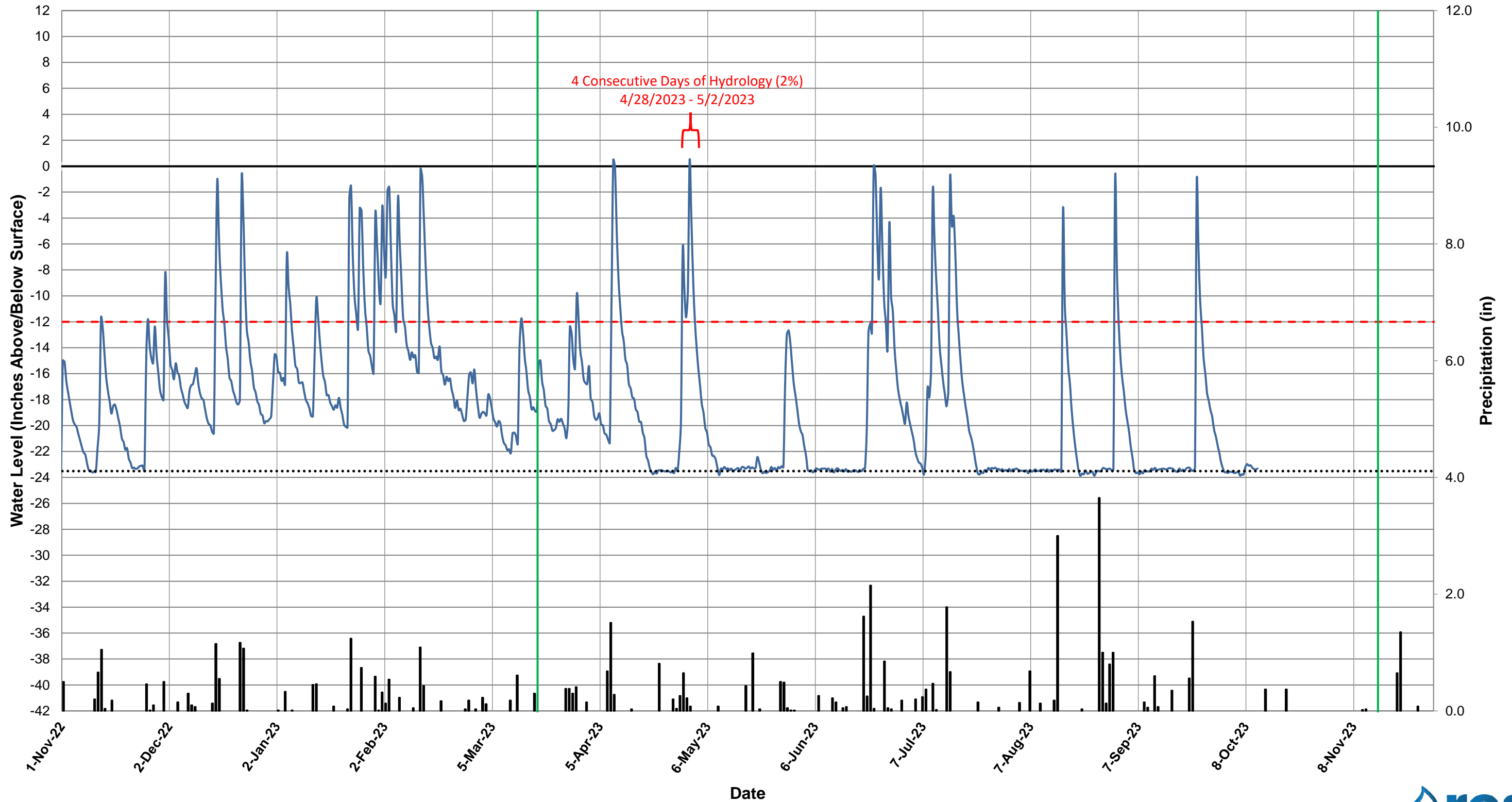
# 2023 Matthew GW6



■ Daily Precip (in)    — GW6    — Growing Season Start    — Growing Season End    ..... Logger Depth



