**Year 1 Monitoring Report**

FINAL

# 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 2022**

Mitigation Services
ENVIRONMENTAL QUALITY

ROY COOPER
*Governor*

ELIZABETH BISER
*Secretary*

January 18, 2022

Via email: kwebber@res.us

Katie Webber
RES / EBX

Subject: Matthew MY1 Comments, Project ID #100043, DMS Contract #0007419

Katie,

After receiving the Draft MY1 report, DMS offers the following comments:

1. Please review DMS Monitoring Report Guidance. This report has a lot of extraneous information that is not necessary, and any condensing of this information is suggested. Examples of things that can be removed are section 1.5, 1.6, and 2.0.
2. Section 1.7 “baseline” is typically used and synonymous with MY0. Please update to show describe MY1 monitoring.
3. CCPV. This map is typically used in monitoring to describe the current conditions of each monitoring year, and this one is a little confusing because of all the detail. Please write out what ESP stands for on legend. Also, it is very difficult to see which portions of the stream and for credit and not for credit. Please update color coding. You can also turn off the structure layers and fill/spoil removal if desired for clarity.

Electronic comments:

1. Please include figures displaying the stage recorder data for RL1-A and RL2.

Thanks for your work,

LHCrocker.

Lindsay Crocker, DMS

# M E M O R A N D U M

3600 Glenwood Avenue, Suite 100 Raleigh, North Carolina 27612 919.770.5573 tel. 919.829.9913 fax

**TO:** **NCDEQ Division of Mitigation Services**

**FROM:** **Katie Webber – RES**

**DATE:** **February 2, 2022**

**RE:** **Response to Draft MY1 Monitoring Report Comments – Matthew Mitigation Site (DMS #100043) Neuse 03020201; Johnston County, NC; Contract No. 0007419**

**Comments:**

1. Please review DMS Monitoring Report Guidance. This report has a lot of extraneous information that is not necessary, and any condensing of this information is suggested. Examples of things that can be removed are section 1.5, 1.6, and 2.0.

   RES understands that the monitoring reports deviate somewhat from the most recent DMS template. However, in order to be consistent with all our DMS projects across the state, we request that the current format remains, at least for established projects. We also find that including the summaries of design, construction, and methodology is helpful to have in each annual report to use as a convenient reference, especially while on site visits with regulators.

2. Section 1.7 "baseline" is typically used and synonymous with MY0. Please update to show describe MY1 monitoring.

   Thank you. This was a typo. Language has been updated to Year 1 Monitoring (MY1).

3. CCPV. This map is typically used in monitoring to describe the current conditions of each monitoring year, and this one is a little confusing because of all the detail. Please write out what ESP stands for on legend. Also, it is very difficult to see which portions of the stream and for credit and not for credit. Please update color coding. You can also turn off the structure layers and fill/spoil removal if desired for clarity.

   CCPV has been revised. ESP is spelled out as "Engineered Sediment Pack." Colors have been updated for the No Credit stream portions, and to clarify, the only No Credit stream segments are RL1-B at the very bottom of the site where the channel abuts the easement/property boundary and the top of RL1-A, outside of the easement below the NC-96 DOT culvert. Both Structures layer and Fill/Spoil Removal areas layer were removed.

**Electronic Comments:**

1. Please include figures displaying the stage recorder data for RL1-A and RL2.

   Stage recorder hydrographs have been created for both reaches. The charts/figures have been added to Appendix E. As for the electronic submission, the excel spreadsheet "MY1_WellCharts_2021" has been updated to include these as well (in folder 5).

## Table of Contents

# 1.0 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.

#### 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.

#### 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.

Vegetation Success Criteria

Specific and measurable success criteria for plant density within the riparian buffers on the Project follow IRT Guidance. The interim measures of vegetative success for the Project is the survival of at least 320 planted three-year old trees per acre at the end of Year 3, 260 trees per acre with an average height of seven feet at the end of Year 5, and the final vegetative success criteria is 210 trees per acre with an average height of 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 |
| **Total** | **3,572** | | **3,253.400** |
| | | | |
| **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 |
| **Total** | **14.165** | | **7.207** |

## *1.5 Design and Approach*

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.

### 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. 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 are included in **Appendix E**.

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 1 Monitoring Performance (MY1)*

The Matthew Year 1 Monitoring activities were performed in November 2021. All MY1 data is present below and in the appendices. The Site is on track to meeting vegetation, wetland, and stream interim success criteria.

#### Vegetation

Monitoring of the ten permanent vegetation plots and four random vegetation plots was completed on November 9, 2021. Vegetation data are in **Appendix C**, associated photos are in **Appendix B,** and plot locations are in **Appendix B**. MY1 monitoring data indicates that all plots are exceeding the interim success criteria of 320 planted stems per acre. Planted stem densities ranged from 567 to 1,093 planted stems per

acre with a mean of 789 planted stems per acre across all plots. A total of 12 species were documented within the plots. Volunteer species were noted in 7 plots and are expected to establish further in upcoming years. Notably, hazel alder (*Alnus serrulata*), yellow polar (*Liriodendron tulipifera*), and black willow (*Salix nigra*) volunteers are appearing and will likely contribute as a desirable species component to the community. The average stem height in the vegetation plots was 2.6 feet.

Visual assessment of vegetation outside of the monitoring plots indicates that the herbaceous vegetation is becoming well established throughout the project. There is a patch of invasive Chinese privet in the downstream forested area off the left bank of RL1 that is noted in **Table 6** and depicted in **Figure 2**. The area will be treated in 2022.

### Stream Geomorphology

Geomorphology data collection for MY1 was collected in November 2021. 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.

### Stream Hydrology

Two stage recorders are currently recording bankfull events on reaches RL1-A and RL2. The stage recorder on RL1-A recorded 15 bankfull events in MY1 with the highest reading being 2.11 feet above the top of bank. The stage recorder on RL2 recorded 11 bankfull events in MY1 with the highest reading being 2.78 feet above the top of bank. Stage recorder locations can be found on **Figure 2**, photos are in **Appendix B**, and hydrology data are in **Appendix E**.

### 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 MY1 demonstrates consecutive hydroperiods ranging from two to 69 percent across all wells onsite. GW2, GW3, GW4, and GW7 fell short of the 12 percent success criteria with hydroperiods ranging from two to seven percent. These lower hydroperiods for the year may be due to multiple factors:

- The beginning and end of the growing season for Johnston County was lower than average, with the end of the growing season falling with a moderate drought period according to U.S. Drought Monitor (See **Appendix E** rain data).
- As mentioned in the approved mitigation plan, due to extensive construction, including stream channel construction and dam removal and the associated soil compaction, “there may be a reduced hydroperiod for the first two years after construction.”

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*

*sagittate*). Evidence of this vegetation can be seen in photos in **Appendix B**. Being the first year post-construction, RES anticipates that the restored wetlands will continue to equilibrate, and under normal climate conditions, hydroperiods will increase. All wetland hydrology data can be found in **Appendix E**. Additionally, upon request by the IRT, RES characterized soil at each groundwater well and data forms are included in **Appendix E**.

## 2.0 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 (**Appendix E)**.

## 3.0 References


Griffith, G.E., J.M.Omernik, J.A. Comstock, M.P. Schafale, W.H.McNab, D.R.Lenat, T.F.MacPherson, J.B. Glover, and V.B. Shelburne. (2002). Ecoregions of North Carolina and South Carolina, (color Poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,500,000).

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

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

Resource Environmental Solutions (2019). Matthew Site Final Mitigation Plan.

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

USACE. Wetlands Regulatory Assistance Program. 2005. Technical Standard for Water-Table Monitoring of Potential Wetland Sites.

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

# 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 | **3230.000** | | | **7.001** | | |
| Re-establishment | | | | | | |
| Rehabilitation | | | | | | |
| Enhancement | | | | | | |
| Enhancement I | | | | | | |
| Enhancement II | | | | | | |
| Creation | | | | | | |
| Preservation | **23.400** | | | **0.206** | | |
| **Total** | **3253.400** | | | **7.207** | | |

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

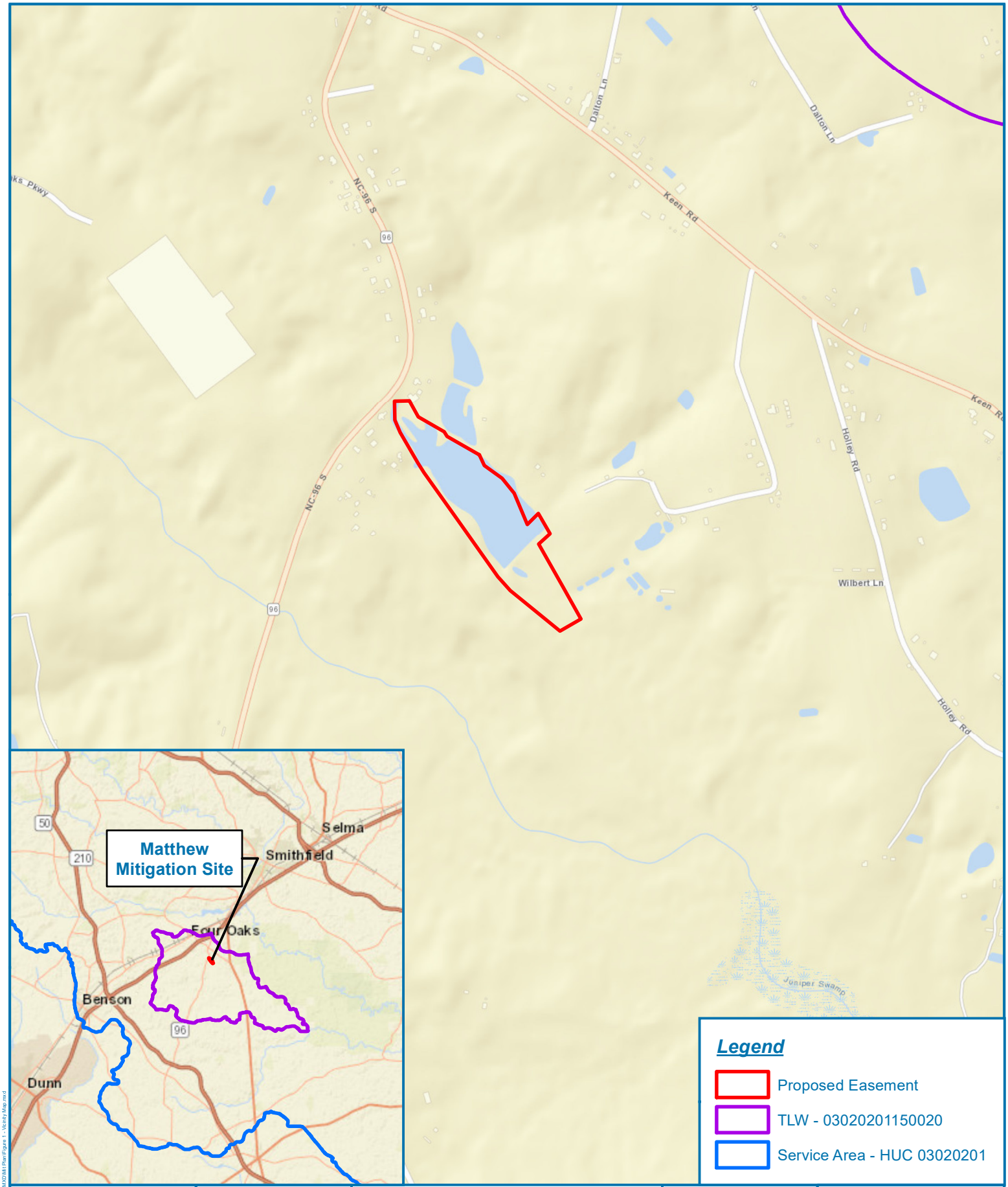
**Elapsed Time Since grading complete:** **11 months**
**Elapsed Time Since planting complete:** **9 months**
**Number of reporting Years[1]:** **1**

| Activity or Deliverable | Data Collection Complete | Completion or Delivery |
|---|---|---|
| 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 | | |
| Year 3 Monitoring | | |
| Year 4 Monitoring | | |
| Year 5 Monitoring | | |
| Year 6 Monitoring | | |
| Year 7 Monitoring | | |

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

| Table 3. Project Contacts Table<br>Matthew Mitigation Site | |
|---|---|
| **Designer**<br><br>Primary project design POC | RES / 3600 Glenwood Ave., Suite 100, Raleigh, NC 27612<br><br>Frasier Mullen, PE |
| **Construction Contractor**<br><br>Construction contractor POC | KBS Earthwork Inc. / 5616 Coble Church Rd., Julian, NC 27283<br><br>Kory Strader |
| **Survey Contractor**<br><br>Survey contractor POC | Matrix East, PLLC / 906 N. Queen St., Suite A, Kinston, NC 28501<br><br>Chris Paderick, PLS |
| **Planting Contractor**<br><br>Planting contractor POC | Shenandoah Habitats<br><br>David Coleman |
| **Monitoring Performers** | RES / 3600 Glenwood Ave, Suite 100, Raleigh, NC 27612 |
| Monitoring POC | Ryan Medric (919) 741-6268 |

| Table 4. Project Background Information | | | | | | |
|---|---|---|---|---|---|---|
| Project Name | | 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 |




0 500 1,000
Feet

**Figure 1 - Site Location Map**

## Matthew Mitigation Site

**Johnston County, North Carolina**

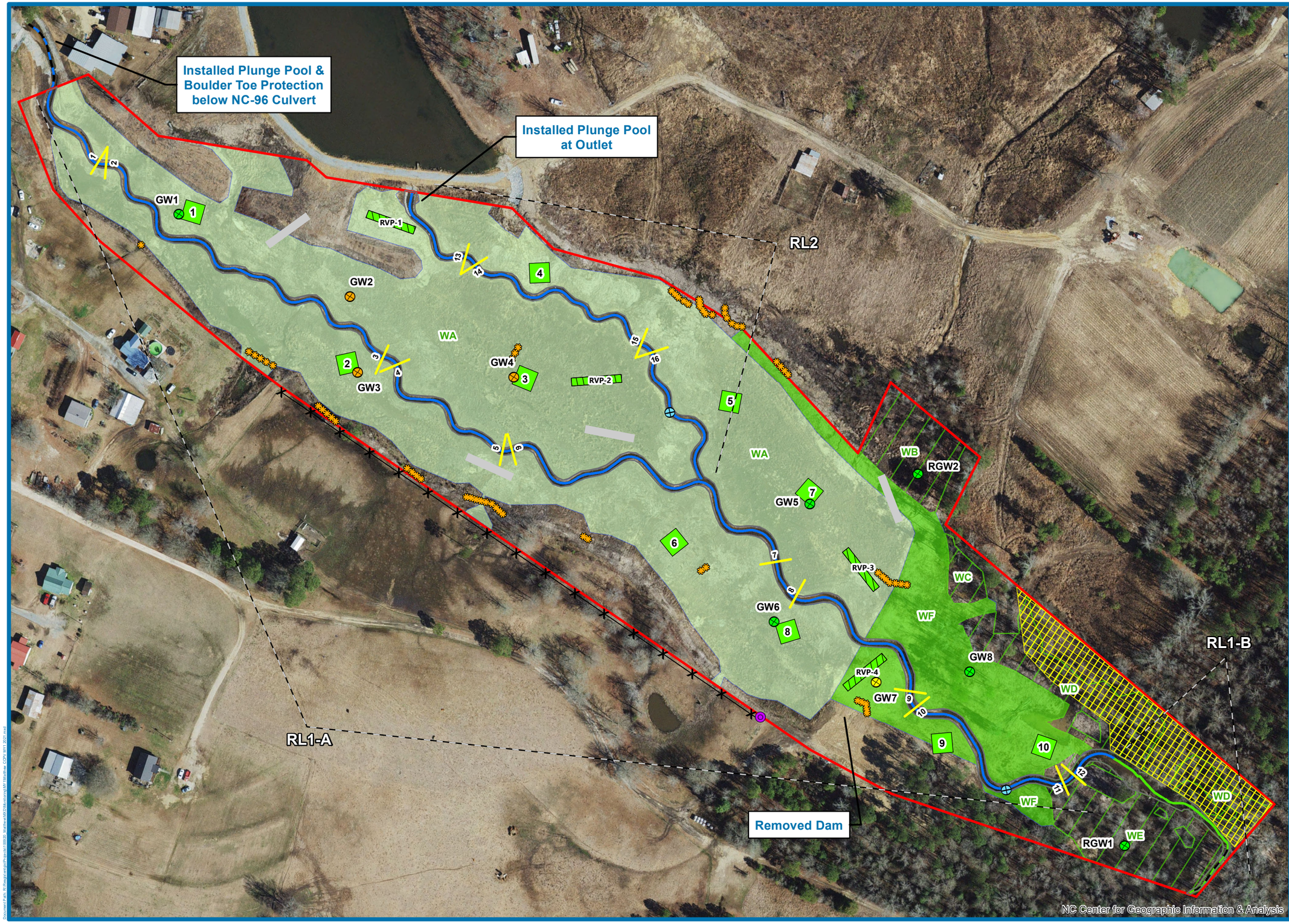
| | |
|---|---|
| Date: | 4/3/2019 |
| Drawn by: | MDD |
| Checked by: | BPB |
| | 1 inch = 1,000 feet |

res

Document Path: S:\@RES GIS\Projects\NC\Matthew\MXD\M1 Plan\Figure 1 - Vicinity Map.mxd

# Appendix B

Visual Assessment Data




res

N
W
E
S

0 75 150
Feet

**Figure 2**

Current Conditions
Plan View

MY1 2021

Matthew
Mitigation Site

Johnston County, NC

| | |
|---|---|
| Date: 2/2/2022 | Drawn by: RTM |
| Lat: 35.424918 | Long: -78.408148 |

## LEGEND

**Groundwater Wells**
- >12% Hydroperiod
- 5-11% Hydroperiod
- <5% Hydroperiod
- Stage Recorder
- Ambient

**Fixed Vegetation Plot**
- >320 stems/ac

**MY1 Random Vegetation Plot**
- >320 stems/ac
- Previous Random Vegetation Plot

**Wetland Mitigation**
- Rehabilitation (2:1)
- Re-establishment (1:1I)
- Preservation
- Top of Bank
- Conservation Easement
- Cross Section
- Engineered Sediment Pack
- Fence Installation

**Stream Mitigation**
- Restoration
- Preservation
- Restoration (No credit)
- Preservation (No credit)

**Vegetation Condition Assessment**

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

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 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. | 46 | 46 | | 100% |
| | **Bank Protection** | Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in DMS monitoring guidance document) | 36 | 36 | | 100% |

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 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. | 19 | 19 | | 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) | 17 | 17 | | 100% |

## Table 6 Vegetation Condition Assessment

**Planted Acreage[1]** **16.4**

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

**Easement Acreage[2]** **19.19**

| Vegetation Category | Definitions | Mapping Threshold | CCPV Depiction | Number of Polygons | Combined Acreage | % of Easement Acreage |
|---|---|---|---|---|---|---|
| **4. Invasive Areas of Concern[4]** | Areas or points (if too small to render as polygons at map scale). | 1000 SF | Yellow Crosshatch | 1 | 0.94 | 4.9% |
| | | | | | | |
| **5. Easement Encroachment Areas[3]** | Areas or points (if too small to render as polygons at map scale). | none | Red Simple Hatch | 0 | 0.00 | 0.0% |

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

2 = The acreage within the easement boundaries.

