Tar River Headwaters Wetland Restoration Site

Person County NC -- Tar-Pamlico River HUC# 03020101-0102

MY-7 (2023) Annual Fall Monitoring Report

NC-DEQ Division of Mitigation Services: DMS Project # 97071
DEQ Contract #6746 DWR # 2016-0233 ACE #SAW-2016-01101
Data Collected: Jan-Dec 2023 Final Report: January 2024

NC Environmental Quality	**Submitted To:** **N.C. Department of Environmental Quality** **DEQ Division of Mitigation Services** **1652 Mail Service Ctr, Raleigh, NC 27699-1652** --- **DMS Project Manager: Jeremiah Dow** **DEQ-DMS Contract # 006746**

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1.0. Project Background Summary

1.1. Project Location and Setting

The Tar River Headwaters Wetland Restoration Site (TRHWR) is a full-delivery wetland mitigation project located in eastern Person County, between Roxboro and Oxford, North Carolina, within the Piedmont Physiographic Province (Figure 1). The easement comprises 9.98 acres, most of which was drained and degraded wetlands or former wetlands with hydric soil indicators. The remaining areas include non-hydric soils, drainage ditches, and a 570-foot long riparian corridor along a ditch and intermittent stream connecting the TRHWR site to the adjacent Tar River Headwaters Riparian Buffer and Nutrient Offset Mitigation Bank project. Both projects are implemented by Mogensen Mitigation, Inc. (MMI), and are located on a 228-acre farm owned by Roy and Joyce Huff, in the Tar-Pamlico River Basin 12-digit HUC # 03020101-0102. The Huff Farm property is located at 333 Bunnie Huff Road, Oxford NC 27565. The access road into the TRHWR site is at Latitude = 36.3913, Longitude = -78.8171.

1.2. Pre-Restoration Conditions

The TRHWR site was cleared and ditched for pasture use in the 1940s according to the owner, and was used for grazing cattle until January 2017 when the conservation easement fence was installed. The project involved plugging drainage ditches to restore wetland hydrology, fencing to exclude livestock, and planting native trees and shrubs to restore a Headwater Forest wetland ecosystem similar to what occurred prior to site clearing and drainage. Remnant native trees left for shade, hydrophytic groundcover plants mixed among the pasture grasses, and plant species recorded in adjacent natural forests (on the same soil mapping unit) provided data for the planting plan.

The project will restore approximately 7.65 acres of headwater riparian wetland (6.53 acres reestablishment plus 1.12 acres rehabilitation) and will generate an estimated 7.28 or more riparian wetland mitigation credits. Approximately 1.27 acres with non-hydric soils in the southeast corner of the mitigation site will also be reforested, and a 100-foot wide by 570-ft long riparian corridor (1.06 acre) extending southeastward along the ditch will connect the TRHWR site to MMI's adjacent stream restoration and nutrient buffer bank project to the south. Total acreage of the wetland mitigation site and riparian connector is 9.98 acres.

Restoration activities including tree planting, surface flow dispersal, and cattle exclusion has reduced soil erosion and nutrient-enriched runoff from adjacent pasture and cropland within its watershed, and helped retain agricultural chemicals used on these lands. It is expected to improve water quality and habitat in the receiving tributary and reduce fine sediment loading which will enhance the overall watershed, particularly in the adjacent stream and nutrient mitigation bank and downstream.

1.3. Mitigation Goals and Performance Criteria

The subject watershed HUC #03020101-0102 is designated by NCDEQ as a Targeted Local Watershed (TLW) for water quality improvement projects, and the Tar River reach within and downstream of this local HUC is recognized as a Significant Natural Heritage Area (SNHA) for its high diversity of aquatic life including protected species of river mussels and fishes. The TRHWR project is intended to support

these TLW and SNHA designations by improving water quality and habitat on the property and downstream. Specific project goals and objectives as identified in the TRHWR Final Mitigation Plan (December 2016) include:

GOALS:

- Restore the natural jurisdictional wetland hydro-period to five or more acres of forested wetland within a nine-acre site;
- Restore forested wetland habitat and improve habitat connectivity between Denny Store Gabbro Forest (NHP Natural Heritage Area) to the north and the Tar River tributaries;
- Buffer storm water runoff from fecal and other cattle-related pollutants and fertilizer.

OBJECTIVES:

- Plug existing ditches and create sheet flows throughout the site. Aerate soils to reduce compaction, improve infiltration, and create micro-topography to retain surface flows;
- Preserve the remnant mature Swamp White Oaks (a regionally rare species) for seed source. Plant appropriate native hardwood trees at a sufficient frequency to establish a diverse bottomland wetland forest. Treat and/or remove invasive species which may cause problems for site restoration, including Chinese privet and multi-flora rose;
- Install fencing to exclude cattle and establish a conservation easement to provide permanent protection on the site.

PERFORMANCE STANDARDS and MONITORING:

GOAL	OBJECTIVE	PERFORMANCE STANDARD	MONITORING APPROACH
Restore natural hydro-period for headwater forest wetland.	Plug existing ditches and create sheet flow throughout the site. Aerate soils to reduce compaction, improve infiltration, and create micro-topography to retain surface flows.	Water must be on or within 12 inches of the surface for 10% of the growing season. Hydrographs will indicate jurisdictional hydrology.	Use 11 shallow groundwater self-reading gauges throughout the site at a frequency of about one per acre. Visual inspection of ponding duration.
Restore forested wetland habitat and improve habitat connectivity with existing forests.	Preserve mature swamp white oak trees for seed source. Plant appropriate native hardwood trees at 10-ft average spacing (435 stems/ac) Treat invasive species.	Survival of 320 stems per acre at year 3, 260 stems per acre at year 5 and 210 stems per acre at MY 7.	Monitor vegetation plots annually and calculate densities of surviving planted & volunteer stems.
Buffer storm water runoff from fecal and other cattle-related nutrient inputs.	Plant trees, fence perimeter and establish a permanent conservation easement.	Insure the integrity of the cattle exclusion fencing for the life of the contract.	Visual inspection will note fence condition through site pictures. Observations will be included in annual monitoring reports.

1.4. Mitigation Approach

Prior to restoration, the TRHWR project area contained 6.53 acres of former riparian wetland (ditched and drained, grazed pasture) with redoximorphic soil characteristics indicating hydric soils, but lacking adequate wetland hydrology based on groundwater gauge data and field observations during 2015-2016. Although the drainage ditches are shallow, they have effectively reduced water retention across much of the site over the past 70 years due to the slow infiltration rate, rapid runoff, and shallow hardpan in these soils. The project will re-establish jurisdictional wetlands in this area by plugging the drainage ditches to increase rainfall retention and dispersal, fencing out livestock, controlling invasive species, and planting suitable native tree species. These 6.53 acres of wetland restoration will generate riparian wetland credits at 1:1 ratio, yielding 6.53 WMU.