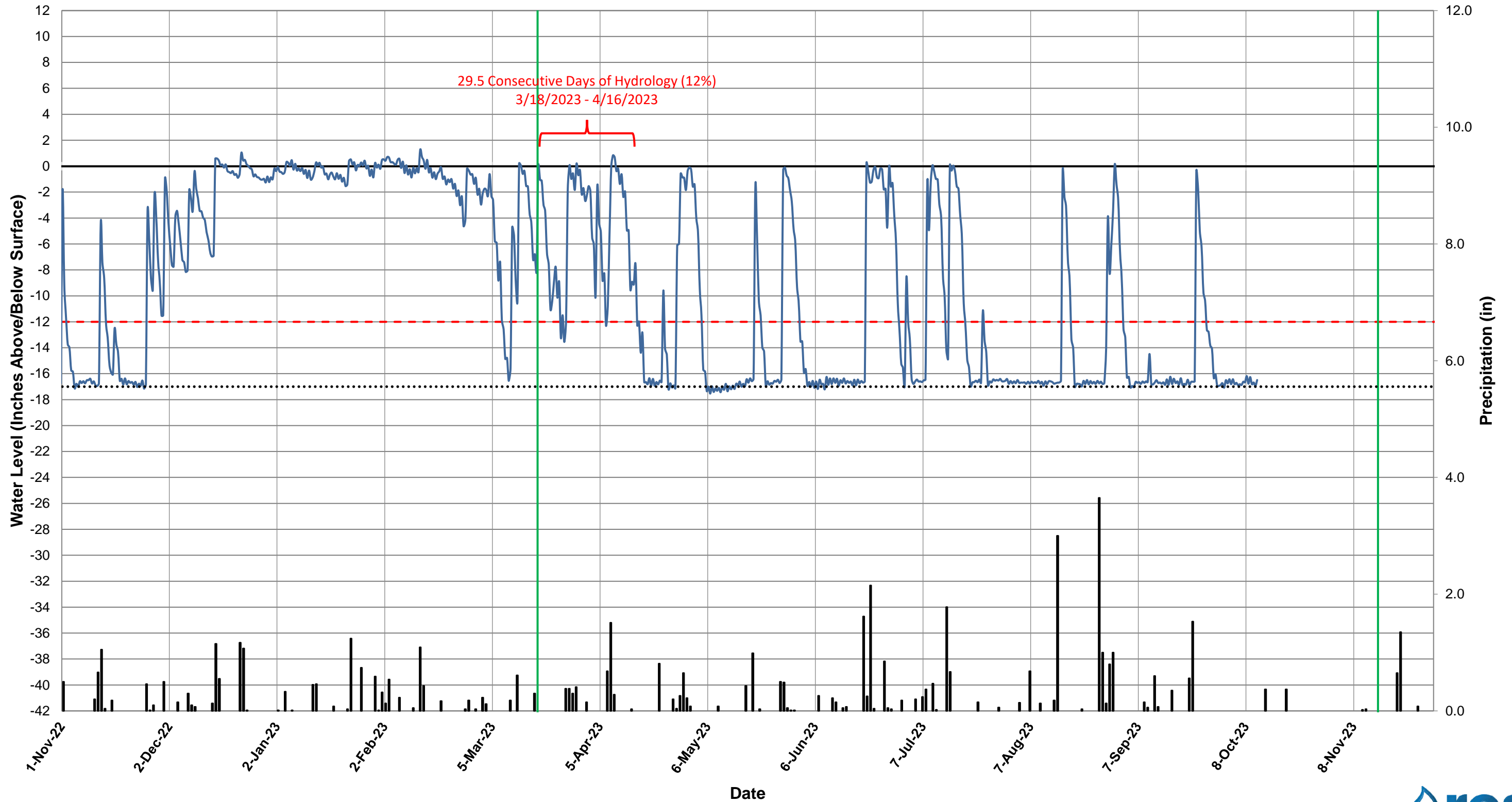
# 2023 Matthew GW7



■ Daily Precip (in)    — GW7    — Growing Season Start    — Growing Season End    ..... Logger Depth