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

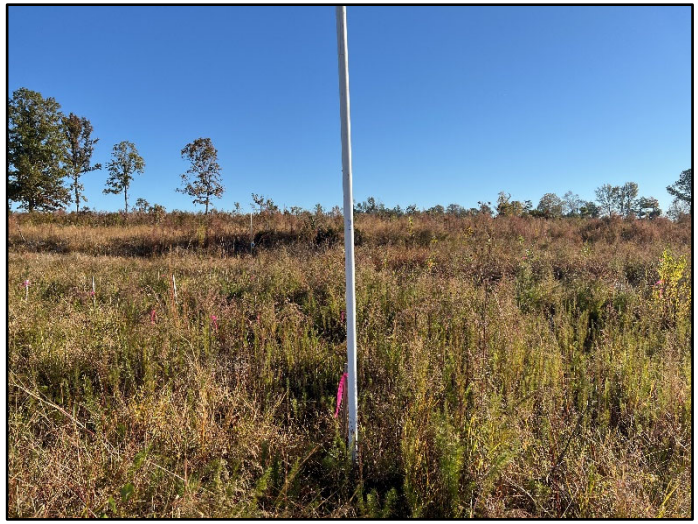
4 = Invasives may occur in or out of planted areas, but still within the easement and will therefore be calculated against the overall easement acreage. Invasives of concern/interest are listed below. The list of high concern spcies are those with the potential to directly outcompete native, young, woody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

**Matthew MY1 Vegetation Monitoring Plot Photos**

Vegetation Plot 1 (3/4/2021)

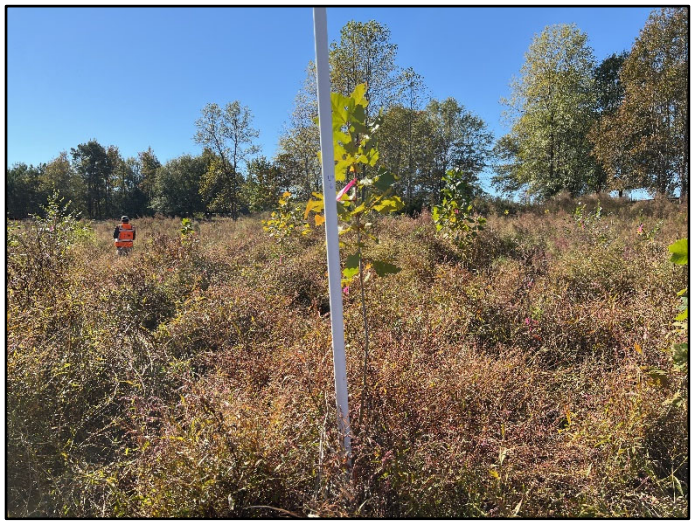
Vegetation Plot 2 (11/9/2021)

Vegetation Plot 3 (11/9/2021)



Vegetation Plot 4 (11/9/2021)

Vegetation Plot 5 (11/9/2021)



Vegetation Plot 6 (11/9/2021)

Vegetation Plot 7 (11/9/2021)

Vegetation Plot 8 (11/9/2021)

Vegetation Plot 9 (11/9/2021)

Vegetation Plot 10 (11/9/2021)

**Matthew MY1 Random Vegetation Monitoring Plot Photo**

Random Vegetation Plot 1 (11/9/2021)

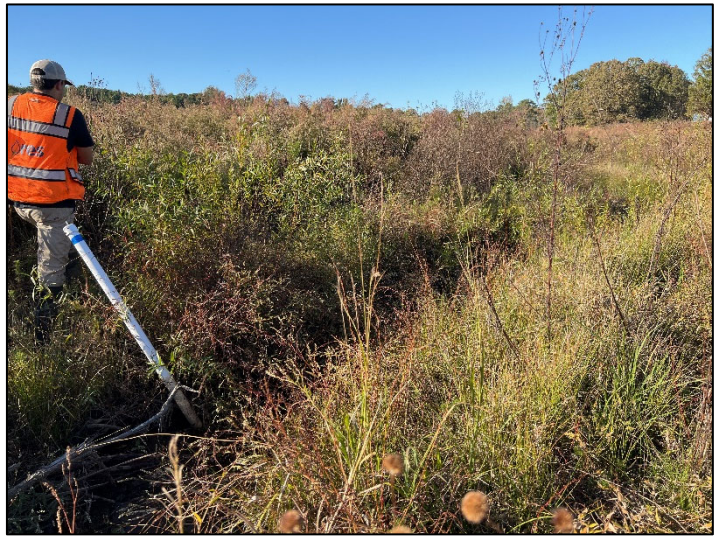
Random Vegetation Plot 2 (11/9/2021)

Random Vegetation Plot 3 (11/9/2021)

Random Vegetation Plot 4 (11/9/2021)

**Matthew Monitoring Device Photos (*All taken on 11/9/2021*)**

Stage Recorder RL1-A



Stage Recorder RL2

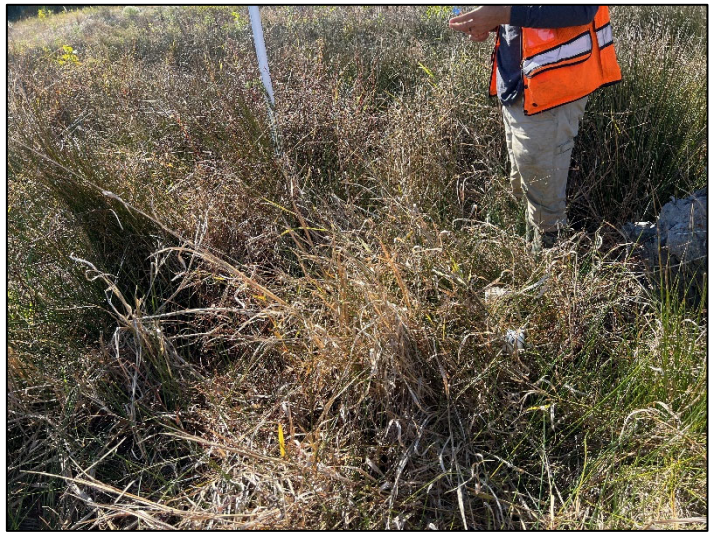
Groundwater Well 1

Groundwater Well 2

Groundwater Well 3

Groundwater Well 4

Groundwater Well 5



Groundwater Well 6

Groundwater Well 7

Groundwater Well 8

Groundwater Well Ref 1

Groundwater Well Ref 2

**Matthew General Site Photos**

RL1-A looking upstream (11/9/2021)

RL2 looking downstream from pond outlet (11/9/2021)

Plunge pool at the top of RL2 (11/9/2021)

Plunge pool and boulder toe protection below NC-96 culvert on RL1-A (11/9/2021)

# Appendix C

Vegetation Plot Data

**Table 7. Planted Species Summary**

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

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

| Plot # | Planted Stems/Acre | Volunteers Stems/Acre | Total Stems/Acre | Success Criteria Met? | Averaged Planted Stem Height (ft.) |
|---|---|---|---|---|---|
| **1** | 769 | 40 | 809 | Yes | 2 |
| **2** | 769 | 40 | 809 | Yes | 2.4 |
| **3** | 769 | 0 | 769 | Yes | 2.3 |
| **4** | 1012 | 0 | 1012 | Yes | 2.7 |
| **5** | 1093 | 121 | 1214 | Yes | 3 |
| **6** | 769 | 0 | 769 | Yes | 3.8 |
| **7** | 728 | 81 | 809 | Yes | 2.6 |
| **8** | 688 | 0 | 688 | Yes | 2.6 |
| **9** | 971 | 121 | 1093 | Yes | 2 |
| **10** | 728 | 202 | 931 | Yes | 1.8 |
| **R1** | 769 | 0 | 769 | Yes | 2.2 |
| **R2** | 486 | 121 | 607 | Yes | 2.8 |
| **R3** | 567 | 0 | 567 | Yes | 3.9 |
| **R4** | 931 | 0 | 931 | Yes | 2.6 |
| **Project Avg** | **789** | **52** | **841** | **Yes** | **2.6** |

**Table 9. Stem Count Total and Planted by Plot Species**

| Matthew | | | Current Plot Data (MY1 2021) | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 100043-01-0001 | | | 100043-01-0002 | | | 100043-01-0003 | | | 100043-01-0004 | | | 100043-01-0005 | | | 100043-01-0006 | | | 100043-01-0007 | | | 100043-01-0008 | | | 100043-01-0009 | | | 100043-01-0010 | | |
| Scientific Name | Common Name | Species Type | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T |
| Alnus serrulata | hazel alder | Shrub | | | | | | | | | | | | | | | 2 | | | | | | 2 | | | | | | | | |
| Betula nigra | river birch | Tree | 2 | 2 | 2 | | | | 2 | 2 | 2 | 16 | 16 | 16 | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 3 | 3 | 3 | 10 | 10 | 10 | 9 | 9 | 9 |
| Cephalanthus occidentalis | common buttonbush | Shrub | 3 | 3 | 3 | 6 | 6 | 6 | | | | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 2 | 8 | 8 | 8 | 2 | 2 | 2 | 1 | 1 | 1 |
| Fraxinus pennsylvanica | green ash | Tree | 1 | 1 | 1 | | | | | | | | | | 2 | 2 | 2 | 1 | 1 | 1 | | | | | | | | | | | | |
| Liquidambar styraciflua | sweetgum | Tree | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | |
| Liriodendron tulipifera | tuliptree | Tree | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | |
| Platanus occidentalis | American sycamore | Tree | 1 | 1 | 1 | | | | | | | 2 | 2 | 2 | 3 | 3 | 3 | 4 | 4 | 4 | 9 | 9 | 9 | 3 | 3 | 3 | 5 | 5 | 5 | | | |
| Quercus michauxii | swamp chestnut oak | Tree | 7 | 7 | 7 | 6 | 6 | 6 | 7 | 7 | 7 | 2 | 2 | 2 | 5 | 5 | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | | | |
| Quercus nigra | water oak | Tree | 1 | 1 | 1 | | | | 3 | 3 | 3 | | | | | | | | | | | | | | | | | | | | | |
| Quercus phellos | willow oak | Tree | 3 | 3 | 3 | 4 | 4 | 4 | 6 | 6 | 6 | 2 | 2 | 2 | 2 | 2 | 2 | 5 | 5 | 5 | | | | 2 | 2 | 2 | 2 | 2 | 2 | 8 | 8 | 8 |
| Salix nigra | black willow | Tree | | | 1 | | | 1 | | | | | | | | | | | | | | | | | | | | 2 | | | | 5 |
| Taxodium distichum | bald cypress | Tree | 1 | 1 | 1 | 3 | 3 | 3 | 1 | 1 | 1 | | | | 9 | 9 | 9 | 3 | 3 | 3 | 1 | 1 | 1 | | | | 2 | 2 | 2 | | | |
| | | Stem count | 19 | 19 | 20 | 19 | 19 | 20 | 19 | 19 | 19 | 25 | 25 | 25 | 27 | 27 | 30 | 19 | 19 | 19 | 18 | 18 | 20 | 17 | 17 | 17 | 24 | 24 | 27 | 18 | 18 | 23 |
| | | size (ares) | 1 | | | 1 | | | 1 | | | 1 | | | 1 | | | 1 | | | 1 | | | 1 | | | 1 | | | 1 | | |
| | | size (ACRES) | 0.02 | | | 0.02 | | | 0.02 | | | 0.02 | | | 0.02 | | | 0.02 | | | 0.02 | | | 0.02 | | | 0.02 | | | 0.02 | | |
| | | Species count | 8 | 8 | 9 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 7 | 7 | 9 | 7 | 7 | 7 | 5 | 5 | 6 | 5 | 5 | 5 | 6 | 6 | 8 | 3 | 3 | 4 |
| | | Stems per ACRE | 769 | 769 | 809 | 769 | 769 | 809 | 769 | 769 | 769 | 1012 | 1012 | 1012 | 1093 | 1093 | 1214 | 769 | 769 | 769 | 728 | 728 | 809 | 688 | 688 | 688 | 971 | 971 | 1093 | 728 | 728 | 931 |

| Matthew | | | Current Plot Data (MY1 2021) | | | | | | | | | | | | Annual Means | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 100043-01-R1 | | | 100043-01-R2 | | | 100043-01-R3 | | | 100043-01-R4 | | | MY1 (2021) | | | MY0 (2021) | | |
| Scientific Name | Common Name | Species Type | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T |
| Alnus serrulata | hazel alder | Shrub | | | | | | 3 | | | | | | | | | 7 | | | |
| Betula nigra | river birch | Tree | 11 | 11 | 11 | 2 | 2 | 2 | 6 | 6 | 6 | 8 | 8 | 8 | 82 | 82 | 82 | 81 | 81 | 81 |
| Cephalanthus occidentalis | common buttonbush | Shrub | 3 | 3 | 3 | | | | | | | | | | 31 | 31 | 31 | 13 | 13 | 13 |
| Fraxinus pennsylvanica | green ash | Tree | | | | | | | | | | | | | 4 | 4 | 4 | 42 | 42 | 42 |
| Liquidambar styraciflua | sweetgum | Tree | | | | | | | | | | | | | | | 1 | | | |
| Liriodendron tulipifera | tuliptree | Tree | | | | | | | | | | | | | | | 1 | | | |
| Platanus occidentalis | American sycamore | Tree | | | | 2 | 2 | 2 | 4 | 4 | 4 | 3 | 3 | 3 | 36 | 36 | 36 | 49 | 49 | 49 |
| Quercus michauxii | swamp chestnut oak | Tree | 4 | 4 | 4 | 4 | 4 | 4 | 2 | 2 | 2 | 3 | 3 | 3 | 46 | 46 | 46 | 49 | 49 | 49 |
| Quercus nigra | water oak | Tree | | | | | | | | | | 2 | 2 | 2 | 6 | 6 | 6 | 13 | 13 | 13 |
| Quercus phellos | willow oak | Tree | | | | | | | | | | 5 | 5 | 5 | 39 | 39 | 39 | 89 | 89 | 89 |
| Salix nigra | black willow | Tree | | | | | | | | | | | | | | | 9 | | | |
| Taxodium distichum | bald cypress | Tree | 1 | 1 | 1 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 2 | 2 | 29 | 29 | 29 | 43 | 43 | 43 |
| | | Stem count | 19 | 19 | 19 | 12 | 12 | 15 | 14 | 14 | 14 | 23 | 23 | 23 | 273 | 273 | 291 | 379 | 379 | 379 |
| | | size (ares) | 1 | | | 1 | | | 1 | | | 1 | | | 14 | | | 14 | | |
| | | size (ACRES) | 0.02 | | | 0.02 | | | 0.02 | | | 0.02 | | | 0.35 | | | 0.35 | | |
| | | Species count | 4 | 4 | 4 | 4 | 4 | 5 | 4 | 4 | 4 | 6 | 6 | 6 | 8 | 8 | 12 | 8 | 8 | 8 |
| | | Stems per ACRE | 769 | 769 | 769 | 486 | 486 | 607 | 567 | 567 | 567 | 931 | 931 | 931 | 789 | 789 | 841 | 1096 | 1096 | 1096 |

# Appendix D

Stream Measurement and

Geomorphology Data

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

| Parameter | Gauge[2] | Regional Curve | | | Pre-Existing Condition | | | | | | Reference Reach(es) Data | | | | | | Design | | | Monitoring Baseline | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Dimension and Substrate - Riffle Only** | | LL | UL | Eq. | Min | Mean | Med | Max | SD[5] | n | Min | Mean | Med | Max | SD[5] | n | Min | Med | Max | Min | Mean | Med | Max | SD[5] | n |
| Bankfull Width (ft) | | --- | --- | --- | 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 | - | - | - | - | - | - |
| [1]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 ($ft^2$) | | --- | --- | --- | 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 |
| [1]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 |
| **Profile** | | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 |
| **Pattern** | | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 | --- | --- |
| **Transport parameters** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Reach Shear Stress (competency) $lb/f^2$ | | | | | --- | | | | | | | | | | | | --- | | | --- | | | | | |
| Max part size (mm) mobilized at bankfull | | | | | --- | | | | | | | | | | | | --- | | | --- | | | | | |
| Stream Power (transport capacity) $W/m^2$ | | | | | --- | | | | | | | | | | | | --- | | | --- | | | | | |
| **Additional Reach Parameters** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Rosgen Classification | | | | | F4b | | | | | | E4/5 | | | | | | E4/5 | | | E4 | | | | | |
| Bankfull Velocity (fps) | | --- | --- | --- | --- | | | | | | --- | | | | | | --- | | | --- | | | | | |
| Bankfull Discharge (cfs) | | --- | --- | --- | --- | | | | | | | | | | | | --- | | | | | | | | |
| Valley length (ft) | | | | | 294 | | | | | | 842 | | | | | | 1013 | | | --- | | | | | |
| Channel Thalweg length (ft) | | | | | 362 | | | | | | 995 | | | | | | 1219 | | | 1219 | | | | | |
| Sinuosity (ft) | | | | | 1.25 | | | | | | 1.18 | | | | | | 1.21 | | | --- | | | | | |
| Water Surface Slope (Channel) (ft/ft) | | | | | --- | | | | | | --- | | | | | | --- | | | --- | | | | | |
| Channel slope (ft/ft) | | | | | 0.002 | | | | | | 0.0027 | | | | | | 0.0025 | | | --- | | | | | |
| [3]Bankfull Floodplain Area (acres) | | | | | --- | | | | | | --- | | | | | | --- | | | --- | | | | | |
| [4]% of Reach with Eroding Banks | | | | | --- | | | | | | --- | | | | | | | | | | | | | | |
| Channel Stability or Habitat Metric | | | | | --- | | | | | | --- | | | | | | | | | | | | | | |
| Biological or Other | | | | | --- | | | | | | --- | | | | | | | | | | | | | | |

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

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

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

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

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

| Parameter | Gauge[2] | Regional Curve | | | Pre-Existing Condition | | | | | | Reference Reach(es) Data | | | | | | Design | | | Monitoring Baseline | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | LL | UL | Eq. | Min | Mean | Med | Max | SD[5] | n | Min | Mean | Med | Max | SD[5] | n | Min | Med | Max | Min | Mean | Med | Max | SD[5] | n |
| **Dimension and Substrate - Riffle Only** | | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 | -- | - | - | - | - | - | - |
| [1]Bankfull Max Depth (ft) | | | | | --- | --- | --- | --- | --- | --- | 1.9 | --- | --- | --- | --- | 1 | --- | 1.3 | -- | 1.3 | 1.4 | 1.4 | 1.4 | 0.1 | 2 |
| Bankfull Cross Sectional Area ($ft^2$) | | --- | --- | --- | --- | --- | --- | --- | --- | --- | 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 |
| [1]Bank Height Ratio | | | | | --- | --- | --- | --- | --- | --- | 1.1 | --- | --- | --- | --- | 1 | --- | 1.0 | --- | 1.0 | 1.0 | 1.0 | 1.0 | 0.0 | 2 |
| **Profile** | | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 |
| **Pattern** | | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 | --- | --- |
| **Transport parameters** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Reach Shear Stress (competency) $lb/f^2$ | | | | | --- | | | | | | | | | | | | --- | | | --- | | | | | |
| Max part size (mm) mobilized at bankfull | | | | | --- | | | | | | | | | | | | --- | | | --- | | | | | |
| Stream Power (transport capacity) $W/m^2$ | | | | | --- | | | | | | | | | | | | --- | | | --- | | | | | |
| **Additional Reach Parameters** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Rosgen Classification | | | | | --- | | | | | | E4/5 | | | | | | E4/5 | | | E4/E5 | | | | | |
| Bankfull Velocity (fps) | | --- | --- | --- | --- | | | | | | --- | | | | | | --- | | | --- | | | | | |
| Bankfull Discharge (cfs) | | --- | --- | --- | --- | | | | | | | | | | | | --- | | | | | | | | |
| Valley length (ft) | | | | | --- | | | | | | 842 | | | | | | 655 | | | --- | | | | | |
| Channel Thalweg length (ft) | | | | | --- | | | | | | 995 | | | | | | 792 | | | 792 | | | | | |
| Sinuosity (ft) | | | | | --- | | | | | | 1.18 | | | | | | 1.21 | | | --- | | | | | |
| Water Surface Slope (Channel) (ft/ft) | | | | | --- | | | | | | --- | | | | | | --- | | | --- | | | | | |
| Channel slope (ft/ft) | | | | | --- | | | | | | 0.0027 | | | | | | 0.004 | | | --- | | | | | |
| [3]Bankfull Floodplain Area (acres) | | | | | --- | | | | | | --- | | | | | | --- | | | --- | | | | | |
| [4]% of Reach with Eroding Banks | | | | | --- | | | | | | --- | | | | | | | | | | | | | | |
| Channel Stability or Habitat Metric | | | | | --- | | | | | | --- | | | | | | | | | | | | | | |
| Biological or Other | | | | | --- | | | | | | --- | | | | | | | | | | | | | | |