Another 1.12 acres in the TRHWR project area has been less effectively drained by the ditches, and still has sufficient hydrology to meet jurisdictional wetland criteria, based on groundwater gauge data and field observations during 2015-2016. The project will rehabilitate these areas of degraded jurisdictional wetland (grazed pasture with reduced hydrology) by plugging ditches to increase hydrology, fencing out livestock, and planting suitable native tree species. These 1.12 acres of wetland rehabilitation will generate riparian wetland credits at 1.5:1 ratio, yielding 0.75 WMU. TRHWR project components and mitigations assets are summarized in Table 1, matching the proposed assets in the Mitigation Plan.

2.0. Monitoring Methods

Vegetation plots are monitored annually in accordance with current DMS monitoring guidance (June 2017). The nine installed CVS vegetation plots, each 10 x 10 meters, represents 2.8 percent of the planted mitigation area. Vegetation monitoring occurs between September and early November, prior to the loss of leaves. The vegetation success criteria are specified in the Performance Standards above. If success criteria are not met, site maintenance and monitoring will continue until the success criteria are met.

Ten onsite groundwater monitoring gauges (RDS and Hobo) and one offsite reference wetland gauge are downloaded and maintained at least quarterly. Gauge data in the mitigation credit areas are plotted and evaluated for success based on the mitigation plan performance standard of continuous saturation within 12 inches of the ground surface for 10 percent of the growing season. Growing season based on air temperature at a weather station east of Roxboro is from March 28 to November 3, which is 221 days (from USDA WETS table). MMI installed a Hobo dual-probe soil temperature logger near the middle of the TRHWR site (beside GW-H) in late January 2017. Soil temperature on the site remained above 41 F at both 10-inch and 20-inch depths throughout February and March 2017. The lowest temperatures recorded were 42.7 F at 10 inches and 45.4 F at 20 inches. Based on soil temperatures remaining above the USDA-designated temperature for plant physiological activity, March 1 is used as the start of the growing season, based on field discussions with DMS and USACE. The revised growing season length is thus 248 days, and the groundwater hydrology success criterion is 25 days. Subsequent data from 2018 to 2023 confirm that soil temperature has remained above 42 F after the end of February each year. These data along with late-February bud swelling on *Acer, Betula*, and *Salix*, plus new growth of groundcover plants (*Lamium, Cardamine, Lactuca, Allium, Bromus, Alopecurus, Ranunculus, Senecio, Geranium, Plantago, Viola,* and *Persicaria*) support the use of March 1 as the growing season start date.

The conservation easement perimeter fence and ditch plug integrity have been monitored visually and documented with photo points.

3.0. Current Conditions Summary

Groundwater gauge data were collected from January 1 through September 4, 2023, during several visits to the site. The condition of the ditches, ditch plugs, and planted and volunteer trees were evaluated visually during these visits. CVS vegetation plot data and photos were collected in late September. All nine CVS plots had 6 or more surviving planted trees and exceeded the 210 stems per acre success criteria for MY-7 based on planted stems alone (Tables 6 and 7). The average density across all nine plots was 346 planted stems per acre and 612 total stems (including volunteers of planted species) per acre.

Outside of the CVS plots, planted stem survival is generally good throughout the site, with an estimated 20 percent mortality since the original planting. Leader die-back is common on many of the taller saplings, especially on tulip poplar, river birch, and musclewood, but many of the trees exhibiting leader die-back also have vigorous basal sprouts. Small unflagged trees outside of the CVS plots, especially resprouted trees, remain difficult to see in summer and fall due to the dense groundcover.

A few isolated plants of Multiflora rose, Chinese privet, and Callery pear were treated.in 2020 to 2022, and no "invasive exotic" problem areas were identified in September 2023. Groundcover vegetation is dense and diverse throughout the site, in both the treated areas (non-wetland and drained wetland) and non-treated areas (existing wetland). Exotic grasses including fescue (*Lolium*) and carpet grass (*Arthraxon*) are abundant in some areas, but have not been treated. All ditch plugs appear to be stable and performing as designed. Survival of planted trees, live-stakes, and herbaceous cover on the plug slopes and tops appears to be providing good protection; no erosion on the plugs was observed. Most of the ditches are now obscured by vegetation. Ponding behind each ditch plug was evident in spring, but the ditches were mostly dry during summer and fall 2023.

Ten groundwater gauges (A through L) on the project site are arranged in four transects perpendicular to the main ditch (Figure 2). Three gauges (A, H and J) are within existing wetland rehabilitation areas, and seven gauges (D, E, F, G, I, L, and K) are within the drained wetland reestablishment areas. Two additional gauges (B and C) are south of the lowermost ditch plug in an area that is not intended to generate wetland credits. These two gauges were monitored from 2016 until 2021 but are no longer monitored as they do not pertain to the project success criteria. Wetland hydrology success for the TRHWR site is based on saturation within 12 inches of the ground surface for 10% of the 248-day growing season (March 1 to November 3). Manual water table measurements were also collected at each well one or more times during the year, and gauge data were calibrated to fit the actual measurements. The gauges measure the free water table depth and do not account for capillary fringe saturation which can extend well above the free water table in fine-textured soils (https://vernonjames.ces.ncsu.edu/eleventh-annual-on-site/soil-wetness/).

Rainfall in 2023, relative to the 30-year normal values (1981 to 2010), was high (70th percentile or greater) during January, April, and September; low (30th percentile or less) during February, March, May, July, August, October, and November; and "normal" (between 30th and 70th percentiles) during June. Despite the low rainfall in February and March, all 11 gauges (ten in the mitigation credit area, and one off-site reference gauge) exceeded the minimum of 25 consecutive days for hydrologic success during the early part of the growing season, with consecutive day saturation periods ranging from 51 to 84 days (Table 8).

The soil temperature gauge and water temperatures recorded in the groundwater monitoring wells all indicate that soil temperatures remained above 41 F after February 28, 2022, which supports the accepted growing season start date of March 1.

The easement perimeter fence is intact and is successfully excluding the cattle on the adjacent pasture areas. There was one brief cattle encroachment episode in 2020 when a gate was inadvertently left open. The gates are now kept locked. Conservation easement signs, rebar pin caps, and witness post signs are presently being replaced or installed, and easement marking will be completed by January 2024.