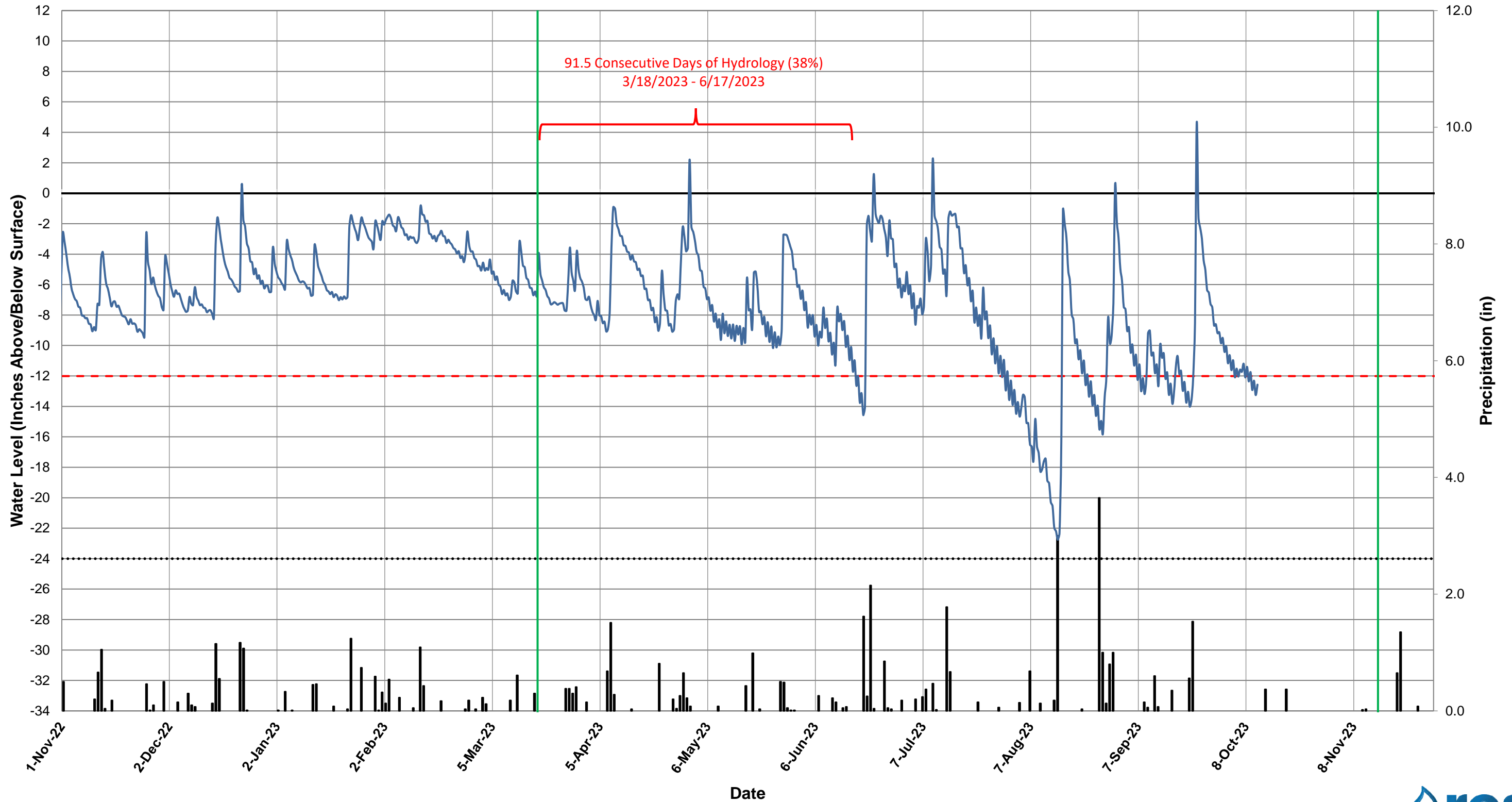
# 2023 Matthew GW8



■ Daily Precip (in)    — GW8    — Growing Season Start    — Growing Season End    ..... Logger Depth