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

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

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

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

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

### Project Name/Number: 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+ |
| **Bankfull Elevation (ft) - Based on AB-XSA[1]** | 127.2 | 127.6 | | | | | | 127.1 | 127.7 | | | | | | 126.2 | 126.3 | | | | | | 126.0 | 126.0 | | | | | | 125.5 | 125.6 | | | | | |
| Bankfull Width (ft)[1] | 10.1 | 9.1 | | | | | | 10.0 | 9.9 | | | | | | 8.8 | 10.5 | | | | | | 9.8 | 10.1 | | | | | | 9.7 | 11.4 | | | | | |
| Floodprone Width (ft)[1] | - | - | | | | | | >49.9 | >49.9 | | | | | | >50.0 | >50 | | | | | | - | - | | | | | | - | - | | | | | |
| Bankfull Max Depth (ft)[2] | 1.5 | 1.2 | | | | | | 1.3 | 1.2 | | | | | | 1.6 | 1.6 | | | | | | 2.0 | 2.2 | | | | | | 2.9 | 2.8 | | | | | |
| Low Bank Elevation (ft) | - | - | | | | | | 127.1 | 127.4 | | | | | | 126.2 | 126.2 | | | | | | - | - | | | | | | - | - | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 9.0 | 7.4 | | | | | | 8.6 | 6.1 | | | | | | 9.9 | 9.3 | | | | | | 12.1 | 12.3 | | | | | | 15.3 | 14.7 | | | | | |
| Bankfull Entrenchment Ratio[1] | - | - | | | | | | >5.0 | >5.0 | | | | | | >5.7 | >4.8 | | | | | | - | - | | | | | | - | - | | | | | |
| Bankfull Bank Height Ratio[1] | - | - | | | | | | 1.0 | 0.8 | | | | | | 1.0 | 1.0 | | | | | | - | - | | | | | | - | - | | | | | |

| | 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+ |
| **Bankfull Elevation (ft) - Based on AB-XSA[1]** | 125.4 | 125.6 | | | | | | 124.0 | 124.1 | | | | | | 123.4 | 123.2 | | | | | | 123.5 | 123.5 | | | | | | 122.9 | 21.6 | | | | | |
| Bankfull Width (ft)[1] | 8.9 | 8.8 | | | | | | 11.9 | 12.8 | | | | | | 11.2 | 11.3 | | | | | | 12.0 | 13.1 | | | | | | 13.4 | 13.5 | | | | | |
| Floodprone Width (ft)[1] | >49.9 | >50 | | | | | | >49.9 | >49.9 | | | | | | - | - | | | | | | >50 | >49.9 | | | | | | - | - | | | | | |
| Bankfull Max Depth (ft)[2] | 1.4 | 1.2 | | | | | | 2.0 | 1.9 | | | | | | 2.8 | 3.0 | | | | | | 2.0 | 1.9 | | | | | | 2.7 | 2.9 | | | | | |
| Low Bank Elevation (ft) | 125.4 | 125.2 | | | | | | 124.0 | 124.0 | | | | | | - | - | | | | | | 123.5 | 123.4 | | | | | | - | - | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 8.8 | 6.1 | | | | | | 16.6 | 15.0 | | | | | | 19.9 | 22.0 | | | | | | 16.5 | 15.9 | | | | | | 21.6 | 23.9 | | | | | |
| Bankfull Entrenchment Ratio[1] | >5.6 | >5.7 | | | | | | >4.2 | >3.9 | | | | | | - | - | | | | | | >4.2 | >3.8 | | | | | | - | - | | | | | |
| Bankfull Bank Height Ratio[1] | 1.0 | 0.8 | | | | | | 1.0 | 0.9 | | | | | | - | - | | | | | | 1.0 | 1.0 | | | | | | - | - | | | | | |

| | 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+ |
| **Bankfull Elevation (ft) - Based on AB-XSA[1]** | 122.3 | 122.2 | | | | | | 122.2 | 122.2 | | | | | | 126.4 | 126.3 | | | | | | 126.7 | 126.8 | | | | | | 125.4 | 125.4 | | | | | |
| Bankfull Width (ft)[1] | 11.5 | 11.1 | | | | | | 12.1 | 13.3 | | | | | | 9.4 | 10.0 | | | | | | 9.3 | 10.1 | | | | | | 8.3 | 8.5 | | | | | |
| Floodprone Width (ft)[1] | - | - | | | | | | >49.8 | >49.9 | | | | | | - | - | | | | | | >49.8 | >50 | | | | | | >50 | >50 | | | | | |
| Bankfull Max Depth (ft)[2] | 3.2 | 3.2 | | | | | | 1.7 | 1.8 | | | | | | 2.3 | 2.5 | | | | | | 1.4 | 1.3 | | | | | | 1.3 | 1.4 | | | | | |
| Low Bank Elevation (ft) | - | - | | | | | | 122.2 | 122.2 | | | | | | - | - | | | | | | 126.7 | 126.8 | | | | | | 125.4 | 125.4 | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 19.8 | 21.8 | | | | | | 14.4 | 14.6 | | | | | | 13.9 | 16.1 | | | | | | 9.0 | 9.0 | | | | | | 7.7 | 8.5 | | | | | |
| Bankfull Entrenchment Ratio[1] | - | - | | | | | | >4.1 | >3.7 | | | | | | - | - | | | | | | >5.4 | >4.9 | | | | | | >6.0 | >5.9 | | | | | |
| Bankfull Bank Height Ratio[1] | - | - | | | | | | 1.0 | 1.0 | | | | | | - | - | | | | | | 1.0 | 1.0 | | | | | | 1.0 | 1.1 | | | | | |

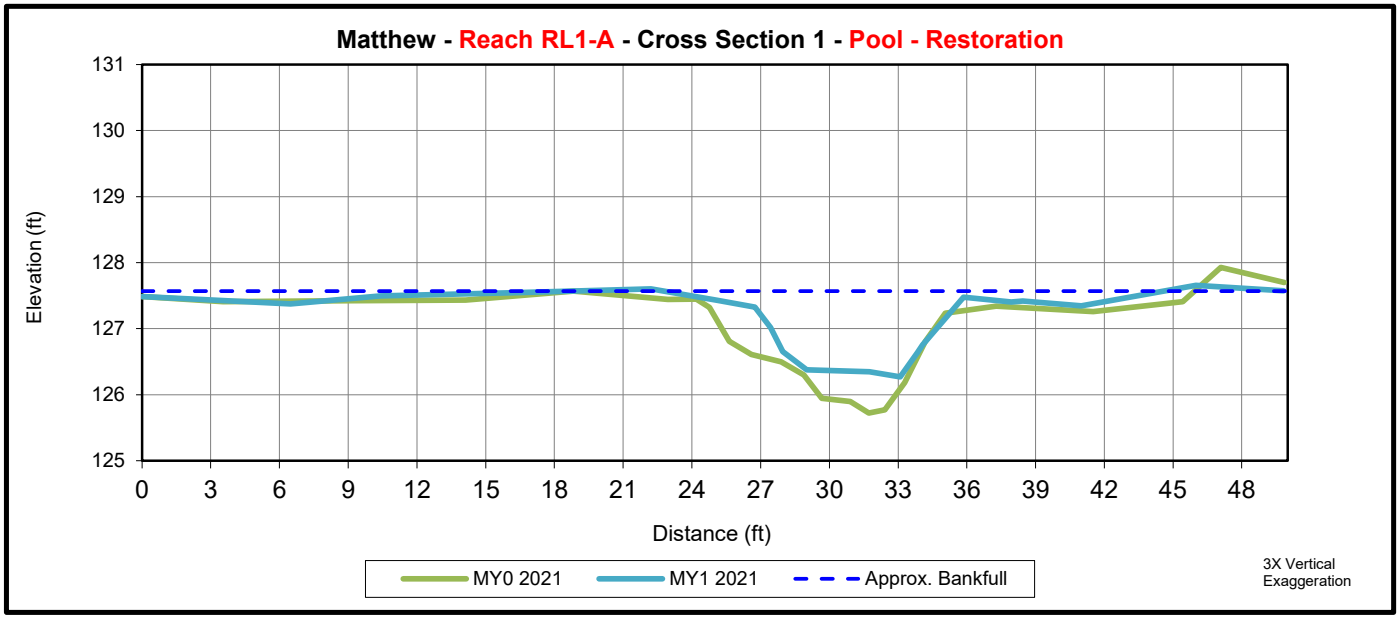
| | Cross Section 16 (Pool) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA[1]** | 125.2 | 125.3 | | | | | |
| Bankfull Width (ft)[1] | 9.2 | 9.6 | | | | | |
| Floodprone Width (ft)[1] | - | - | | | | | |
| Bankfull Max Depth (ft)[2] | 2.4 | 2.1 | | | | | |
| Low Bank Elevation (ft) | - | - | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 12.6 | 11.3 | | | | | |
| Bankfull Entrenchment Ratio[1] | - | - | | | | | |
| Bankfull Bank Height Ratio[1] | - | - | | | | | |

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

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

Upstream

Downstream

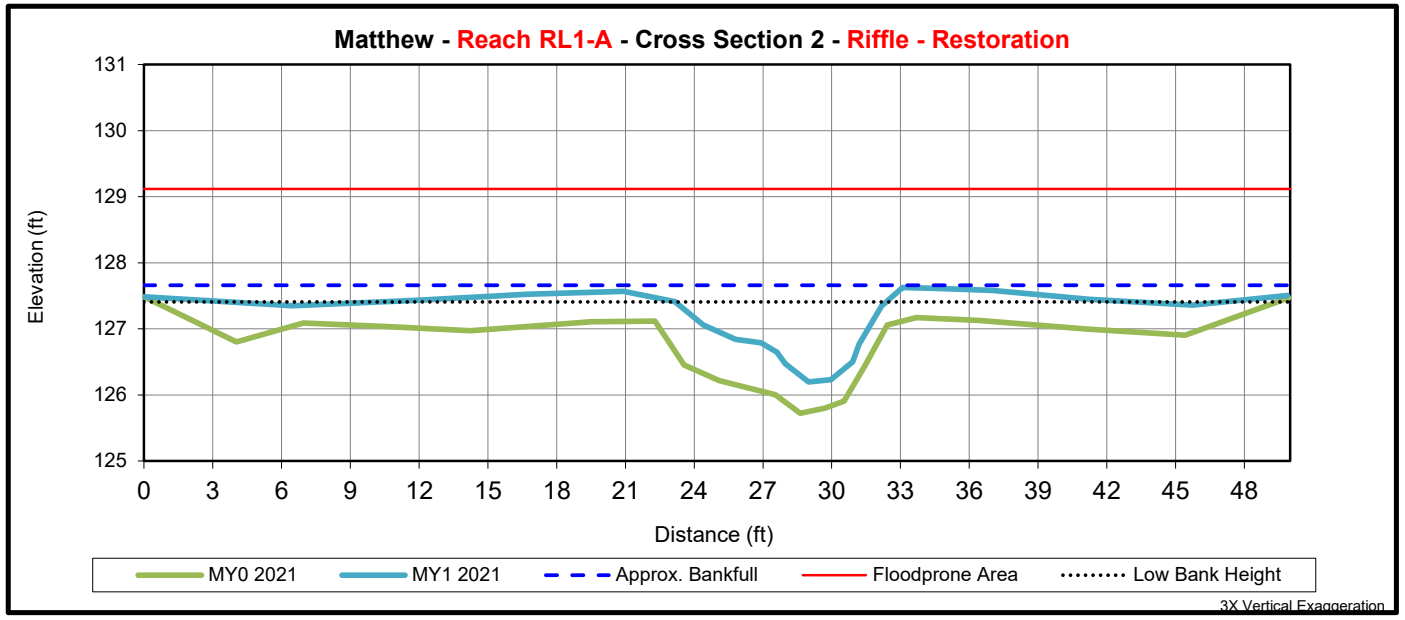



| | Cross Section 1 (Pool) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA**[1] | 127.2 | 127.6 | | | | | |
| Bankfull Width (ft)[1] | 10.1 | 9.1 | | | | | |
| Floodprone Width (ft)[1] | - | - | | | | | |
| Bankfull Max Depth (ft)[2] | 1.5 | 1.2 | | | | | |
| Low Bank Elevation (ft) | - | - | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 9.0 | 7.4 | | | | | |
| Bankfull Entrenchment Ratio[1] | - | - | | | | | |
| Bankfull Bank Height Ratio[1] | - | - | | | | | |

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

Upstream

Downstream

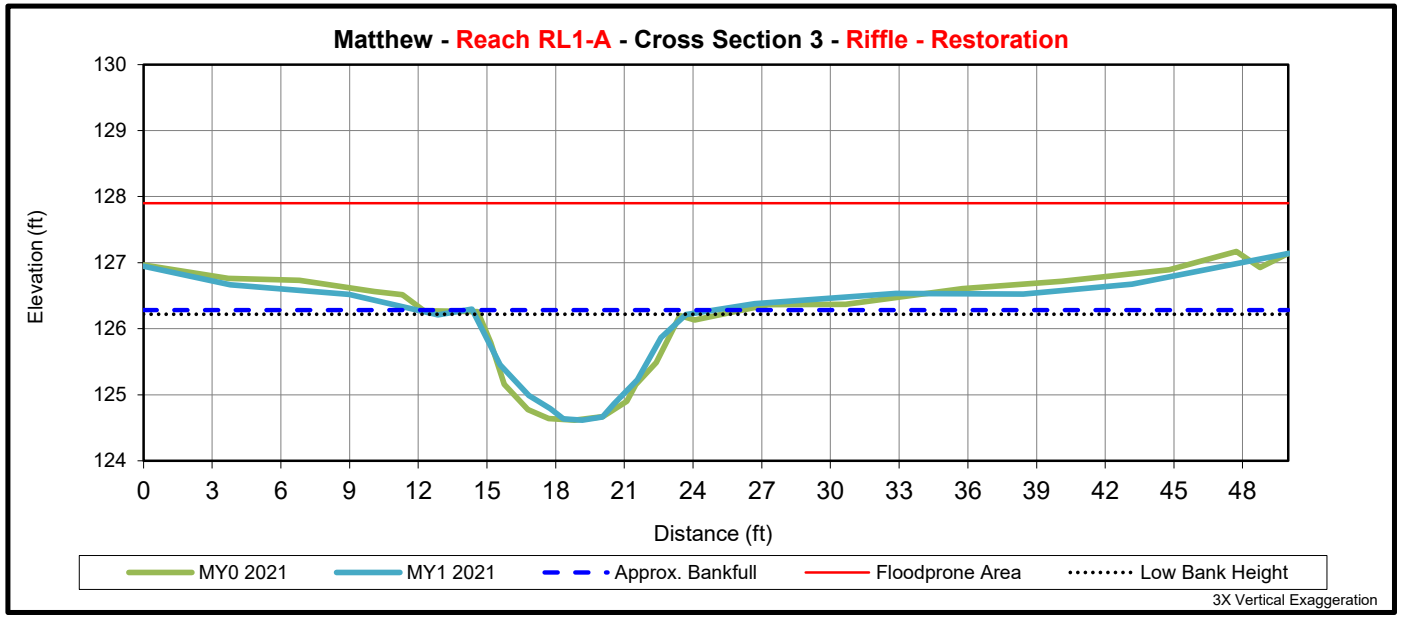



| | Cross Section 2 (Riffle) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA**[1] | 127.1 | 127.7 | | | | | |
| Bankfull Width (ft)[1] | 10.0 | 9.9 | | | | | |
| Floodprone Width (ft)[1] | >49.9 | >49.9 | | | | | |
| Bankfull Max Depth (ft)[2] | 1.3 | 1.2 | | | | | |
| Low Bank Elevation (ft) | 127.1 | 127.4 | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 8.6 | 6.1 | | | | | |
| Bankfull Entrenchment Ratio[1] | >5.0 | >5.0 | | | | | |
| Bankfull Bank Height Ratio[1] | 1.0 | 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

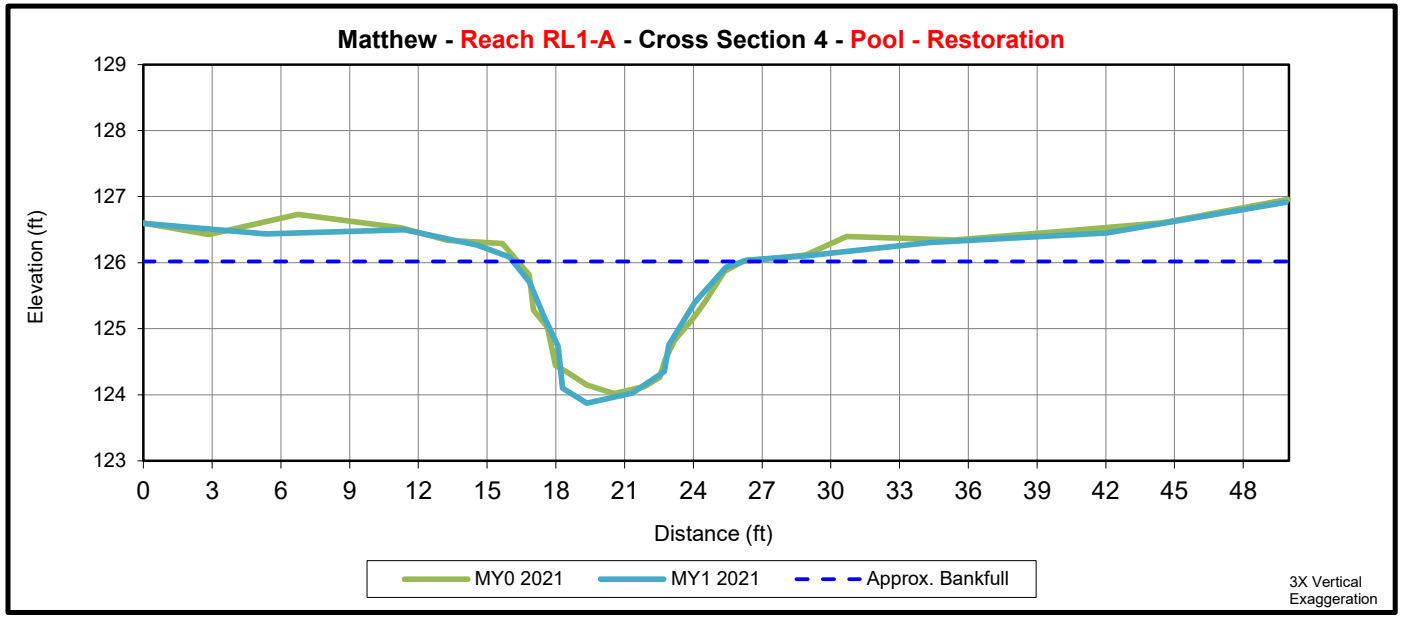



| | Cross Section 3 (Riffle) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA**[1] | 126.2 | 126.3 | | | | | |
| Bankfull Width (ft)[1] | 8.8 | 10.5 | | | | | |
| Floodprone Width (ft)[1] | >50.0 | >50 | | | | | |
| Bankfull Max Depth (ft)[2] | 1.6 | 1.6 | | | | | |
| Low Bank Elevation (ft) | 126.2 | 126.2 | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 9.9 | 9.3 | | | | | |
| Bankfull Entrenchment Ratio[1] | >5.7 | >4.8 | | | | | |
| Bankfull Bank Height Ratio[1] | 1.0 | 1.0 | | | | | |