4.0. Conclusions

The MY7 (2023) monitoring data demonstrate that the TRHWR site is meeting hydrologic and vegetation success criteria, although a few small areas exhibit somewhat stunted tree growth. The TRHWR site is a headwater flat wetland with low-porosity Iredell clay loam soil and a hardpan confining layer within a few feet below the soil surface that supports a seasonal perched water table. Based on the adjacent surrounding natural communities and the NC Natural Heritage Program (NHP) community classification system, the site was presumably a *Piedmont mixed moisture hardpan forest* (Schafale, 2012) prior to being cleared and ditched for use as cattle pasture in the 1940s. The plant community was likely similar to the Denny Store Gabbro Forest natural area described by LeGrand (2007) on the adjacent property to the north. A defining characteristic of this community type is "alternately wet and dry, with water pooled on part of the ground surface at times but dry most of the time" (Schafale, 2012).

During pre-restoration monitoring in 2016, only three groundwater gauges in the wettest areas of the TRHWR site (farthest from drainage ditches) met the hydrologic success criteria with a least 25 consecutive days (10% of growing season) during which the water table was within 12 inches of the ground surface. Hydrologic restoration work (plugging ditches) was completed in January 2017 and trees were planted the following month. During MY1 (2017) seven of the 11 gauges met hydrologic success, and in MY2 through MY7 (2018 to 2023) all gauges met success. By early to mid-May in most years, the water table drops and remains below 16 inches (often below the gauge detection depth) through summer and fall except for short periods after heavy rainfall events. This hydrology pattern is typical for *Piedmont mixed moisture hardpan forest* communities.

The dense, low-porosity soil and hardpan presents a challenging environment for trees to get established in hardpan forests. Rooting depth is often shallow and wind-throw is common, creating frequent gaps with a relatively open forest canopy in this community type. Prolonged dry periods in summer and fall can also reduce the survival and growth of trees. Many planted trees on the site showed leader die-back during droughts, but most re-sprouted the following year. All of the nine vegetation plots currently meet the MY-7 tree density criteria of 210 planted stems per acre (range = 243 to 486, average = 355), and the average density across all plots is 616 trees per acre including volunteer stems of planted species (range = 526 to 891). A few areas on the site have a noticeable proportion of trees that are small for their age, particularly in the northwest area near Well-J and east-central area near Well-F where the temporary strip plots were sampled during 2020 to 2022, as seen in the 2023 Google Earth aerial imagery (Figure 7).

During the first few years after cattle were excluded a variety of groundcover plants typical of glades and open woodlands re-sprouted on the site suggesting a sparse canopy historically. These include milkweeds (*Asclepias purpurascens* and *A. incarnata*), mistflower (*Conoclinum coelestinum*), thoroughworts

(*Eupatorium* spp), sneezeweed (*Helenium autumnale*), Carolina rose (*Rosa carolina*), mountain mints (*Pycnanthemum* spp), skullcap (*Scutellaria* spp), lobelia (*Lobelia* spp), monkey-flower (*Mimulus alatus*), rose-pink (*Sabatia angularis*), black-eyed Susan (*Rudbeckia* spp), and many others. Swamp white oak (*Quercus bicolor*), a tree typical of midwest and northern open woodlands and rare in the Carolinas, also occurs on the site. The slow growth rates of both planted and volunteer trees on some parts of this site is likely a natural feature of the native soil and extreme hydrologic variability, from prolonged saturation during winter and spring to extended dry conditions in summer and fall. For long-term management, periodic controlled burning would be useful for maintaining the native plant community on this site.

5.0. References

Lee, Michael T., Peet, Robert K., Roberts, Steven D., Wentworth, Thomas R. (2008). *CVS-EEP Protocol for Recording Vegetation version 4.2, October 2008*. Retrieved September 2011, from: http://cvs.bio.unc.edu/methods.htm

LeGrand, Harry E. Jr. (2007) Natural Areas Inventory of Person County, NC. NC Natural Heritage Program, Raleigh NC.

NC Division of Mitigation Services. (2017). *NC-DMS Annual Monitoring Report Format, Data Requirements, and Content Guidance, June 2017.* http://portal.ncdenr.org/web/eep/dbb-resources

Schafale, Michael P. (2012) Classification of the Natural Communities of North Carolina, Fourth Approximation. NC Natural Heritage Program, Raleigh, NC.

Sink, Larry T. (1995). *Soil Survey of Person County, North Carolina*. USDA Soil Conservation Service (Natural Resources Conservation Service), Raleigh, NC.

United States Department of Agriculture, Natural Resources Conservation Service, 2016. Web Soil Survey. Available: http://websoilsurvey.nrcs.usda.gov/app/