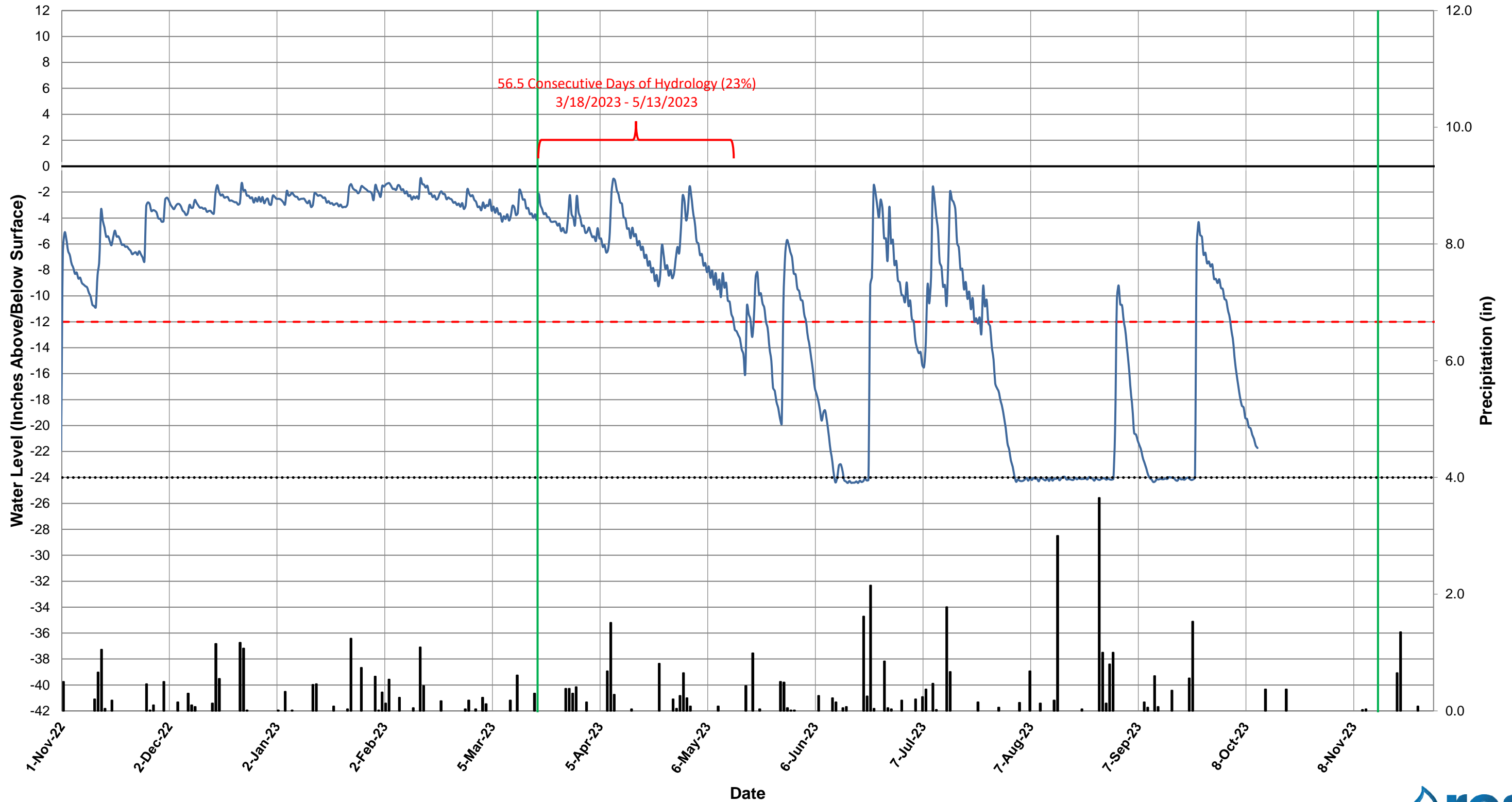
# 2023 Matthew REF GW1



■ Daily Precip (in)    — REFGW1    — Growing Season Start    — Growing Season End    ..... Logger Depth