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

Upstream

Downstream

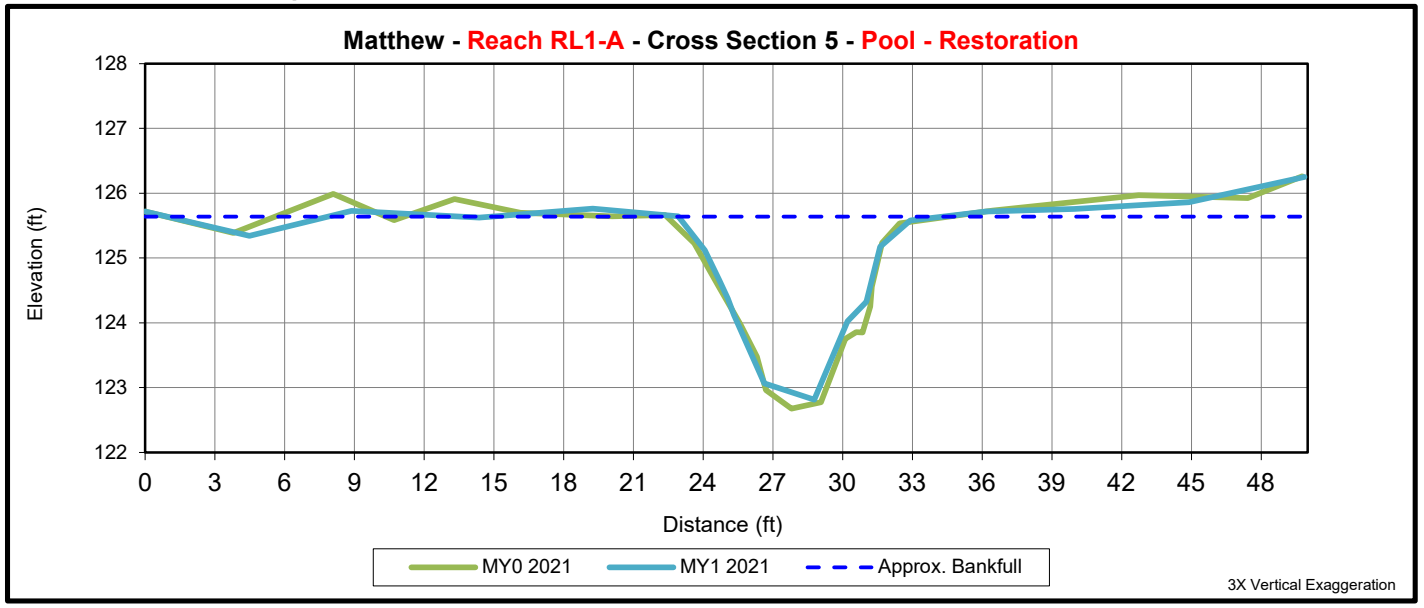



| | Cross Section 4 (Pool) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA**[1] | 126.0 | 126.0 | | | | | |
| Bankfull Width (ft)[1] | 9.8 | 10.1 | | | | | |
| Floodprone Width (ft)[1] | - | - | | | | | |
| Bankfull Max Depth (ft)[2] | 2.0 | 2.2 | | | | | |
| Low Bank Elevation (ft) | - | - | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 12.1 | 12.3 | | | | | |
| Bankfull Entrenchment Ratio[1] | - | - | | | | | |
| Bankfull Bank Height Ratio[1] | - | - | | | | | |

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

Upstream

Downstream

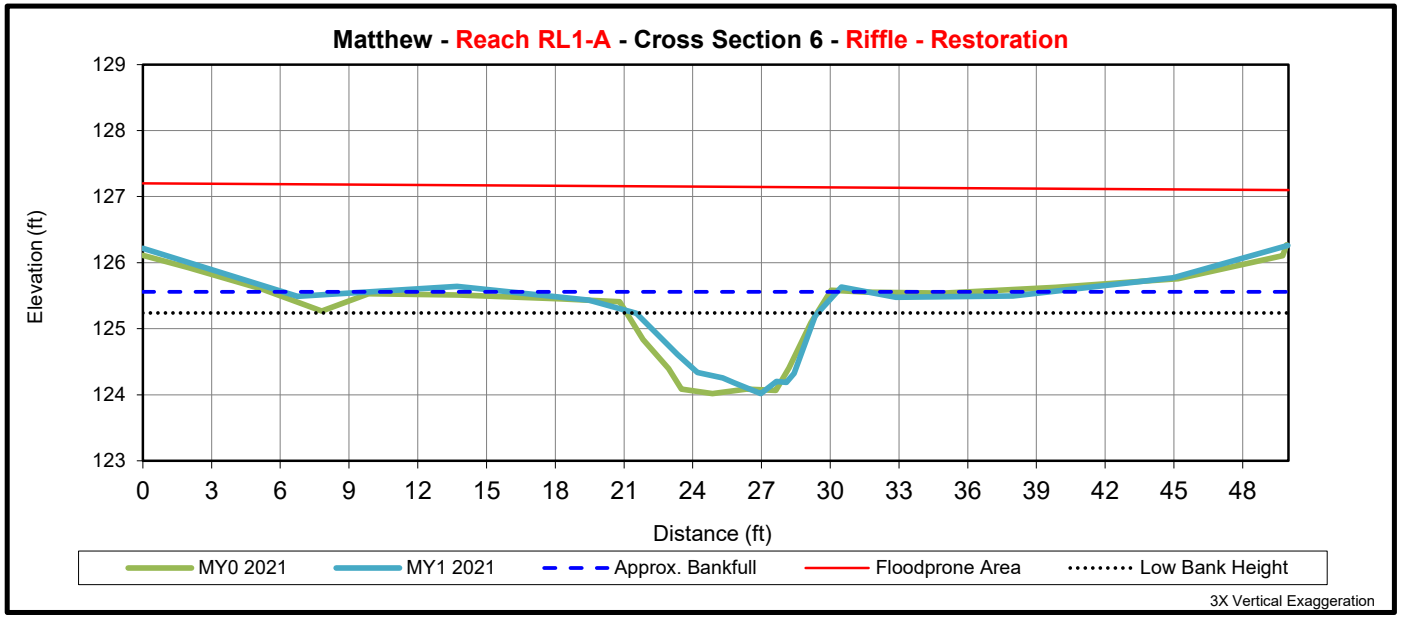



| | Cross Section 5 (Pool) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA**[1] | 125.5 | 125.6 | | | | | |
| Bankfull Width (ft)[1] | 9.7 | 11.4 | | | | | |
| Floodprone Width (ft)[1] | - | - | | | | | |
| Bankfull Max Depth (ft)[2] | 2.9 | 2.8 | | | | | |
| Low Bank Elevation (ft) | - | - | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 15.3 | 14.7 | | | | | |
| Bankfull Entrenchment Ratio[1] | - | - | | | | | |
| Bankfull Bank Height Ratio[1] | - | - | | | | | |

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

Upstream

Downstream

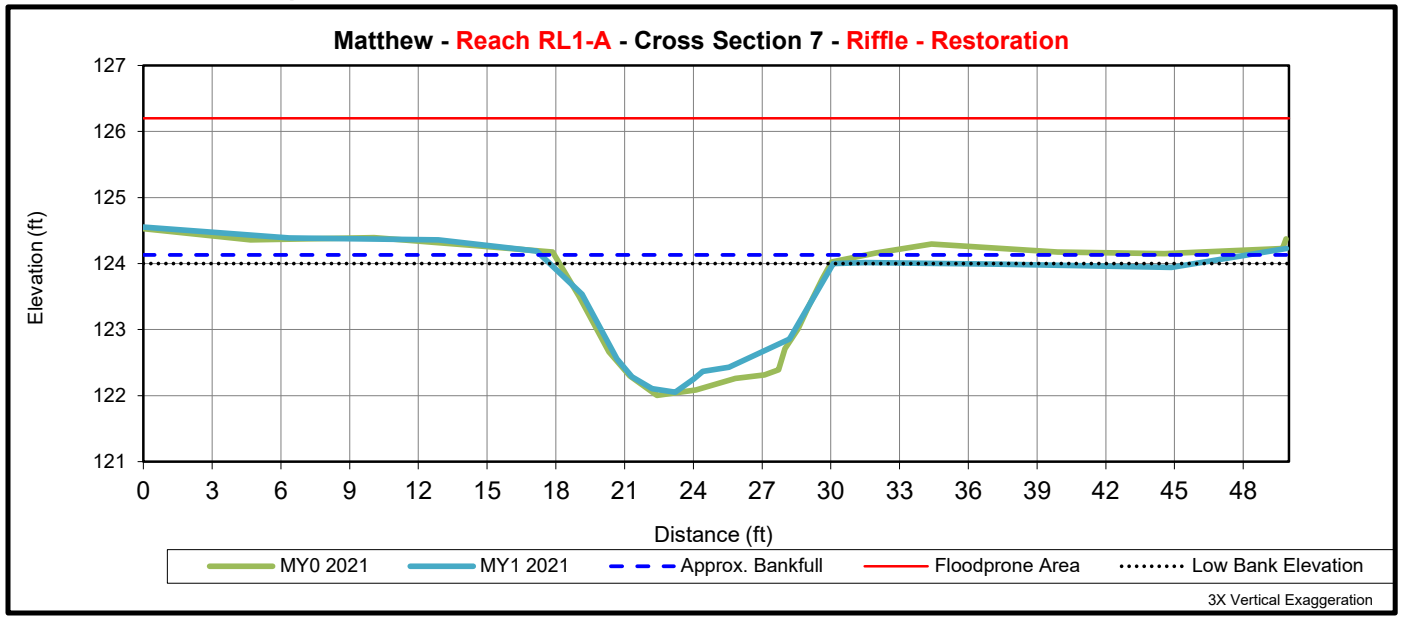



| | Cross Section 6 (Riffle) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA**[1] | 125.4 | 125.6 | | | | | |
| Bankfull Width (ft)[1] | 8.9 | 8.8 | | | | | |
| Floodprone Width (ft)[1] | >49.9 | >50 | | | | | |
| Bankfull Max Depth (ft)[2] | 1.4 | 1.2 | | | | | |
| Low Bank Elevation (ft) | 125.4 | 125.2 | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 8.8 | 6.1 | | | | | |
| Bankfull Entrenchment Ratio[1] | >5.6 | >5.7 | | | | | |
| Bankfull Bank Height Ratio[1] | 1.0 | 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

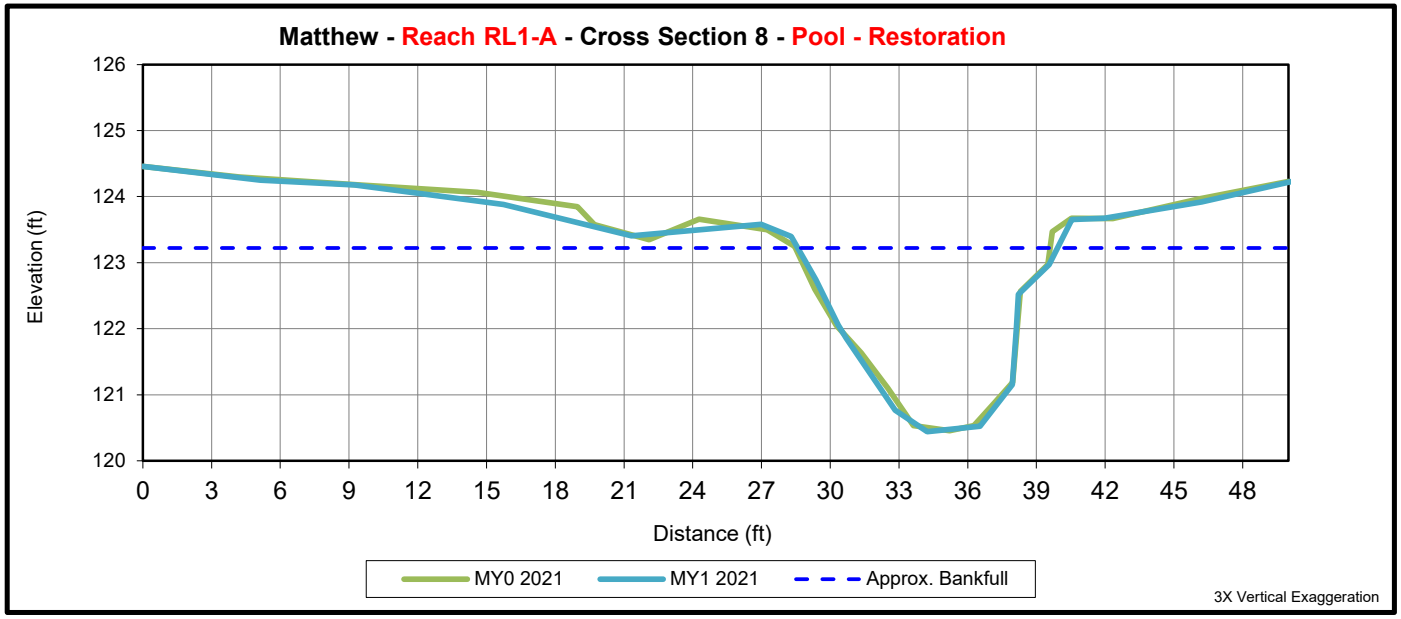



| | Cross Section 7 (Riffle) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA**[1] | 124.0 | 124.1 | | | | | |
| Bankfull Width (ft)[1] | 11.9 | 12.8 | | | | | |
| Floodprone Width (ft)[1] | >49.9 | >49.9 | | | | | |
| Bankfull Max Depth (ft)[2] | 2.0 | 1.9 | | | | | |
| Low Bank Elevation (ft) | 124.0 | 124.0 | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 16.6 | 15.0 | | | | | |
| Bankfull Entrenchment Ratio[1] | >4.2 | >3.9 | | | | | |
| Bankfull Bank Height Ratio[1] | 1.0 | 0.9 | | | | | |

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

Upstream

Downstream

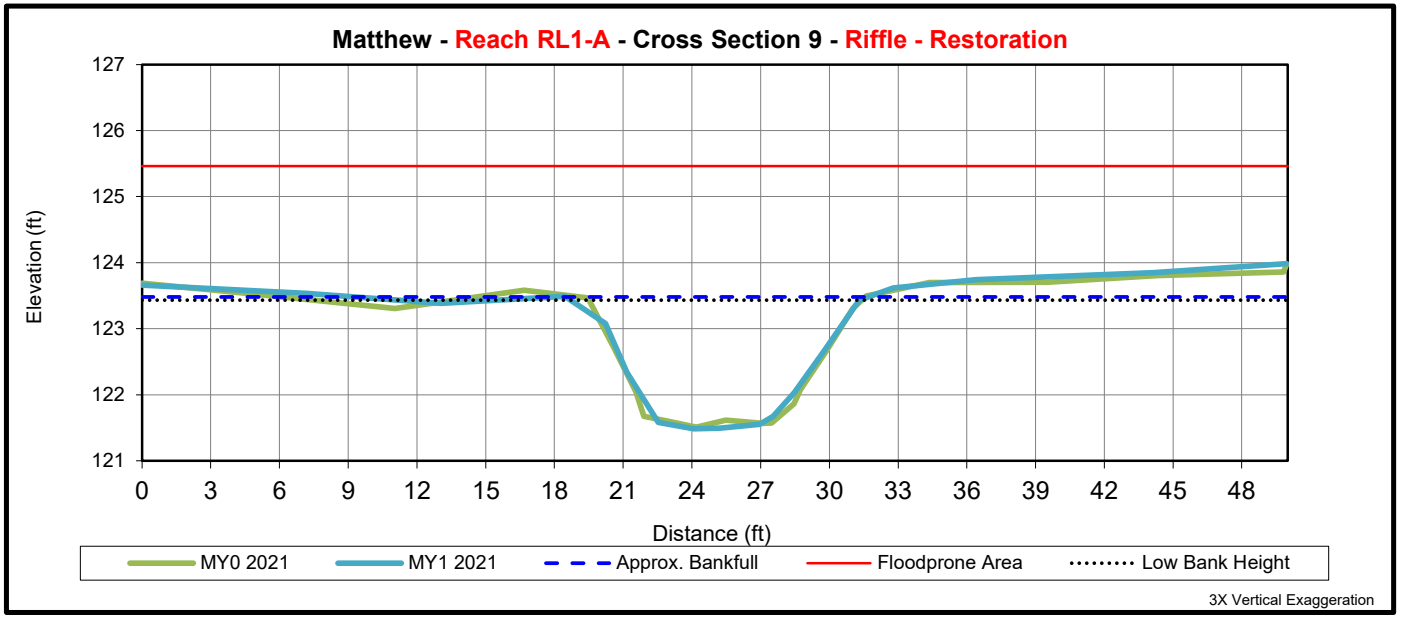



| | Cross Section 8 (Pool) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA**[1] | 123.4 | 123.2 | | | | | |
| Bankfull Width (ft)[1] | 11.2 | 11.3 | | | | | |
| Floodprone Width (ft)[1] | - | - | | | | | |
| Bankfull Max Depth (ft)[2] | 2.8 | 3.0 | | | | | |
| Low Bank Elevation (ft) | - | - | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 19.9 | 22.0 | | | | | |
| Bankfull Entrenchment Ratio[1] | - | - | | | | | |
| Bankfull Bank Height Ratio[1] | - | - | | | | | |

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

Upstream

Downstream

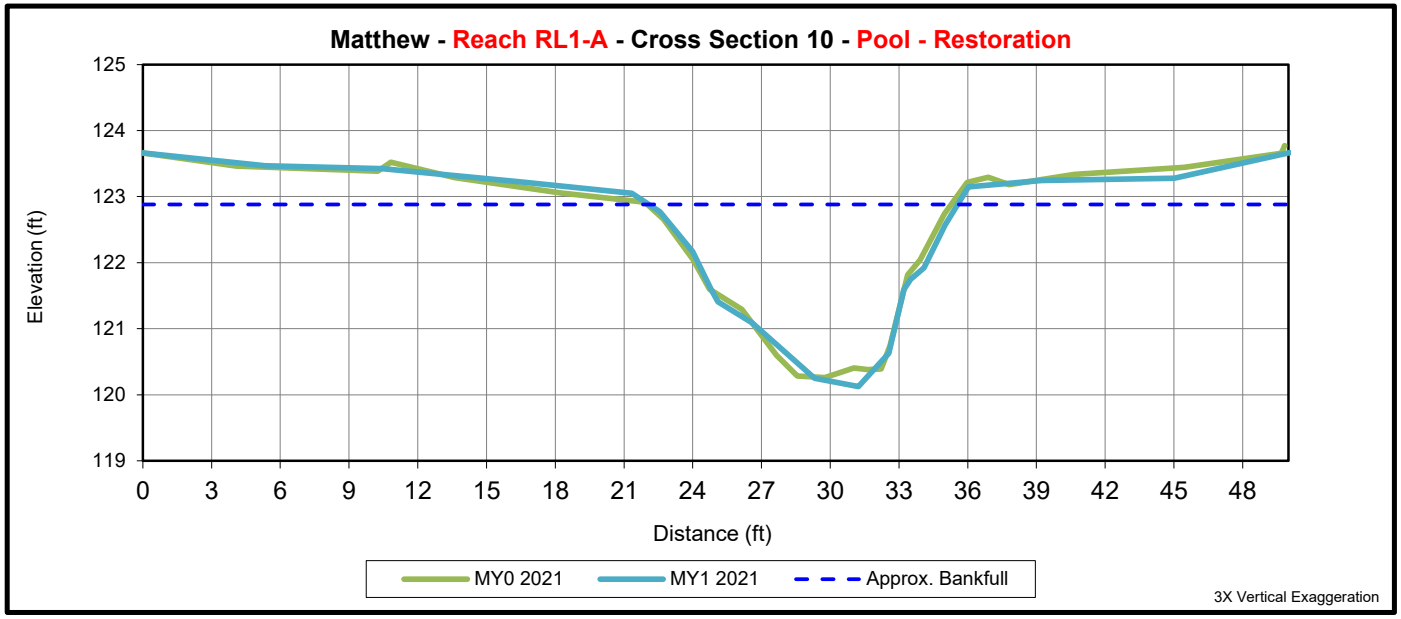



| | Cross Section 9 (Riffle) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA**[1] | 123.5 | 123.5 | | | | | |
| Bankfull Width (ft)[1] | 12.0 | 13.1 | | | | | |
| Floodprone Width (ft)[1] | >50 | >49.9 | | | | | |
| Bankfull Max Depth (ft)[2] | 2.0 | 1.9 | | | | | |
| Low Bank Elevation (ft) | 123.5 | 123.4 | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 16.5 | 15.9 | | | | | |
| Bankfull Entrenchment Ratio[1] | >4.2 | >3.8 | | | | | |
| Bankfull Bank Height Ratio[1] | 1.0 | 1.0 | | | | | |