APPENDIX A. Project Background Data

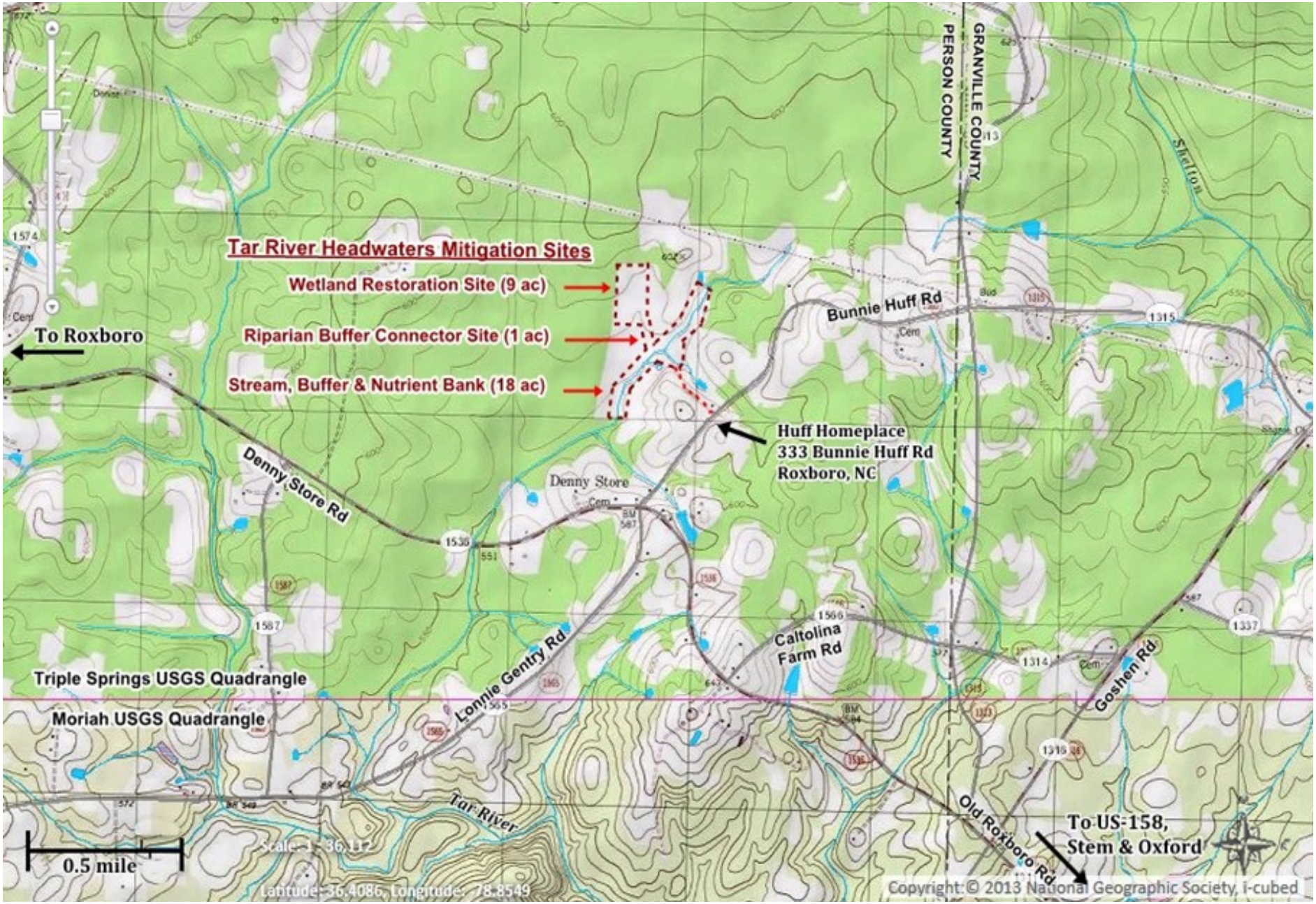


Figure 1. Project Vicinity Map: Tar River Headwaters Wetland Mitigation Site and related mitigation projects at 333 Denny Store Rd, Roxboro, Person County NC, Tar-Pamlico River HUC# 03020101-0102. The farm gate entrance into the mitigation site is at 36.3895, -78.8153.

Table 1. Project Components and Mitigation Credits -- Tar River Headwaters Wetland Restoration Site, DMS Project # 97071									
Mitigation Credits									
	Stream		**Riparian Wetland**		**Non-riparian Wetland**		**Buffer**	**Nutrient Offset**	
Type	**R**	**RE**	**R**	**RE**	**R**	**RE**			
Acres			7.650						
Credits			7.270						
TOTAL CREDITS			7.277						

Project Components						
Project Component or Reach ID	**Stationing/ Location**	**Existing Footage or Acreage**	**Approach (PI, PII etc.)**	**Restoration or Restoration Equivalent**	**Restoration Footage or Acreage**	
Drained Wetland	--	6.530	Restore Hydrology, Fence & Plant	R (Reestablish)	6.530 ac	
Grazed Wetland	--	1.120	Fence & Plant	R (Rehabilitate)	1.120 ac	

Component Summation						
Restoration Level	**Stream (lin. feet)**	**Riparian Wetland (acres)**		**Non-Riparian Wetland (acres)**	**Buffer (sq. feet)**	**Upland (acres)**
		Riverine	**Non-Riverine**			
Re-establishment **(1: 1.0)**			6.530 ac			
Rehabilitation **(1: 1.5)**			1.120 ac			
Enhancement I						
Enhancement II						
Creation						
Preservation						
High Quality Preservation						
TOTAL feet or acres	**-**	**-**	**7.650 ac**			
TOTAL WMU	**-**	**-**	**7.277**			

Table 2. Project Activity & Reporting History		
Tar River Headwaters Wetland Restoration Site, DMS Project# 97071		
Activity or Report	**Data Collection Complete**	**Actual Completion or Delivery**
Mitigation Plan		Dec 2016
Final Construction Plans		Dec 2016
Construction		Jan 2017
Planting		Feb 2017
Baseline Monitoring/Report	Feb 2017	Apr 2017
Year 1 Monitoring	Nov 2017	Dec 2017
Year 2 Monitoring	Nov 2018	Dec 2018
Year 3 Monitoring	Nov 2019	Jan 2020
Year 4 Monitoring	Nov 2020	Dec 2020
Year 5 Monitoring	Oct 2021	Nov 2021
Year 6 Monitoring	Nov 2022	Dec 2022
Year 7 Monitoring	Oct 2023	Dec 2023

Table 3. Project Contacts Table **Tar River Headwaters Wetland Restoration Site, DMS Project # 97071**	
Designer	Ecological Engineering, Raleigh NC Heather Smith: 919-557-0929
Construction Contractor	KBS Earthworks, Greensboro NC Kory Strader & Brett Strader: 336-685-4339
Survey Contractor	Michael T. Brandon, PLS, Roxboro NC Michael Brandon: 336-597-8673
Fence Contractor	Strader Fencing, Inc., Julian NC Kenneth Strader: 336-314-2935
Herbicide and Seeding	KBS Earthworks, Greensboro NC Kory Strader & Brett Strader: 336-685-4339
Planting Contractor	Mogensen Mitigation Inc, Charlotte NC Rich Mogensen: 704-576-1111; Gerald Pottern: 919-556-8845
Nursery Stock Suppliers	Mellowmarsh Farms, Siler City NC Joanie McLean: 919-742-1200
Monitoring Performers	Mogensen Mitigation Inc, Charlotte NC Rich Mogensen: 704-576-1111; Gerald Pottern: 919-556-8845

Table 4. Project Attributes			
Tar River Headwaters Wetland Restoration Site, DMS Project # 97071			
Project Name	Tar River Headwaters Wetland Restoration Site		
County	Person County		
Project Area (acres)	9.9 acres (Wetland + Buffer Easement combined)		
Project Coordinates (lat. and long.)	36.3895, -78.8153		
Project Watershed Summary Information			
Physiographic Province	Piedmont, Carolina Slate Belt		
River Basin	Tar-Pamlico River-01		
USGS Hydrologic Unit 8-digit and 12-digit:	03020101-0102		
DWQ Sub-basin	Tar-Pam-01		
Project Drainage Area (acres)	60		
Project Drainage Area Percent Impervious Area	0%		
CGIA Land Use Classification	Pasture, Crop, and Deciduous Forest		
Wetland Summary Information (Post-Restoration)			
Parameters	**Wetland Area**		
Size of Wetland (acres)	1.12 ac existing + 6.53 ac drained = 7.65 ac		
Wetland Type (non-riparian, riparian riverine or riparian non-riverine)	Riparian non-riverine (Headwater)		
Mapped Soil Series	Iredell Loam (IrB)		
Drainage class	Iredell = moderately well; Hydric inclusions = poorly		
Soil Hydric Status	Drained Hydric		
Source of Hydrology	Shallow ponding; perched on shallow aquitard		
Hydrologic Impairment	Drainage ditches (1940s)		
Native vegetation community	Headwater depression wetland forest (prior to pasture conversion)		
Percent composition exotic invasive vegetation	20% Fescue (sprayed)		
Regulatory Considerations			
Regulation	**Applicable?**	**Resolved?**	**Supporting Documentation**
Waters of the United States – Section 404	Yes	Yes	Prelim JD
Waters of the United States – Section 401	Yes	Yes	Prelim JD
Endangered Species Act	No	N/A	US FWS Letter
Historic Preservation Act	No	N/A	NC SHPO Letter
Coastal Zone Management Act (CZMA) Coastal Area Management Act (CAMA)	No	N/A	N/A
FEMA Floodplain Compliance	No	N/A	NC Floodmaps Data
Essential Fisheries Habitat	No	N/A	N/A