# 2023 Matthew REF GW2



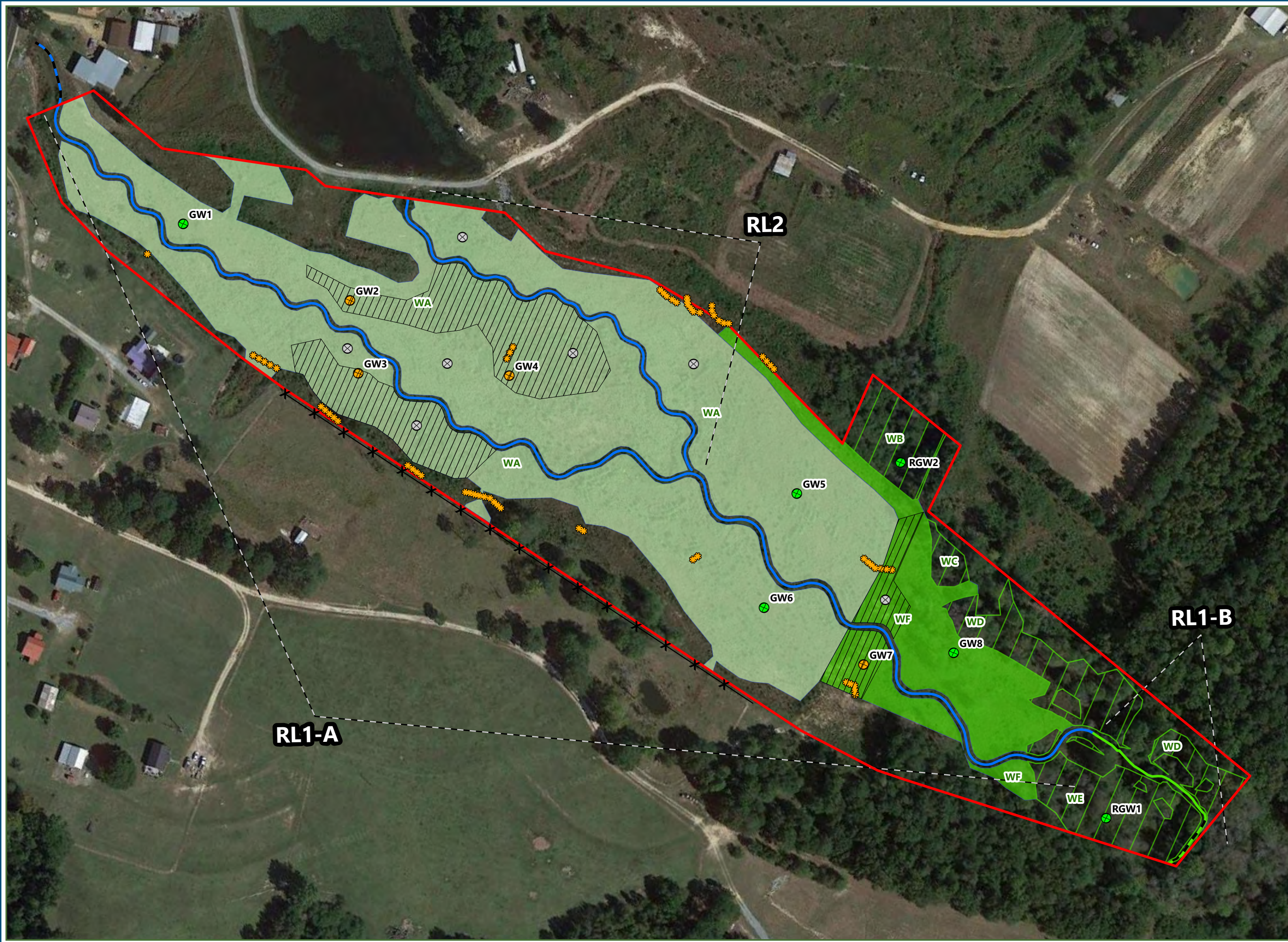
■ Daily Precip (in)    — REFGW2    — Growing Season Start    — Growing Season End    ..... Logger Depth



**Figure 3**  
Wetland Investigation

MY3 2023

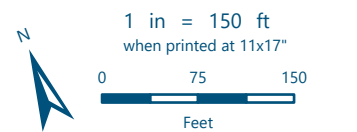
**Matthew**  
Johnston County, North Carolina  
78.4062°W 35.4222°N



- Conservation Easement
- Wetland Investigation Area
- Wetland Mitigation Approach**
- Rehabilitation (2:1)
- Re-establishment (1:1)
- Preservation
- Stream Mitigation Approach**
- Restoration
- Preservation
- Restoration (No credit)
- Preservation (No credit)
- X Fence Installation
- Engineered Sediment Pack
- Groundwater Wells**
- > 12% Hydroperiod
- < 5% Hydroperiod
- ⊗ Proposed Additional Groundwater Wells

**Vegetation Condition Assessment**

Invasive Species	Target Community		
	Present	Marginal	Absent
Absent			
Present			



*Reference:* This information is not to be used as final legal boundaries.  
*Imagery Source:* Google  
*Spatial Reference:* NAD 1983 StatePlane North Carolina FIPS 3200 Feet  
*Date Exported:* 12/20/2023