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

Upstream

Downstream

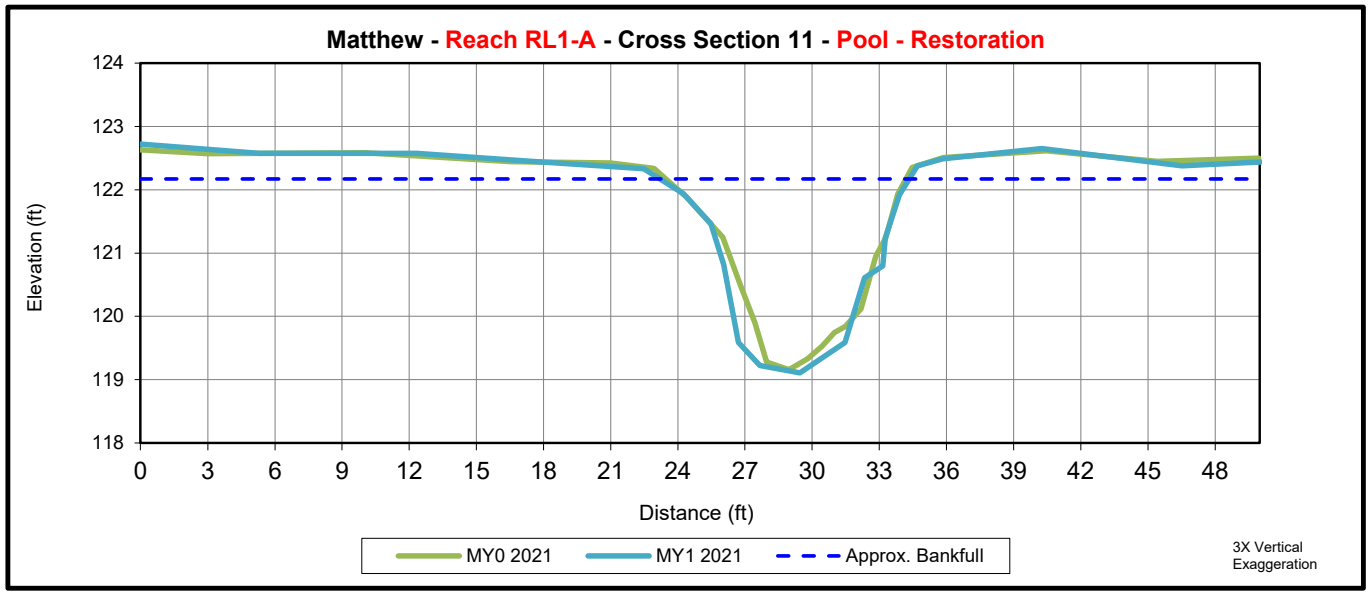



| | Cross Section 10 (Pool) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA**[1] | 122.9 | 21.6 | | | | | |
| Bankfull Width (ft)[1] | 13.4 | 13.5 | | | | | |
| Floodprone Width (ft)[1] | - | - | | | | | |
| Bankfull Max Depth (ft)[2] | 2.7 | 2.9 | | | | | |
| Low Bank Elevation (ft) | - | - | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 21.6 | 23.9 | | | | | |
| Bankfull Entrenchment Ratio[1] | - | - | | | | | |
| Bankfull Bank Height Ratio[1] | - | - | | | | | |

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

Upstream

Downstream

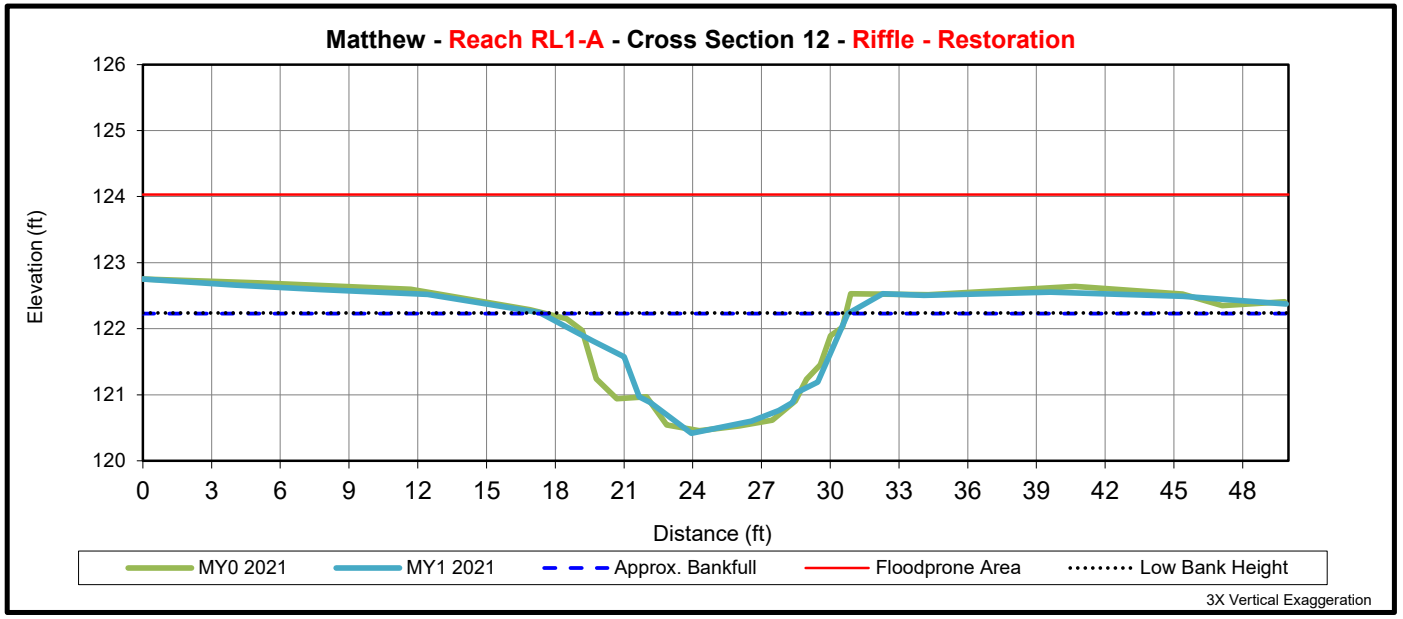



| | Cross Section 11 (Pool) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA**[1] | 122.3 | 122.2 | | | | | |
| Bankfull Width (ft)[1] | 11.5 | 11.1 | | | | | |
| Floodprone Width (ft)[1] | - | - | | | | | |
| Bankfull Max Depth (ft)[2] | 3.2 | 3.2 | | | | | |
| Low Bank Elevation (ft) | - | - | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 19.8 | 21.8 | | | | | |
| Bankfull Entrenchment Ratio[1] | - | - | | | | | |
| Bankfull Bank Height Ratio[1] | - | - | | | | | |

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

Upstream

Downstream

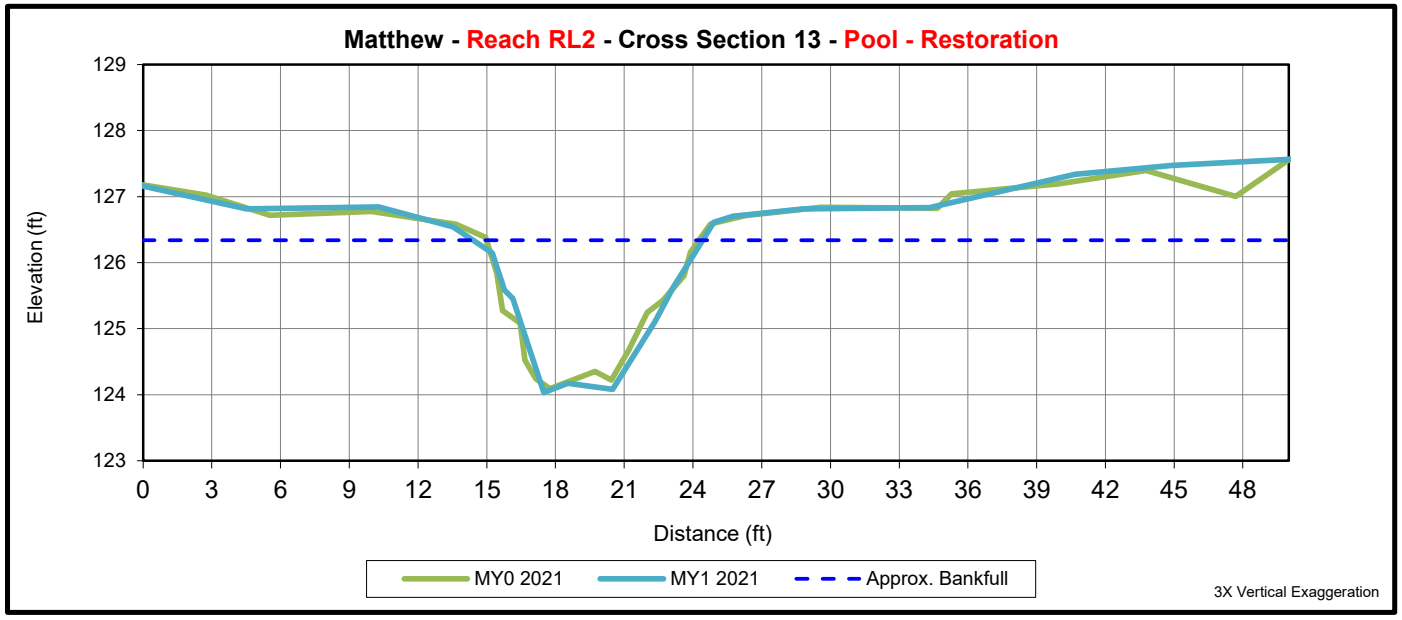



| | Cross Section 12 (Riffle) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA[1]** | 122.2 | 122.2 | | | | | |
| Bankfull Width (ft)[1] | 12.1 | 13.3 | | | | | |
| Floodprone Width (ft)[1] | >49.8 | >49.9 | | | | | |
| Bankfull Max Depth (ft)[2] | 1.7 | 1.8 | | | | | |
| Low Bank Elevation (ft) | 122.2 | 122.2 | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 14.4 | 14.6 | | | | | |
| Bankfull Entrenchment Ratio[1] | >4.1 | >3.7 | | | | | |
| Bankfull Bank Height Ratio[1] | 1.0 | 1.0 | | | | | |

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

Upstream

Downstream

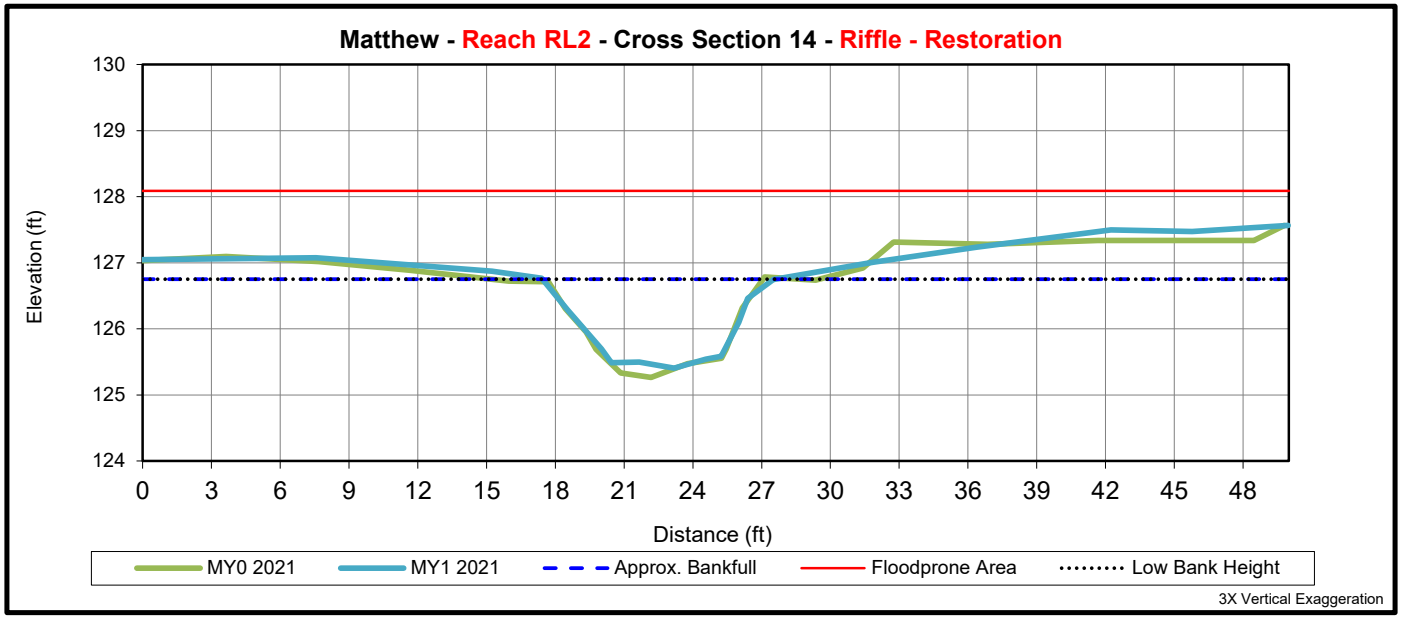



| | Cross Section 13 (Pool) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA[1]** | 126.4 | 126.3 | | | | | |
| Bankfull Width (ft)[1] | 9.4 | 10.0 | | | | | |
| Floodprone Width (ft)[1] | - | - | | | | | |
| Bankfull Max Depth (ft)[2] | 2.3 | 2.5 | | | | | |
| Low Bank Elevation (ft) | - | - | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 13.9 | 16.1 | | | | | |
| Bankfull Entrenchment Ratio[1] | - | - | | | | | |
| Bankfull Bank Height Ratio[1] | - | - | | | | | |

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

Upstream

Downstream

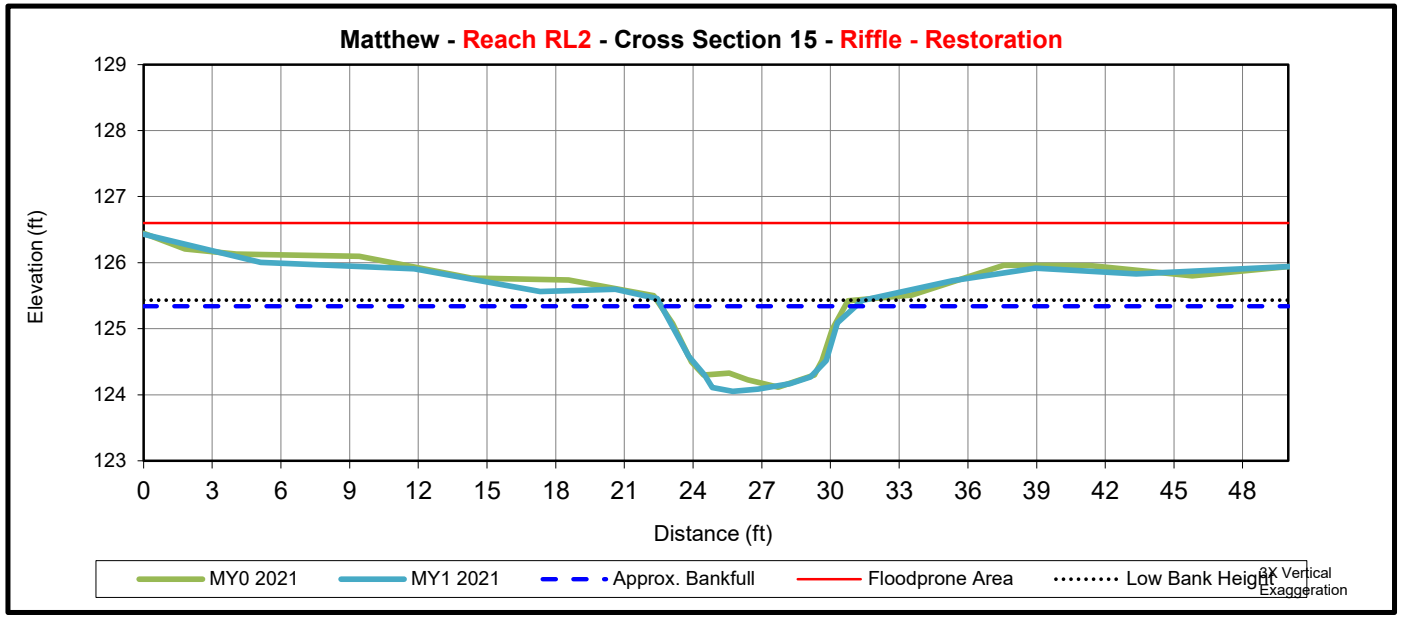



| | Cross Section 14 (Riffle) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA**[1] | 126.7 | 126.8 | | | | | |
| Bankfull Width (ft)[1] | 9.3 | 10.1 | | | | | |
| Floodprone Width (ft)[1] | >49.8 | >50 | | | | | |
| Bankfull Max Depth (ft)[2] | 1.4 | 1.3 | | | | | |
| Low Bank Elevation (ft) | 126.7 | 126.8 | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 9.0 | 9.0 | | | | | |
| Bankfull Entrenchment Ratio[1] | >5.4 | >4.9 | | | | | |
| Bankfull Bank Height Ratio[1] | 1.0 | 1.0 | | | | | |

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

Upstream

Downstream

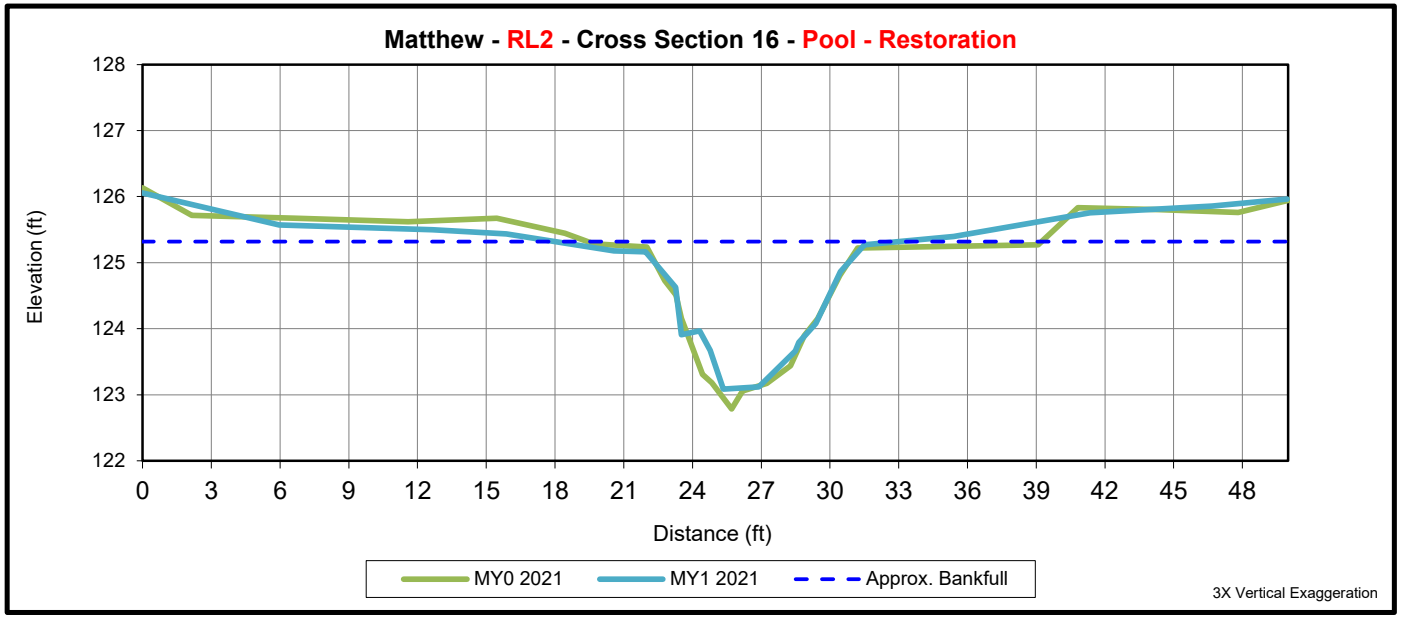



| | Cross Section 15 (Riffle) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA[1]** | 125.4 | 125.4 | | | | | |
| Bankfull Width (ft)[1] | 8.3 | 8.5 | | | | | |
| Floodprone Width (ft)[1] | >50 | >50 | | | | | |
| Bankfull Max Depth (ft)[2] | 1.3 | 1.4 | | | | | |
| Low Bank Elevation (ft) | 125.4 | 125.4 | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 7.7 | 8.5 | | | | | |
| Bankfull Entrenchment Ratio[1] | >6.0 | >5.9 | | | | | |
| Bankfull Bank Height Ratio[1] | 1.0 | 1.1 | | | | | |