APPENDIX B. Visual Assessment Data

Figure 2. Current Conditions Plan View, Fall 2023
Table 5. Vegetation Conditions Assessment
Figure 3. Vegetation Plot Photos
Figure 4. Photo Point Photos
Figure 5. Google Earth Aerial Photos, 2016 and 2023

Figure 2. Current Conditions Plan View, Fall 2023, MY-7.

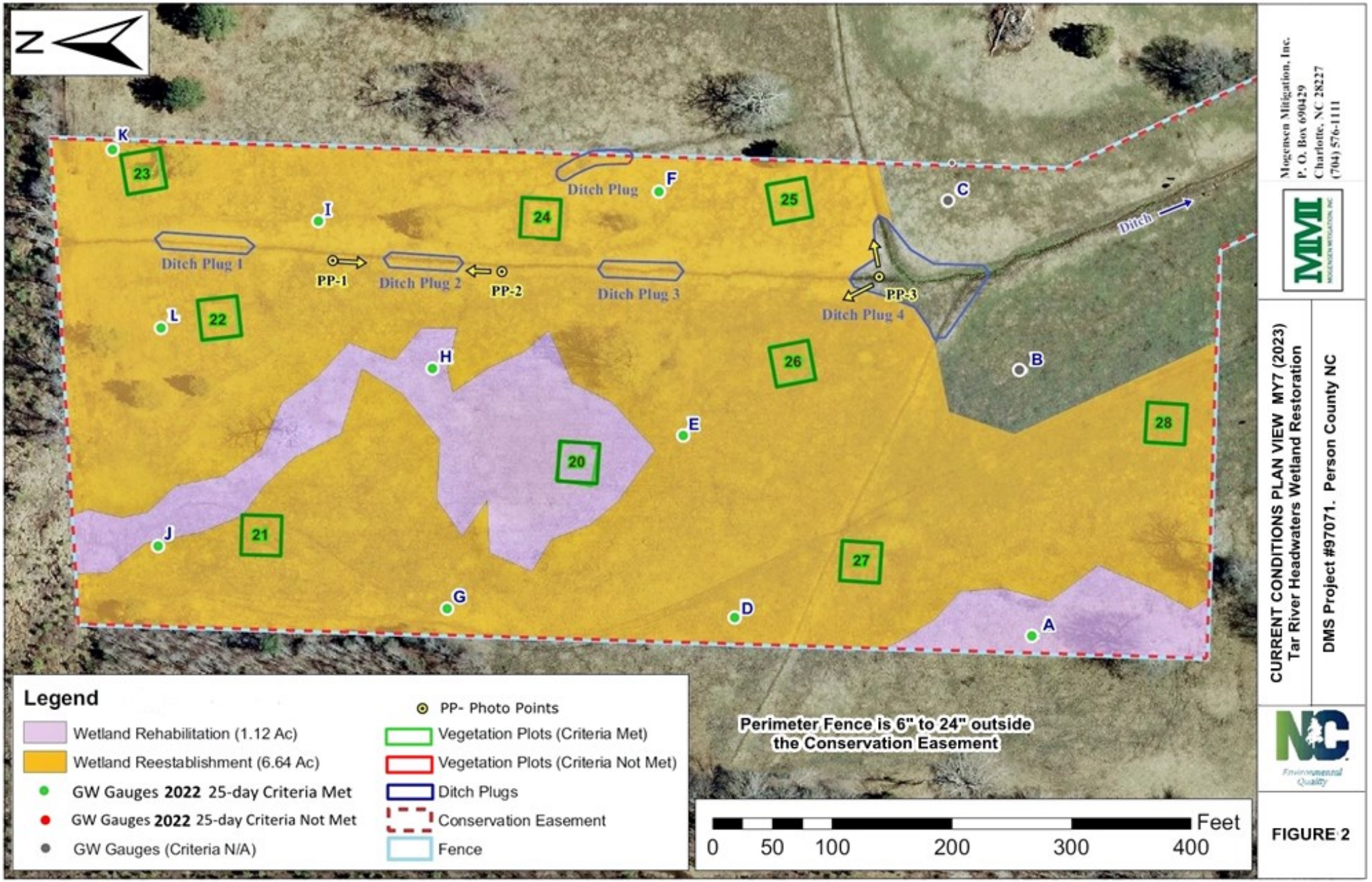


Table 5: Vegetation Condition Assessment Table -- MY-7 (2023)
Tar River Headwaters Wetland Restoration #97071. Person County HUC #03020101-0102

Planted Acreage = 7.65

Vegetation Problem Category	Definitions	Mapping Threshold (acres)	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
Bare Areas	Very limited cover of both woody and herbaceous material	0.10	N/A	0	0	0%
Low Stem Density Areas	Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria.	0.10	N/A	0	0	0%
			Total	**0**		**0%**
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	N/A	0	0	0%
			Cumulative Total	0	0	**0%**

Easement Acreage = 9.98

Vegetation Problem Category	Definitions	Mapping Threshold (SF)	CCPV Depiction	Number of Polygons	Combined Acreage	% of Easement Acreage
Invasive Areas of Concern	Areas or points (if too small to render as polygons at map scale).	1000	N/A	0	0	0%
Easement Encroachment Areas	Areas or points (if too small to render as polygons at map scale).	none	N/A	0	0	0%

** There are two areas on the site of approximately 0.25 acre each where planted trees have remained relatively small: (1) the northwest corner of the site near Well J and VP-21, and (2) the east-central side of the site near Well F and VP-24. These areas were mapped as low density or low-vigor areas in previous years, but strip test plots during 2020 to 2022 revealed adequate stem density. The slow growth rates appear to be a natural condition of *Piedmont hardpan forest* vegetation communities, as explained in Section 4.0. This allows prairie plant species including the regionally-rare purple milkweed to persist. These areas are not mapped as Low Vigor in the current monitoring report.