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

Upstream

Downstream




| | Cross Section 16 (Pool) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA**[1] | 125.2 | 125.3 | | | | | |
| Bankfull Width (ft)[1] | 9.2 | 9.6 | | | | | |
| Floodprone Width (ft)[1] | - | - | | | | | |
| Bankfull Max Depth (ft)[2] | 2.4 | 2.1 | | | | | |
| Low Bank Elevation (ft) | - | - | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 12.6 | 11.3 | | | | | |
| Bankfull Entrenchment Ratio[1] | - | - | | | | | |
| Bankfull Bank Height Ratio[1] | - | - | | | | | |

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

# Appendix E

Hydrology Data

&

Soil Characterization

**Table 12. 2021 Rainfall Summary**

| Month | Average | Normal Limits | | Project Location Precipitation* |
|---|---|---|---|---|
| | | 30 Percent | 70 Percent | |
| January | 3.37 | 2.39 | 3.99 | 5.66 |
| February | 3.25 | 2.10 | 3.92 | 8.87 |
| March | 4.23 | 3.10 | 4.98 | 2.89 |
| April | 3.71 | 2.38 | 4.47 | 1.63 |
| May | 4.25 | 2.93 | 5.06 | 2.13 |
| June | 4.60 | 2.99 | 5.54 | 4.76 |
| July | 5.56 | 4.24 | 6.47 | 8.08 |
| August | 5.10 | 3.61 | 6.04 | 4.29 |
| September | 5.02 | 2.98 | 6.09 | 1.94 |
| October | 3.32 | 2.21 | 3.98 | 5.36 |
| November | 3.24 | 1.87 | 3.94 | 1.16 |
| December | 3.28 | 2.24 | 3.91 | 2.41† |
| Total Annual ** | 48.93 | 44.37 | 52.62 | 49.20 |
| Above Normal Limits | Within Normal Limits | Below Normal Limits | | |

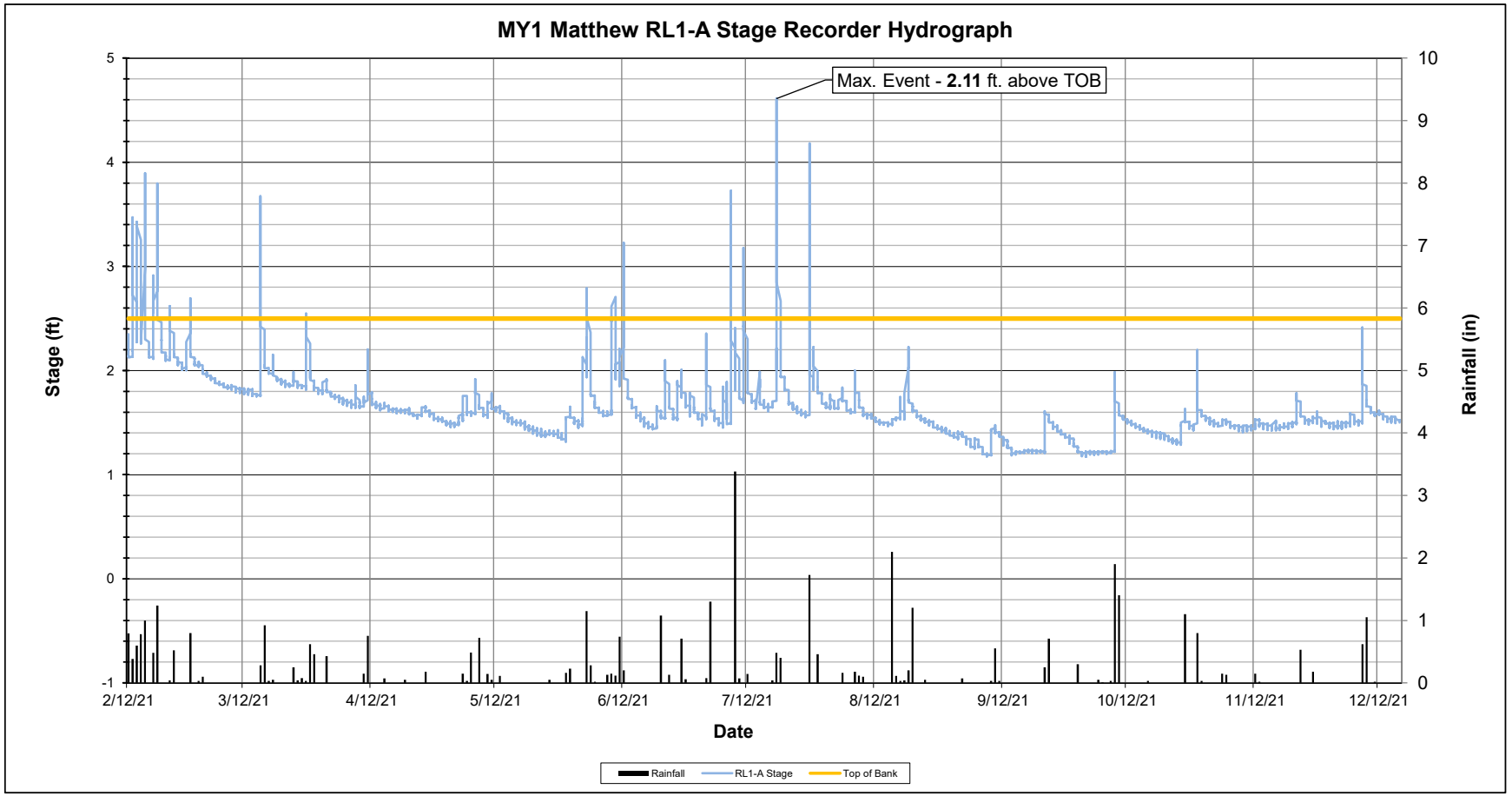
*Project Location Precipitation is a location-weighted average of surrounding gauged data retrieved by the USACE Antecedent Precipitation Tool. Gauges used include Benson 7.5 ESE, Clayton 5.7 SSE, Clayton WTP, Smithfield 2.8 SE, and Smithfield

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

†Only represents data collected through 12/19

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

| Year | Number of Bankfull Events | Maximum Bankfull Height (ft) | Date of Maximum Bankfull Event |
|---|---|---|---|
| Stage Recorder RL1-A | | | |
| MY1 2021 | 15 | 2.11 | 7/20/2021 |
| Stage Recorder RL2 | | | |
| MY1 2021 | 11 | 2.78 | 7/20/2021 |


MY1 Matthew RL1-A Stage Recorder Hydrograph
Max. Event - 2.11 ft. above TOB
Stage (ft)
Rainfall (in)
Date
2/12/21
3/12/21
4/12/21
5/12/21
6/12/21
7/12/21
8/12/21
9/12/21
10/12/21
11/12/21
12/12/21
Rainfall
RL1-A Stage
Top of Bank

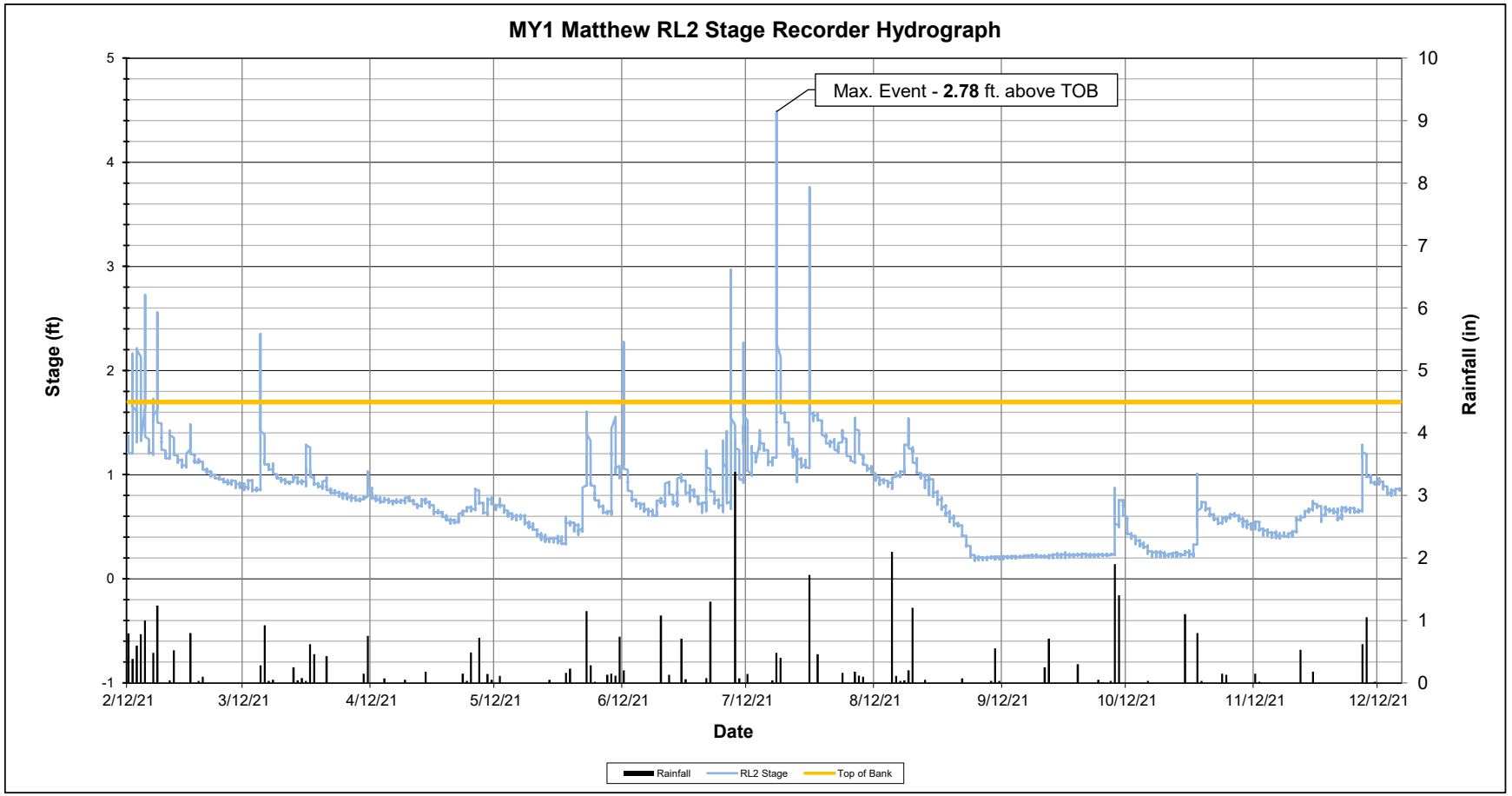
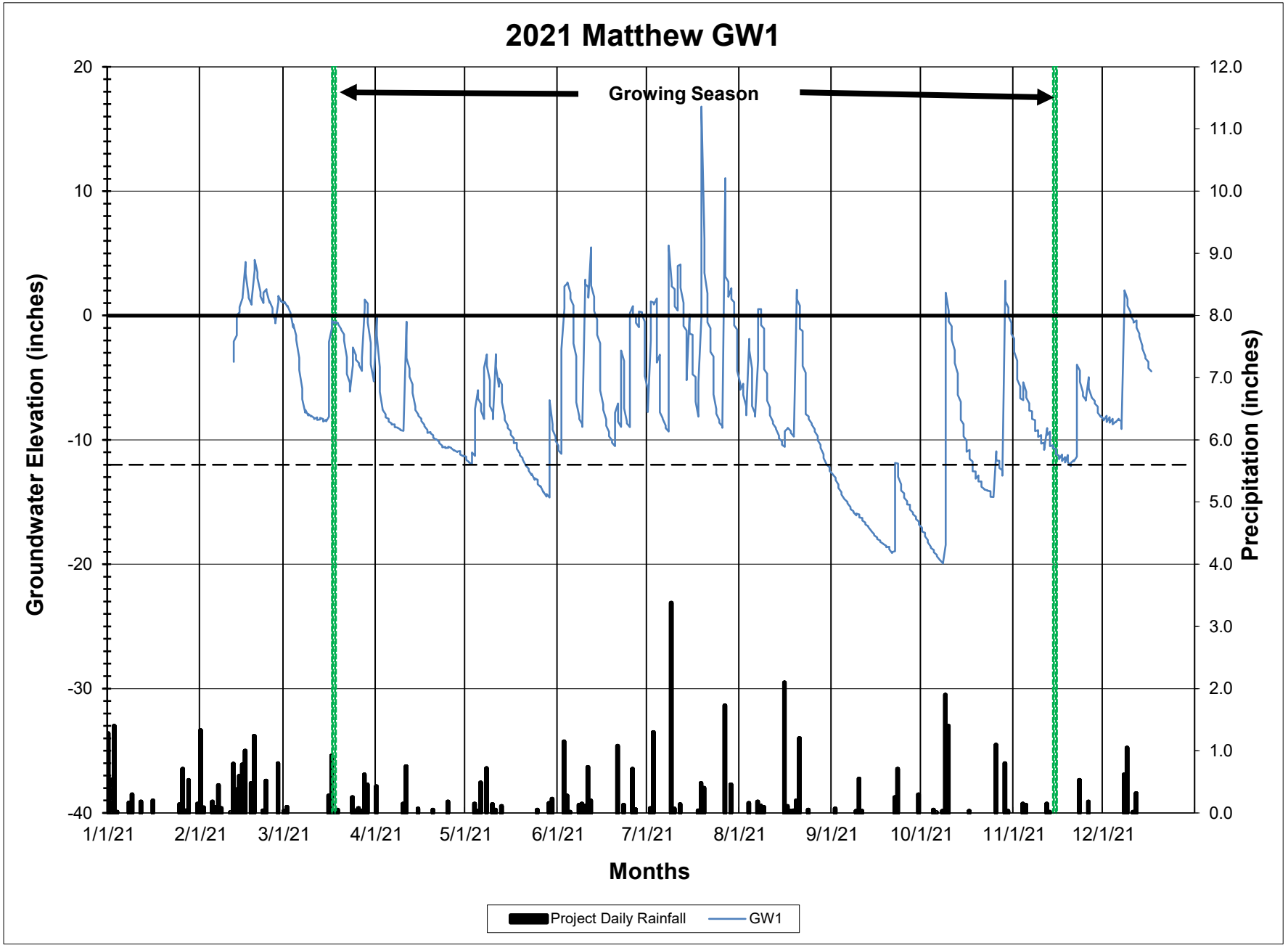

MY1 Matthew RL2 Stage Recorder Hydrograph
Max. Event - 2.78 ft. above TOB
Stage (ft)
Rainfall (in)
Date
2/12/21
3/12/21
4/12/21
5/12/21
6/12/21
7/12/21
8/12/21
9/12/21
10/12/21
11/12/21
12/12/21
Rainfall
RL2 Stage
Top of Bank