Figure 3. Vegetation Plots: Tar River Headwaters Wetland Restoration Site #97071 MY-7 Fall 2023

CVS VegPlot-20: MY-0 Spring 2017

CVS VegPlot-20: MY-7 30 Sep 2023

CVS VegPlot-21: MY-0 Spring 2017

CVS VegPlot-21: MY-7 30 Sep 2023

Figure 3. Vegetation Plots: Tar River Headwaters Wetland Restoration Site #97071 MY-7 Fall 2023

CVS VegPlot-22: MY-0 Spring 2017

CVS VegPlot-22: MY-7 30 Sep 2023

CVS VegPlot-23: MY-0 Spring 2017

CVS VegPlot-23: MY-7 30 Sep 2023

Figure 3. Vegetation Plots: Tar River Headwaters Wetland Restoration Site #97071 MY-7 Fall 2023

CVS VegPlot-24: MY-0 Spring 2017

CVS VegPlot-24: MY-7 30 Sep 2023

CVS VegPlot-25: MY-0 Spring 2017

CVS VegPlot-25: MY-7 30 Sep 2023

Figure 3. Vegetation Plots: Tar River Headwaters Wetland Restoration Site #97071 MY-7 Fall 2023

CVS VegPlot-26: MY-0 Spring 2017

CVS VegPlot-26: MY-7 30 Sep 2023

CVS VegPlot-27: MY-0 Spring 2017

CVS VegPlot-27: MY-7 30 Sep 2023

Figure 3. Vegetation Plots: Tar River Headwaters Wetland Restoration Site #97071 MY-7 Fall 2023

CVS VegPlot-28: MY-0 Spring 2017

CVS VegPlot-28: MY-7 30 Sep 2023

Figure 4. Photo Points: Tar River Headwaters Wetland Restoration Site #97071 MY-7 Fall 2023

Photo Point 1: MY-0 Spring 2017

Photo Point 1: MY-7 30 Sep 2023

Photo Point 2: MY-0 Spring 2017

Photo Point 2: MY-7 30 Sep 2023

Figure 4. Photo Points: Tar River Headwaters Wetland Restoration Site #97071 MY-6 Fall 2022

Photo Point 3-East: MY-0 Spring 2017

Photo Point 3-East: MY-7 30 Sep 2023

Photo Point 3-North: MY-0 Spring 2017

Photo Point 3-North: MY-7 30 Sep 2023

Figure 5A. Google Earth 2016 aerial photo of Tar River Headwaters Wetland Mitigation Site.

Figure 5B. Google Earth 2023 aerial photo of Tar River Headwaters Wetland Mitigation Site.

APPENDIX C. Vegetation Plot Data

Table 6. Vegetation Plot Stem Density Success Summary
Table 7. Vegetation Plot Stem Counts and Stem Density

Table 6. CVS Plot Stem Density Success Summary, MY-7 (Sept 2023)

CVS Plot #	Wetland Planted Stems		Planted + Volunteer Stems		Invasive Woody Stems	Success Criteria Met?
	per plot	per acre	per plot	per acre		
97071- 20	9	364	15	607	0	Yes
97071- 21	6	243	13	526	0	Yes
97071- 22	8	324	20	809	0	Yes
97071- 23	12	486	22	890	0	Yes
97071- 24	8	324	13	526	0	Yes
97071- 25	10	405	14	567	0	Yes
97071- 26	9	364	13	526	0	Yes
97071- 27	7	283	12	486	0	Yes
97071- 28	10	405	15	607	0	Yes
Plots 20-28	79		137		0	
Project Avg	8.8	355	15.2	616	0	Yes

Success Criteria = 320 planted + volunteer stems per acre at MY3, 260 planted + volunteer stems at MY5, and 210 planted + volunteer stems per acre at MY7 (planted species only).

Color codes for Success	MY6 to MY7
Exceeds criteria by 10% or more	**(232 or more)**
Exceeds criteria by less than 10%	**(210 - 231)**
Fails criteria by less than 10%	**(189 - 209)**
Fails criteria by more than 10%	**(188 or less)**

Table 7. CVS Plot Stem Counts and Density by Species -- Tar River Headwaters Wetland Restoration (TRHWR) Project, DMS # 97071.
Monitoring Year 7 (Sept 2023) -- Person County NC. Tar-Pamlico HUC# 03020101-0102.

			Current Year Stem Counts by Plot Data (MY7 - Sept 30, 2023)																	
			97071-20		97071-21		97071-22		97071-23		97071-24		97071-25		97071-26		97071-27		97071-28	
Scientific Name	Common Name	Growth Type	Plant	Total	Plant	Total	Plant	Total	Plant	Total	Plant	Total	Plant	Total	Plant	Total	Plant	Total	Plant	Total
Acer rubrum	Red Maple	Tree		2		1												1		
Baccharis halimifolia	Groundsel-tree	Shrub																1		1
Betula nigra	River Birch	Tree (P)	4	4	3	3	1	1	4	4					7	7			2	2
Carpinus caroliniana	Musclewood	Tree (P)															2	2	4	4
Cornus amomum	Silky dogwood	Shrub (P)	1	1																
Diospyros virginiana	Persimmon	Tree (P)	2	3		2		1			2	4		1						1
Fraxinus pennsylvanica	Green Ash	Tree (P)		2	1	5	3	12	2	10	1	4				4	2	5	2	6
Ilex vomitoria	Yaupon holly	Shrub (P)									2	2	1	1						
Liquidambar styraciflua	Sweetgum	Tree		1		9		3		5				1		3		3		2
Liriodendron tulipifera	Tulip Poplar	Tree (P)			1	1														
Pinus taeda	Loblolly pine	Tree						2		1										
Platanus occidentalis	Sycamore	Tree (P)	2	2			2	2									1	1		
Quercus bicolor *	Swamp White Oak	Tree (P)											1	1						
Quercus michauxi *	Swp Chestnut Oak	Tree (P)							2	2										
Quercus phellos *	Willow Oak	Tree (P)		1			1	1	4	4	2	2	8	8	2	2			2	2
Ulmus alata	Winged Elm	Tree						3												
Ulmus americana	American Elm	Tree (P)		2	1	2	1	3		2	1	1		3			2	4		
	Planted & Total Stem count		9	15	6	13	8	20	12	22	8	13	10	14	9	13	7	12	10	15
(P) = planted species		ares	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		acres	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
	Creditable Species count		4	7	4	5	5	6	4	5	5	5	3	5	2	3	4	4	4	5
	Plot Stems per ACRE		364	607	243	526	324	810	486	891	324	526	405	567	364	526	283	486	405	607

Plant = Planted Stems; Total = Planted + Volunteer Stems of planted species only.
Red = volunteer non-planted species, NOT counted in totals or density.
Blue highlight = Totals that include 1 or more volunteer stems of planted species.
*** Quercus seedlings misidentified in 2017 were corrected in 2018-2019.**

Color codes for Plot Density & Success	MY1 to MY3	MY4 to MY5	MY6 to MY7
Exceeds criteria by 10% or more	(352 or more)	(287 or more)	(232 or more
Exceeds criteria by less than 10%	(320 - 351)	(260 - 286)	(210 - 231)
Fails criteria by less than 10%	(289 - 319)	(234 - 259)	(189 - 209)
Fails criteria by more than 10%	(288 or less)	(233 or less)	(188 or less)

Table 7, continued

			Annual Stem Count Totals and Mean Density Across ALL Plots 2017 - 2023															
			MY0 (2017)		MY1 (2017)		MY2 (2018)		MY3 (2019)		MY4 (2020)		MY5 (2021)		MY6 (2022)		MY7 (2023)	
Scientific Name	Common Name	Growth Type	Plant	Total	Plant	Total	Plant	Total	Plant	Total	Plant	Total	Plant	Total	Plant	Total	Plant	Total
Acer rubrum	Red Maple	Tree														2		4
Baccharis halimifolia	Groundsel-tree	Shrub										2		3		3		**2**
Betula nigra	River Birch	Tree (P)	23	23	23	23	22	22	22	22	22	22	21	21	21	21	21	21
Carpinus caroliniana	Musclewood	Tree (P)	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Cornus amomum	Silky dogwood	Shrub (P)						1		1	1	1	1	1	1	1	1	1
Diospyros virginiana	Persimmon	Tree (P)	2	2			1	3	1	4	1	13	4	12	4	13	4	12
Fraxinus pennsylvanica	Green Ash	Tree (P)	9	9	10	10	10	17	10	23	10	32	11	37	11	34	11	48
Ilex vomitoria	Yaupon holly	Shrub (P)										1	2	2	2	2	3	3
Liquidambar styraciflua	Sweetgum	Tree						3		4		12		14		24		27
Liriodendron tulipifera	Tulip Poplar	Tree (P)	12	12	6	6	1	2	2	2	2	2	2	2	1	1	1	1
Pinus taeda	Loblolly pine	Tree						3		1		3		2		2		3
Platanus occidentalis	Sycamore	Tree (P)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Quercus bicolor *	Swamp White Oak	Tree (P)	3	3	3	3	4	4	2	2	2	2	2	2	1	1	1	1
Quercus michauxi *	Swp Chestnut Oak	Tree (P)							2	2	2	2	2	2	2	2	2	2
Quercus phellos *	Willow Oak	Tree (P)	20	20	18	18	18	19	19	19	19	19	18	18	18	18	19	20
Ulmus alata	Winged Elm	Tree																3
Ulmus americana	American Elm	Tree (P)	10	10	11	14	5	18	8	18	6	17	7	18	7	18	5	17
	Planted & Total Stem count		90	90	82	85	72	97	77	104	76	122	81	126	79	122	79	137
(P) = planted species		**ares**	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
		acres	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222
	Creditable Species count		9	9	11	11	9	10	10	11	11	12	12	12	12	12	12	12
	Mean Stems per ACRE		405	405	369	382	324	436	346	468	342	549	364	567	355	549	355	616

Plant = Planted Stems; Total = Planted + Volunteer Stems of planted species only.

Red = volunteer non-planted species, non-creditable, NOT counted in totals or density.

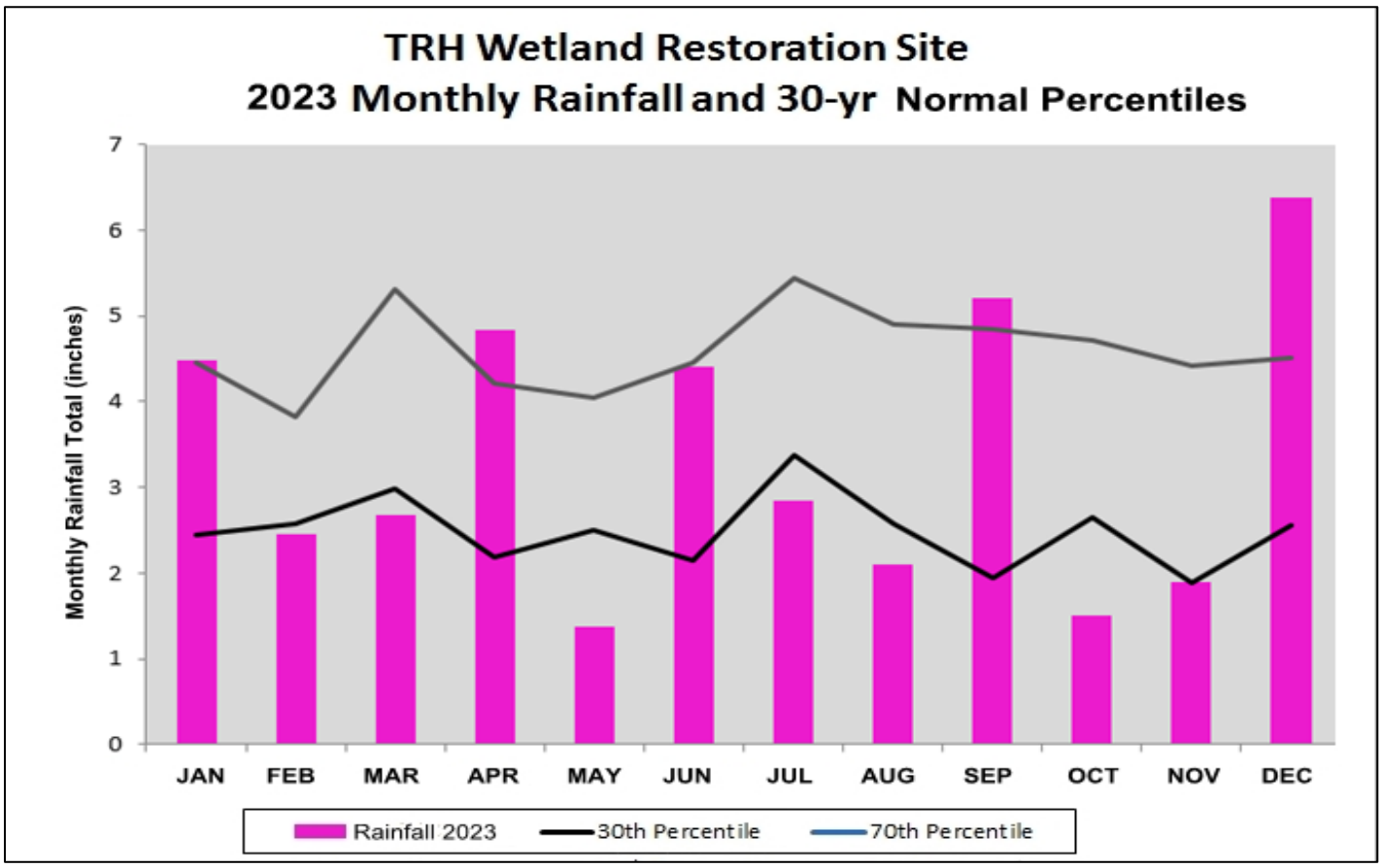
Blue highlight = Totals that include 1 or more volunteer stems of planted species.