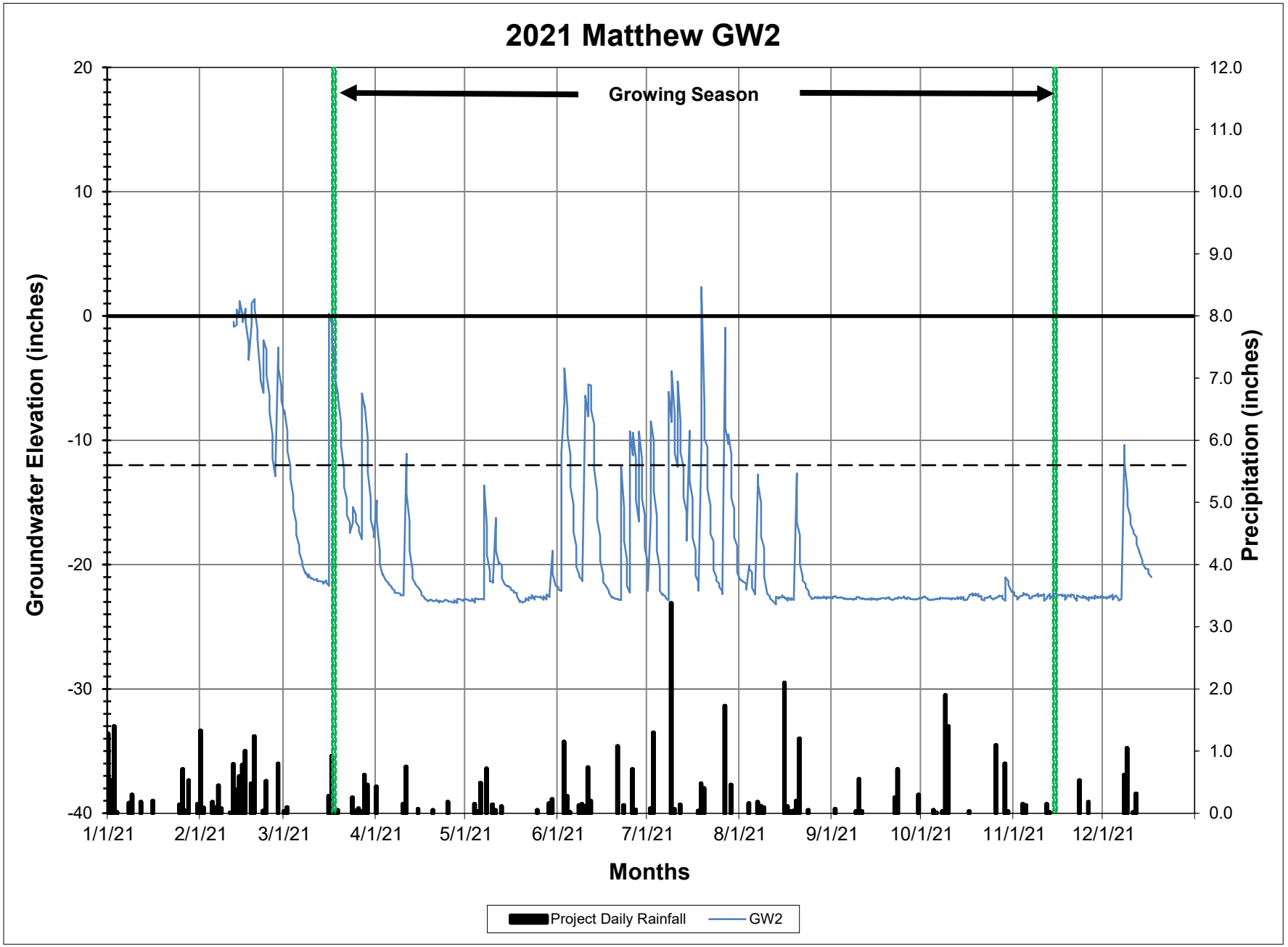
**Table 14. 2021 Max Hydroperiod**

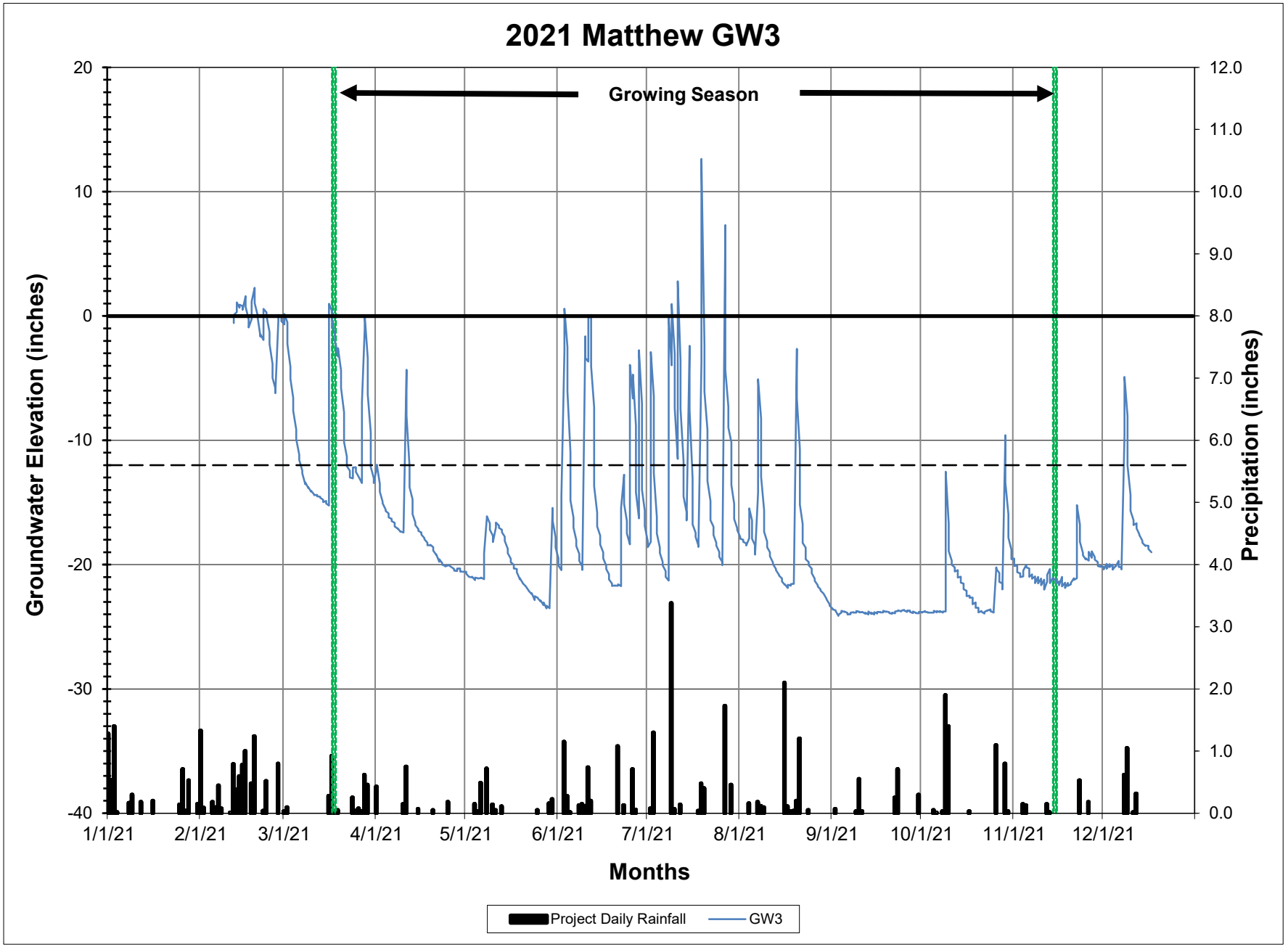
| 2021 Max Hydroperiod (Growing Season 18-Mar through 15-Nov, 242 days) | | | | | |
|---|---|---|---|---|---|
| **Well ID** | **Consecutive** | | **Cumulative** | | **Occurrences** |
| | **Days** | **Hydroperiod (%)** | **Days** | **Hydroperiod (%)** | |
| **GW1** | 94 | 39 | 188 | 78 | 6 |
| **GW2** | 5 | 2 | 27 | 11 | 12 |
| **GW3** | 5 | 2 | 32 | 13 | 16 |
| **GW4** | 6 | 2 | 31 | 13 | 9 |
| **GW5** | 85 | 35 | 153 | 63 | 5 |
| **GW6** | 54 | 22 | 149 | 62 | 8 |
| **GW7** | 16 | 7 | 49 | 20 | 16 |
| **GW8** | 55 | 23 | 137 | 57 | 10 |
| **REF GW1** | 167 | 69 | 208 | 86 | 5 |
| **REF GW2** | 91 | 38 | 193 | 80 | 4 |

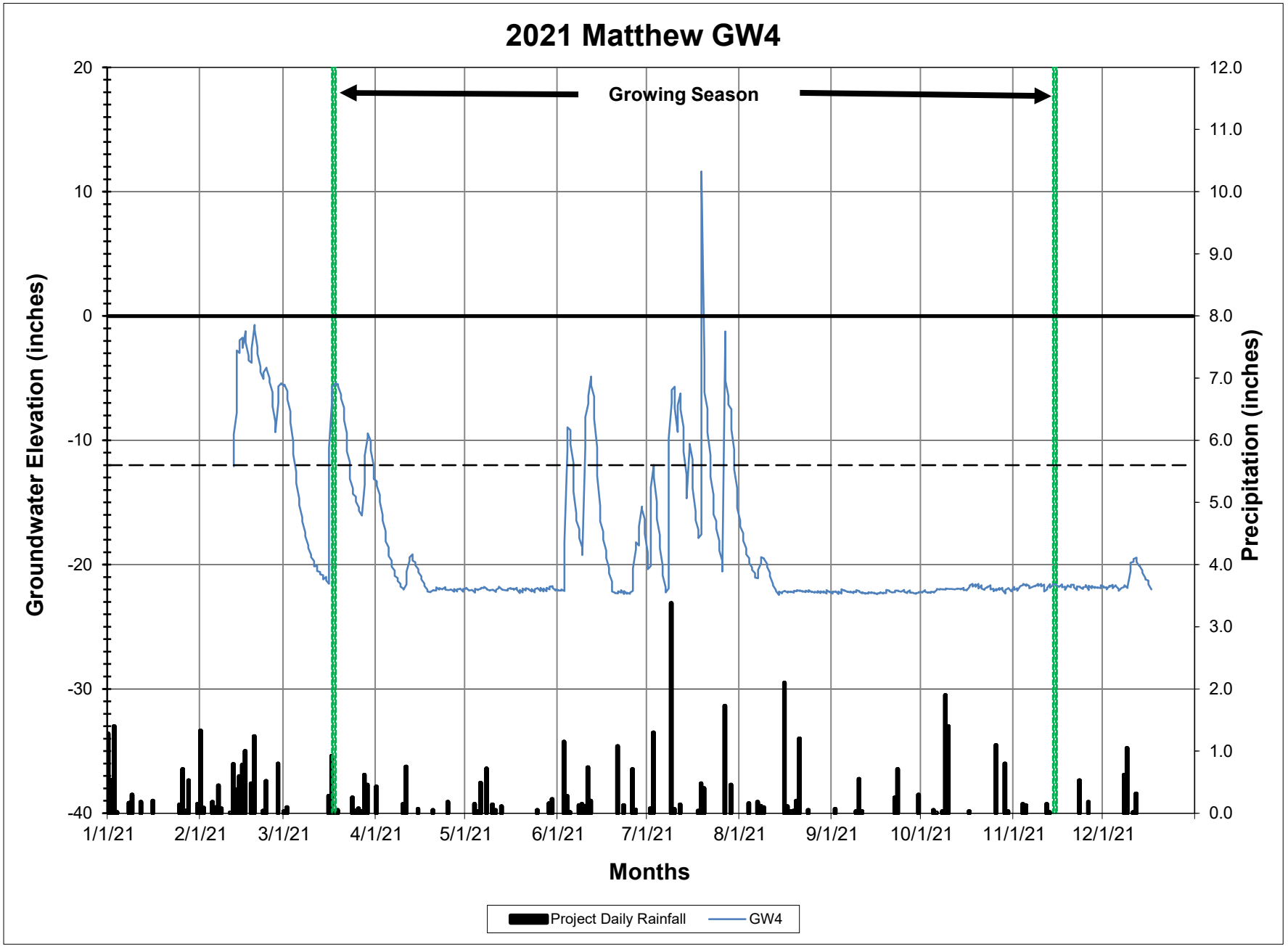
**Table 15. Summary of Groundwater Monitoring Results**

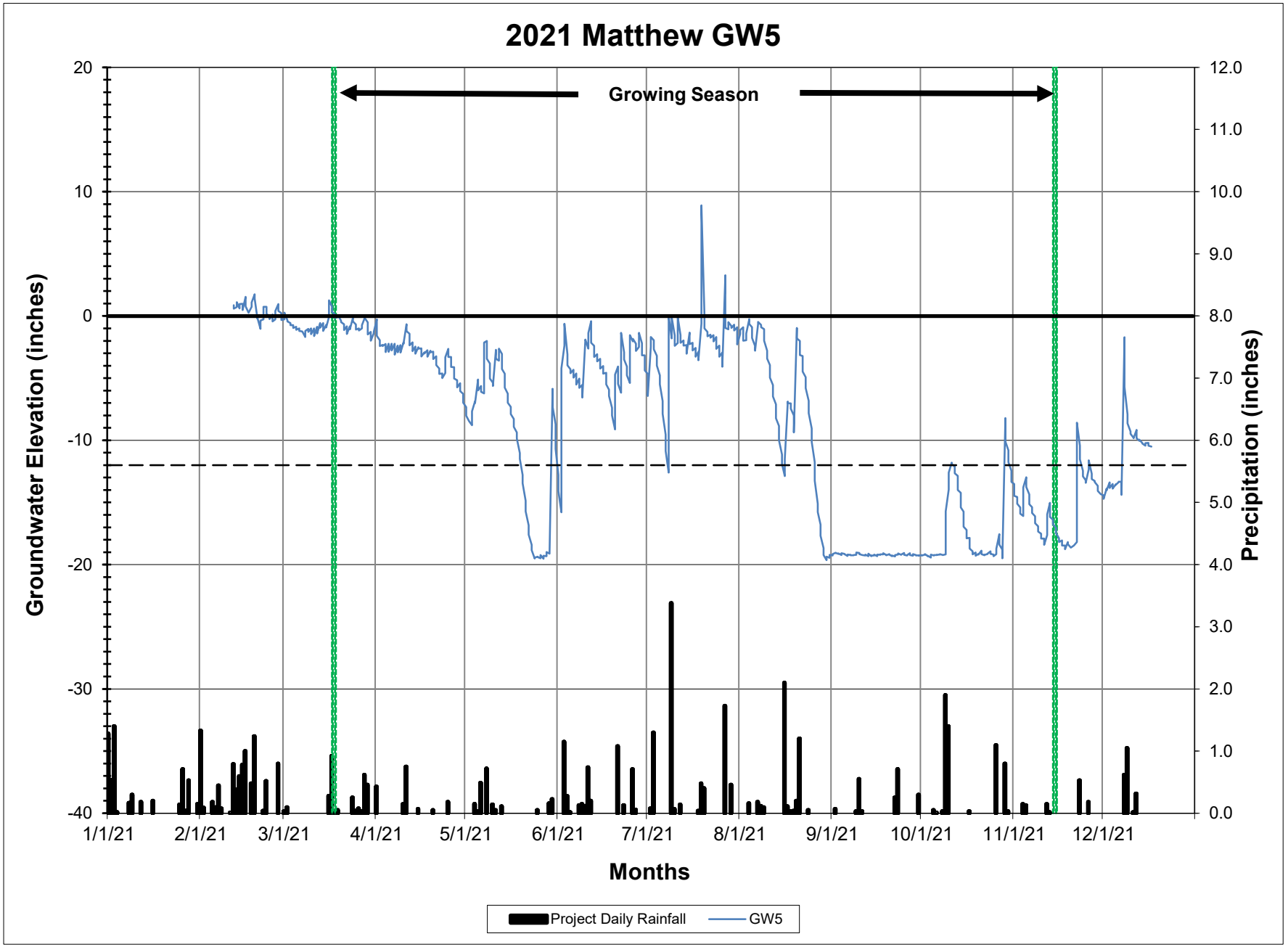
| Summary of Groundwater Monitoring Results<br>Matthew | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Well ID** | **Wetland ID** | **Ground Elevation (ft)** | **Hydroperiod (%)** | | | | | | |
| | | | **Year 1 (2021)** | **Year 2 (2022)** | **Year 3 (2023)** | **Year 4 (2024)** | **Year 5 (2025)** | **Year 6 (2026)** | **Year 7 (2027)** |
| **GW1** | WA | 126.92 | 39 | | | | | | |
| **GW2** | WA | 127.43 | 2 | | | | | | |
| **GW3** | WA | 126.70 | 2 | | | | | | |
| **GW4** | WA | 126.31 | 2 | | | | | | |
| **GW5** | WA | 124.95 | 35 | | | | | | |
| **GW6** | WA | 123.89 | 22 | | | | | | |
| **GW7** | WF | 123.88 | 7 | | | | | | |
| **GW8** | WF | 123.58 | 23 | | | | | | |
| **REF GW1** | WE | N/A | 69 | | | | | | |
| **REF GW2** | WB | N/A | 38 | | | | | | |

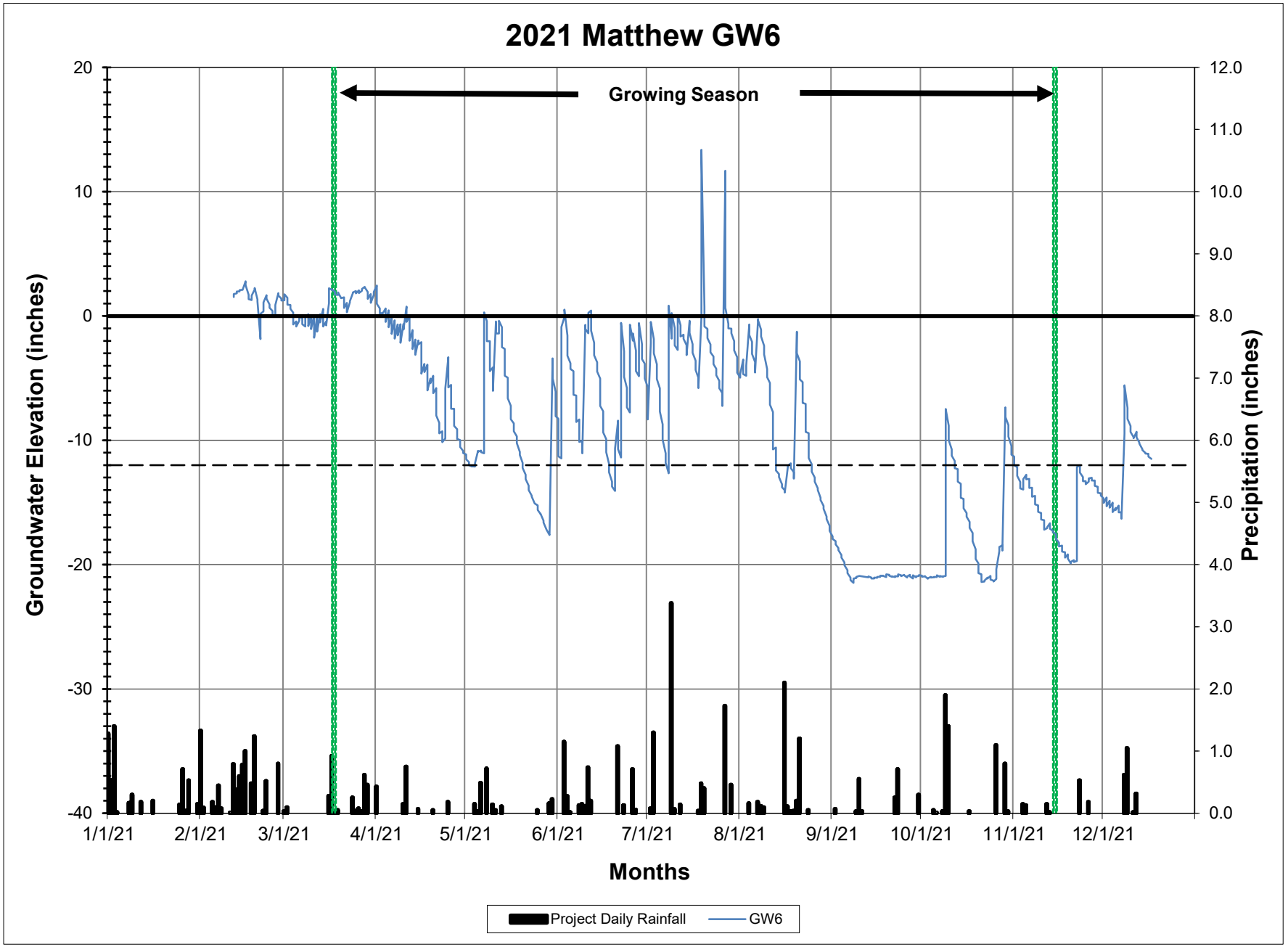

2021 Matthew GW1
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
Months
20
10
0
-10
-20
-30
-40
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1/1/21
2/1/21
3/1/21
4/1/21
5/1/21
6/1/21
7/1/21
8/1/21
9/1/21
10/1/21
11/1/21
12/1/21
Project Daily Rainfall
GW1

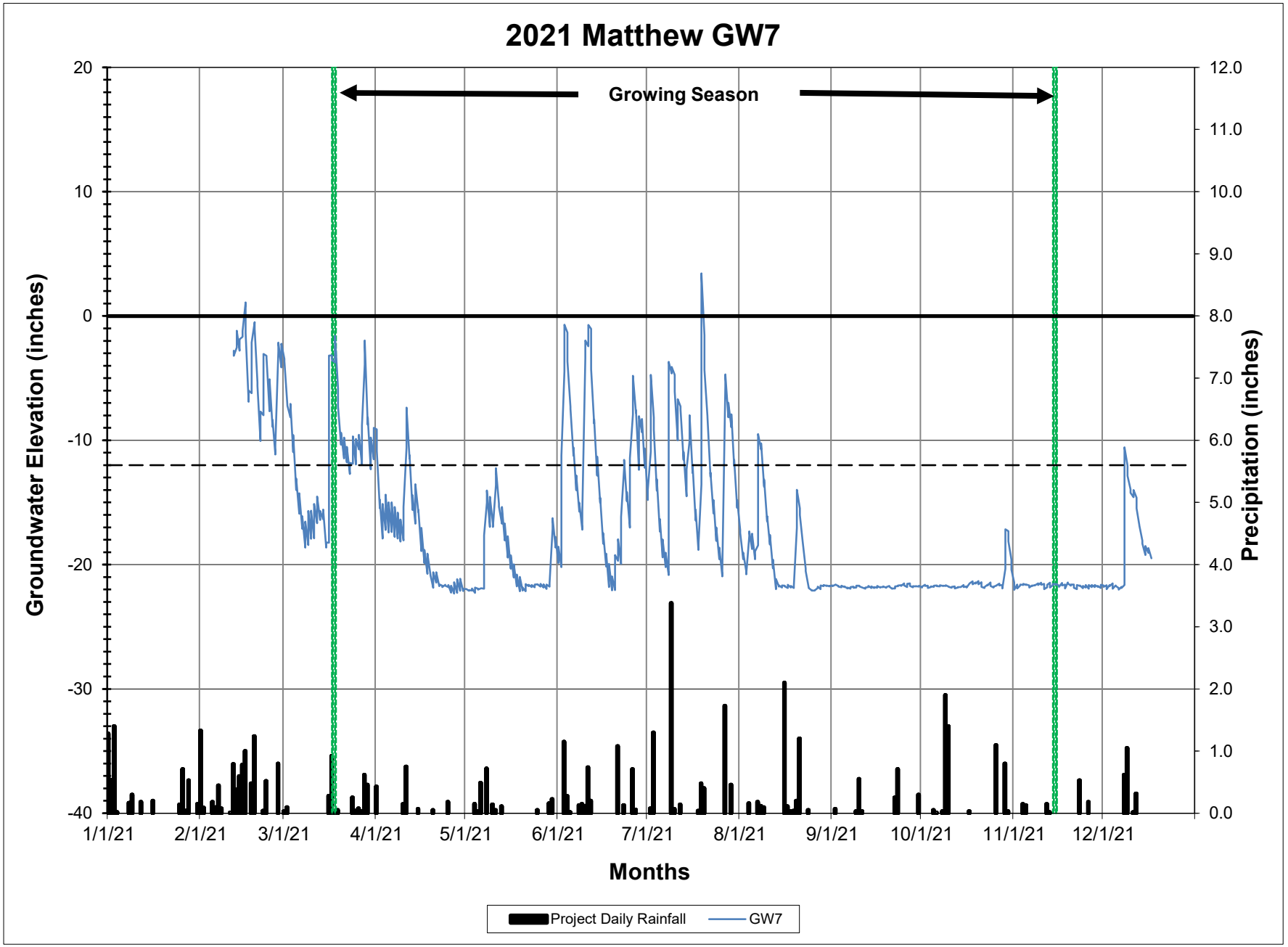

2021 Matthew GW2
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
Months
20
10
0
-10
-20
-30
-40
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1/1/21
2/1/21
3/1/21
4/1/21
5/1/21
6/1/21
7/1/21
8/1/21
9/1/21
10/1/21
11/1/21
12/1/21
Project Daily Rainfall
GW2

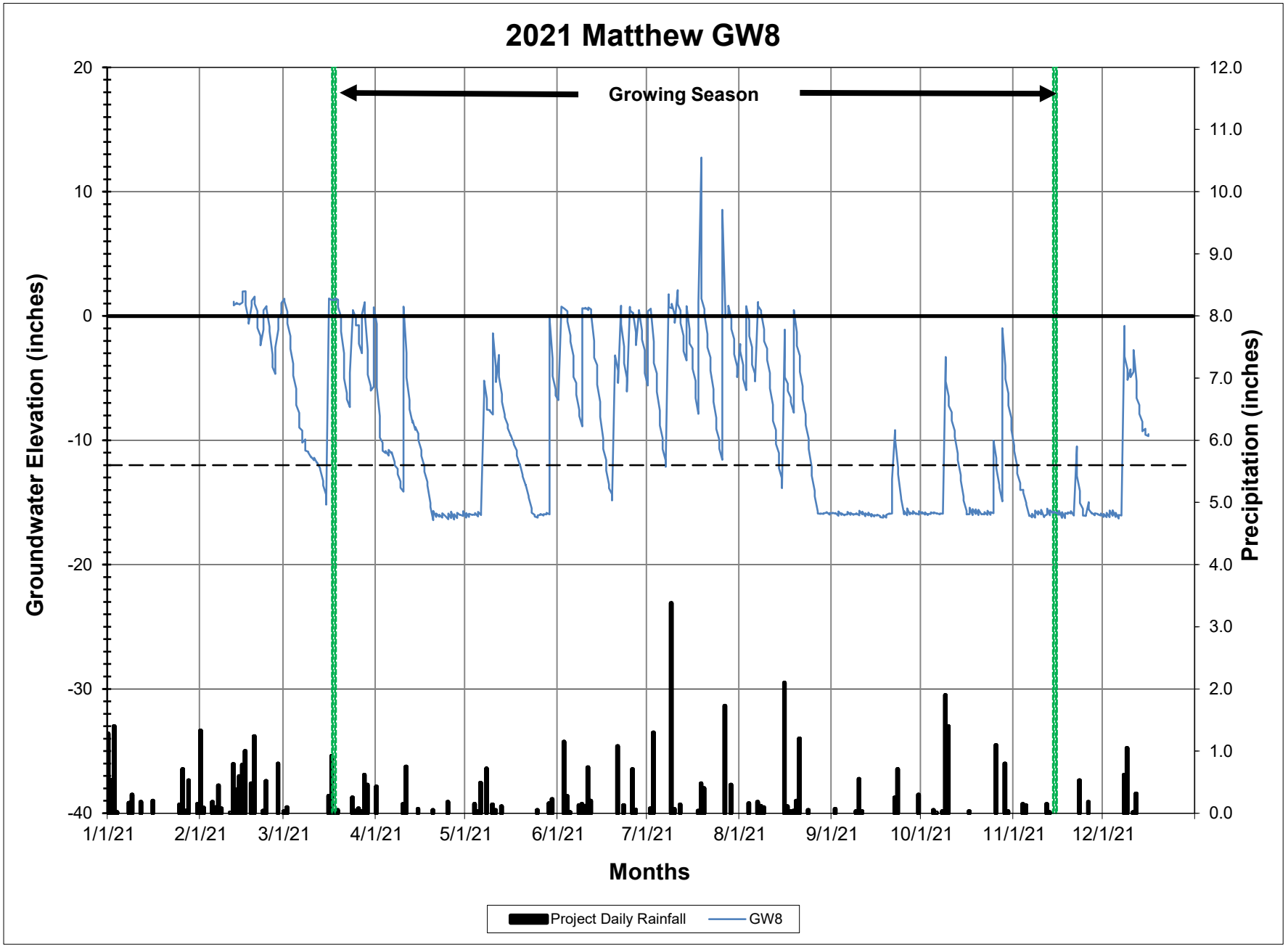

2021 Matthew GW3
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
Months
20
10
0
-10
-20
-30
-40
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1/1/21
2/1/21
3/1/21
4/1/21
5/1/21
6/1/21
7/1/21
8/1/21
9/1/21
10/1/21
11/1/21
12/1/21
Project Daily Rainfall
GW3

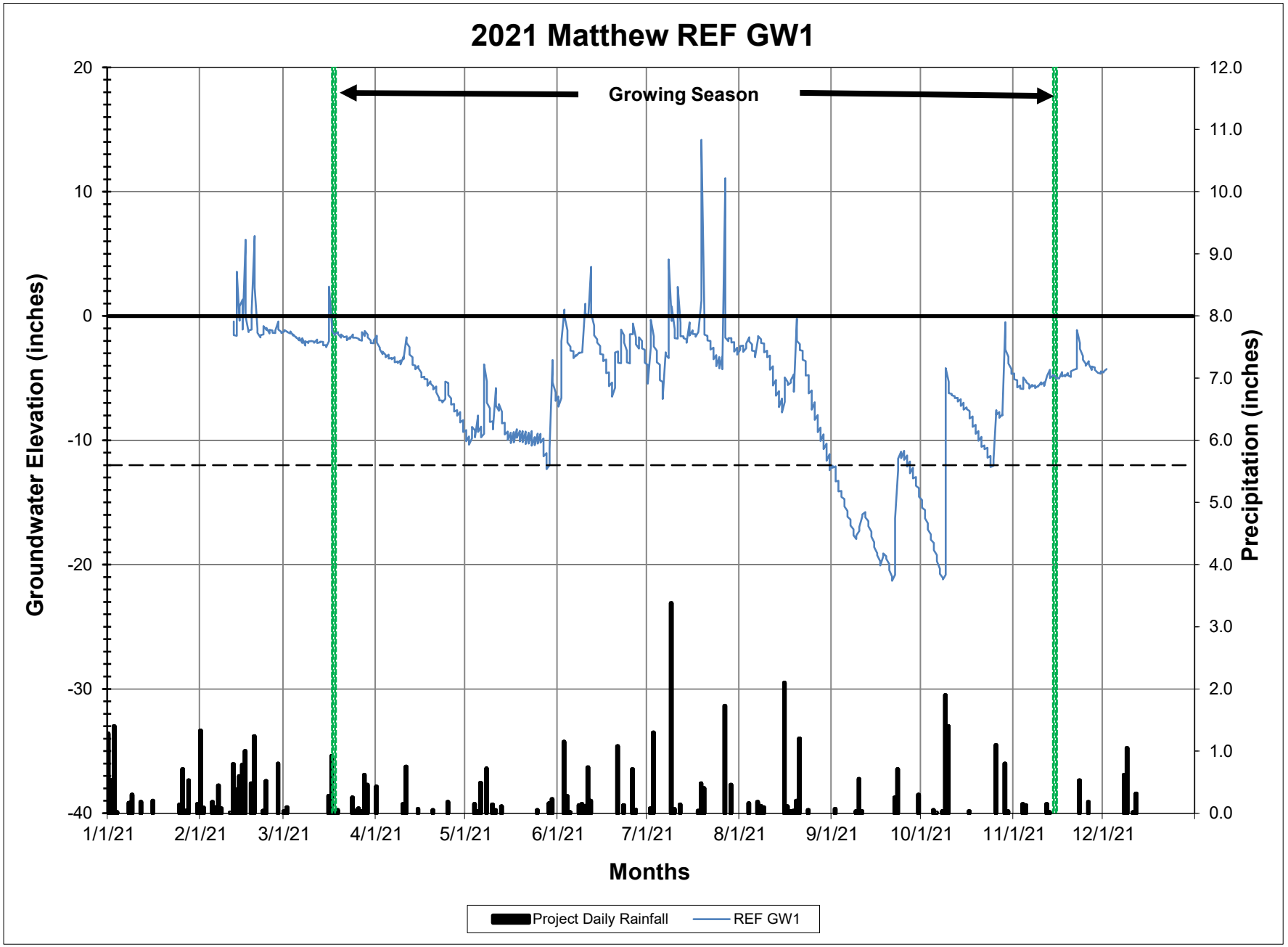

2021 Matthew GW4
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
Months
20
10
0
-10
-20
-30
-40
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1/1/21
2/1/21
3/1/21
4/1/21
5/1/21
6/1/21
7/1/21
8/1/21
9/1/21
10/1/21
11/1/21
12/1/21
Project Daily Rainfall
GW4

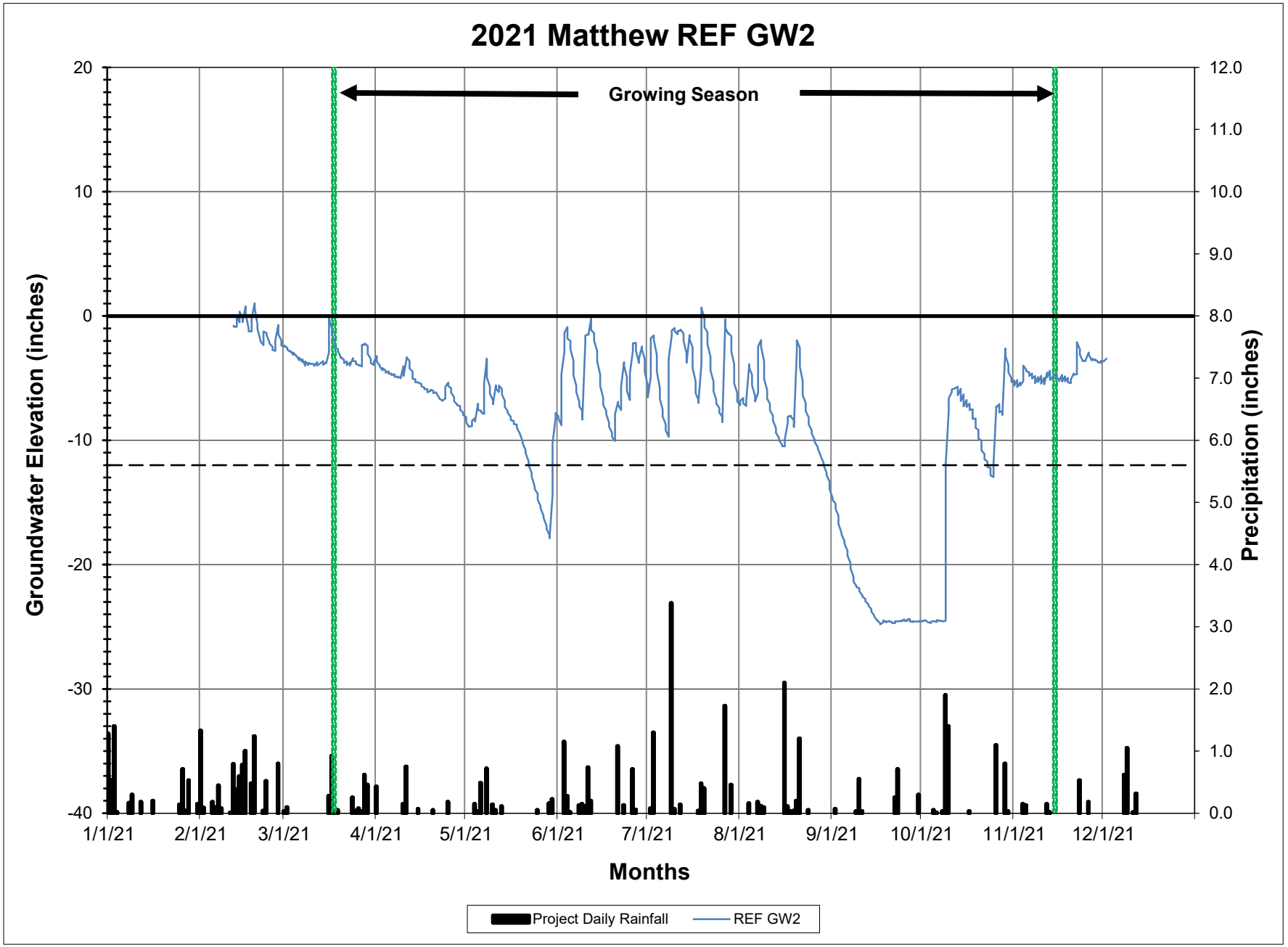

2021 Matthew GW5
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
Months
20
10
0
-10
-20
-30
-40
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1/1/21
2/1/21
3/1/21
4/1/21
5/1/21
6/1/21
7/1/21
8/1/21
9/1/21
10/1/21
11/1/21
12/1/21
Project Daily Rainfall
GW5


2021 Matthew GW6
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
Months
20
10
0
-10
-20
-30
-40
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1/1/21
2/1/21
3/1/21
4/1/21
5/1/21
6/1/21
7/1/21
8/1/21
9/1/21
10/1/21
11/1/21
12/1/21
Project Daily Rainfall
GW6


2021 Matthew GW7
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
Months
20
10
0
-10
-20
-30
-40
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1/1/21
2/1/21
3/1/21
4/1/21
5/1/21
6/1/21
7/1/21
8/1/21
9/1/21
10/1/21
11/1/21
12/1/21
Project Daily Rainfall
GW7


2021 Matthew GW8
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
Months
20
10
0
-10
-20
-30
-40
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1/1/21
2/1/21
3/1/21
4/1/21
5/1/21
6/1/21
7/1/21
8/1/21
9/1/21
10/1/21
11/1/21
12/1/21
Project Daily Rainfall
GW8


2021 Matthew REF GW1
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
Months
20
10
0
-10
-20
-30
-40
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1/1/21
2/1/21
3/1/21
4/1/21
5/1/21
6/1/21
7/1/21
8/1/21
9/1/21
10/1/21
11/1/21
12/1/21
Project Daily Rainfall
REF GW1


2021 Matthew REF GW2
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
Months
20
10
0
-10
-20
-30
-40
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1/1/21
2/1/21
3/1/21
4/1/21
5/1/21
6/1/21
7/1/21
8/1/21
9/1/21
10/1/21
11/1/21
12/1/21
Project Daily Rainfall
REF GW2

## Soil Characterization Data Forms

| GW1 | | | | | | |
|---|---|---|---|---|---|---|
| **Horizon Depths (in.)** | **Texture** | **Matrix Color** | **Redox Features** | | **Induration** | **Roots** |
| | | | **Color** | **Abundance** | | |
| 0-6 | Loamy sand | 10YR 4/1 | 2.5YR 4/6 | 15% | None | Common |
| 6-13 | Sand | 10YR 6/1 | 2.5YR 4/6 | 10% | None | Few |
| 13-18 | Loamy sand | 10YR 4/1 | - | - | None | None |
| 18-24 | Sandy loam | 10YR 3/1 | - | - | None | None |
| **Comments:** Old pond bed | | | | | | |

| GW2 | | | | | | |
|---|---|---|---|---|---|---|
| **Horizon Depths (in.)** | **Texture** | **Matrix Color** | **Redox Features** | | **Induration** | **Roots** |
| | | | **Color** | **Abundance** | | |
| 0-9 | Loam | 10YR 4/1 | 5YR 4/6 | 10% | None | Common |
| 9-15 | Sandy loam | Gley 1 5/N | 2.5YR 3/6 | 10% | None | None |
| 15-24 | Sandy loam | Gley 1 4/N | 2.5 YR 4/6 | 2% | None | None |
| | | | | | | |
| **Comments:** Old pond bed | | | | | | |

| GW3 | | | | | | |
|---|---|---|---|---|---|---|
| **Horizon Depths (in.)** | **Texture** | **Matrix Color** | **Redox Features** | | **Induration** | **Roots** |
| | | | **Color** | **Abundance** | | |
| 0-4 | Silt loam | 10YR 4/1 | 5YR 4/6 | 10% | None | Common |
| 4-5 | Silt loam | 10YR 7/1 | 10YR 5/6 | 15% | None | Common |
| 5-8 | Loam | 10YR 3/1 | 5YR 5/6 | 2% | None | Common |
| 8-24 | Loam | Gley 1 5/N | - | - | None | Few |
| **Comments:** Old pond bed | | | | | | |

| GW4 | | | | | | |
|---|---|---|---|---|---|---|
| **Horizon Depths (in.)** | **Texture** | **Matrix Color** | **Redox Features** | | **Induration** | **Roots** |
| | | | **Color** | **Abundance** | | |
| 0-3 | Silt loam | 10YR 4/2 | 10YR 4/6 | 5% | Weak | Common |
| 3-10 | Silt loam | 10YR 4/1 | 10YR 4/6 | 5% | Weak | Few |
| 10-16 | Sandy loam | Gley 1 4/N | 10YR 4/6 | 3% | None | None |
| 16-27 | Loamy sand | 10YR 6/1 | - | - | None | None |
| **Comments:** Old pond bed, micro-high, large surface soil cracks | | | | | | |

| GW5 | | | | | | |
|---|---|---|---|---|---|---|
| **Horizon Depths (in.)** | **Texture** | **Matrix Color** | **Redox Features** | | **Induration** | **Roots** |
| | | | **Color** | **Abundance** | | |
| 0-4 | Clay loam | 10YR 4/2 | 5YR 4/6 | 20% | None | Common |
| 4-8 | Clay loam | 10 YR 5/2 | 5YR 4/6 | 15% | None | Common |
| 8-12 | Clay loam | 10 YR 5/1 | 5YR 4/6 | 5% | None | Few |
| 12-22 | Sand | 10YR 7/2 | 10YR 5/6 | 20% | None | None |
| **Comments:** Old pond bed | | | | | | |

| GW6 | | | | | | |
|---|---|---|---|---|---|---|
| **Horizon Depths (in.)** | **Texture** | **Matrix Color** | **Redox Features** | | **Induration** | **Roots** |
| | | | **Color** | **Abundance** | | |
| 0-10 | Sandy loam | 10YR 4/2 | 5YR 4/6 | 10% | None | Many |
| 10-16 | Loamy sand | 10YR 6/2 | 10YR 5/8 | 20% | None | Few |
| 16-29 | Clay loam | 10YR 5/1 | 5YR 4/6 | 15% | None | None |
| | | | | | | |
| **Comments:** Old pond bed | | | | | | |

| GW7 | | | | | | |
|---|---|---|---|---|---|---|
| **Horizon Depths (in.)** | **Texture** | **Matrix Color** | **Redox Features** | | **Induration** | **Roots** |
| | | | **Color** | **Abundance** | | |
| 0-18 | Loamy sand | 10YR 4/1 | 5YR 5/8 | 15% | None | None |
| 18-30 | Loamy sand | 10YR 4/2 | 10YR4/6 | 5% | None | None |
| | | | | | | |
| | | | | | | |
| **Comments:** Old damn footprint, likely historic compacted fill | | | | | | |

| GW8 | | | | | | |
|---|---|---|---|---|---|---|
| **Horizon Depths (in.)** | **Texture** | **Matrix Color** | **Redox Features** | | **Induration** | **Roots** |
| | | | **Color** | **Abundance** | | |
| 0-16 | Sandy loam | 10YR 5/1 | 5YR 5/8 | 15% | None | Few |
| 16-28 | Sandy loam | 10YR 4/1 | 10 YR 4/6 | 5% | None | None |
| | | | | | | |
| | | | | | | |
| **Comments:** Newly compacted fill material (used to fill old stream channel) | | | | | | |

| RGW1 | | | | | | |
|---|---|---|---|---|---|---|
| **Horizon Depths (in.)** | **Texture** | **Matrix Color** | **Redox Features** | | **Induration** | **Roots** |
| | | | **Color** | **Abundance** | | |
| 0-10 | Mucky clay loam | 10YR 5/1 | 5YR 5/6 | 20% | None | Many |
| 10-14 | Sandy clay loam | 10YR 4/1 | 5YR 5/6 | 10% | None | Few |
| 14-16 | Loamy sand | 10YR 6/1 | - | - | None | None |
| 16-24 | Sandy clay loam | 10YR 3/1 | - | - | None | None |
| **Comments:** | | | | | | |

| RGW2 | | | | | | |
|---|---|---|---|---|---|---|
| **Horizon Depths (in.)** | **Texture** | **Matrix Color** | **Redox Features** | | **Induration** | **Roots** |
| | | | **Color** | **Abundance** | | |
| 0-6 | Mucky loam | 10YR 4/1 | 5YR 4/6 | 5% | None | Many |
| 6-12 | Mucky loam | 10YR 5/1 | - | - | None | Common |
| 12-18 | Sandy clay loam | 10YR 5/1 | - | - | None | Few |
| 18-22 | Sandy clay loam (gravelly) | 10YR 7/1 | 10YR 5/8 | 15% | None | None |
| **Comments:** | | | | | | |