*** Quercus seedlings misidentified in 2017 were corrected in 2018-2019.**

Color codes for Plot Density & Success	MY1 to MY3	MY4 to MY5	MY6 to MY7
Exceeds criteria by 10% or more	(352 or more)	(287 or more)	(232 or more)
Exceeds criteria by less than 10%	(320 - 351)	(260 - 286)	(210 - 231)
Fails criteria by less than 10%	(289 - 319)	(234 - 259)	(189 - 209)
Fails criteria by more than 10%	(288 or less)	(233 or less)	(188 or less)

APPENDIX D. Hydrologic Data

Figure 6. Monthly Rainfall Totals in 2023, with 30th and 70th normal percentiles.



2023 Monthly Rainfall Totals and 30-year Historical Monthly Rainfall at ROXBORO 7 ESE Gauge # 317516						
				30-year Climate Normal Precipitation (1981 - 2010)		
		Month	2023 inches	30th %	50th %	70th %
		Jan-2023	4.49	2.45	3.81	4.46
		Feb-2023	2.46	2.58	3.33	3.82
		Mar-2023	2.68	2.99	4.45	5.32
		Apr-2023	4.84	2.18	3.34	4.21
		May-2023	1.38	2.51	3.35	4.04
		Jun-2023	4.40	2.15	3.84	4.45
		July-2023	2.84	3.38	4.57	5.44
		Aug-2023	2.10	2.57	3.89	4.90
		Sep-2023	5.20	1.94	3.91	4.85
		Oct-2023	1.50	2.65	3.72	4.72
		Nov-2023	1.90	1.89	3.46	4.42
		Dec-2023	6.39	2.56	3.71	4.52
		Annual Total	40.29		45.38	

Figure 7. Groundwater Gauges A and D

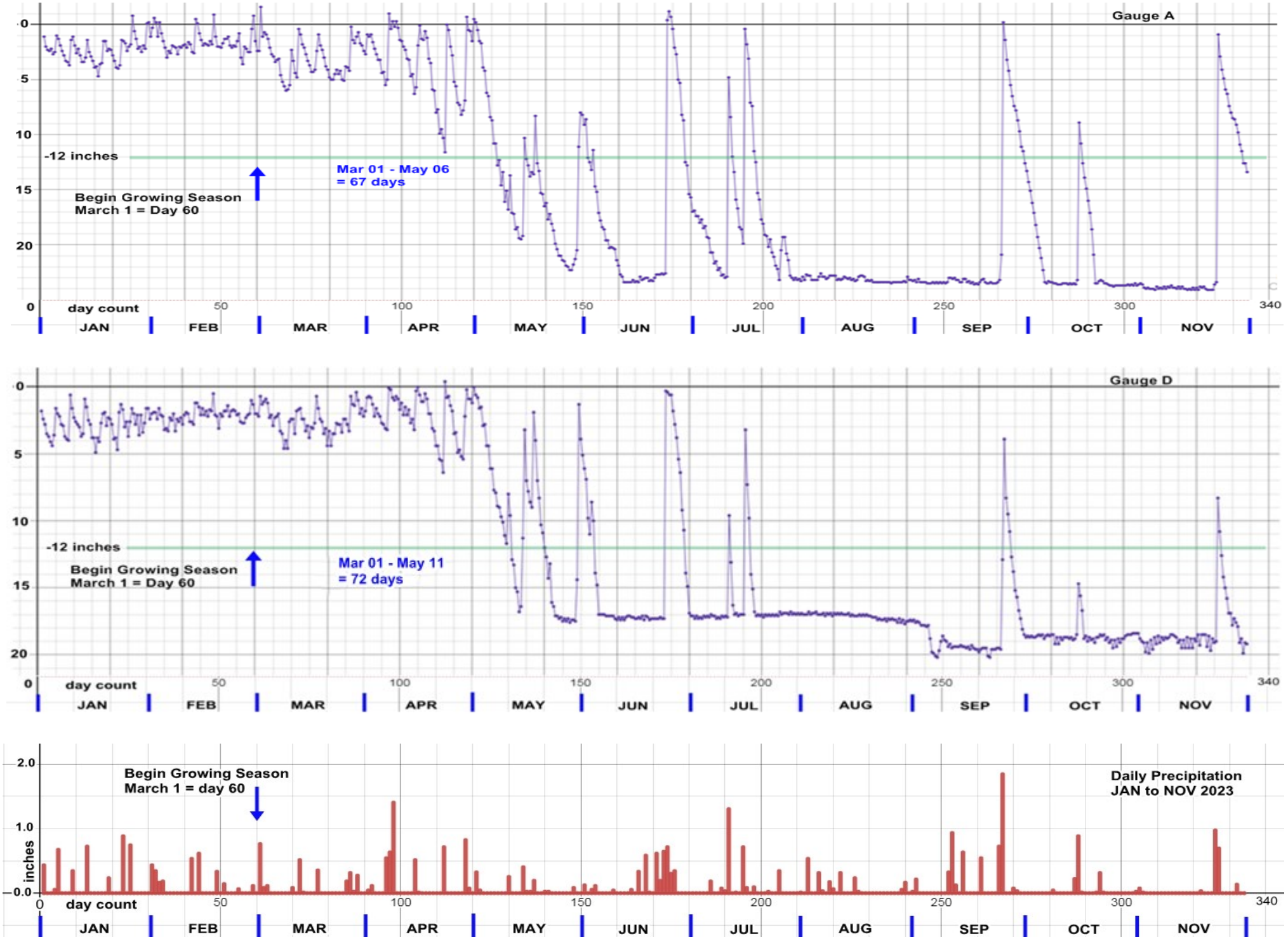


Figure 7. Groundwater Gauges E and F

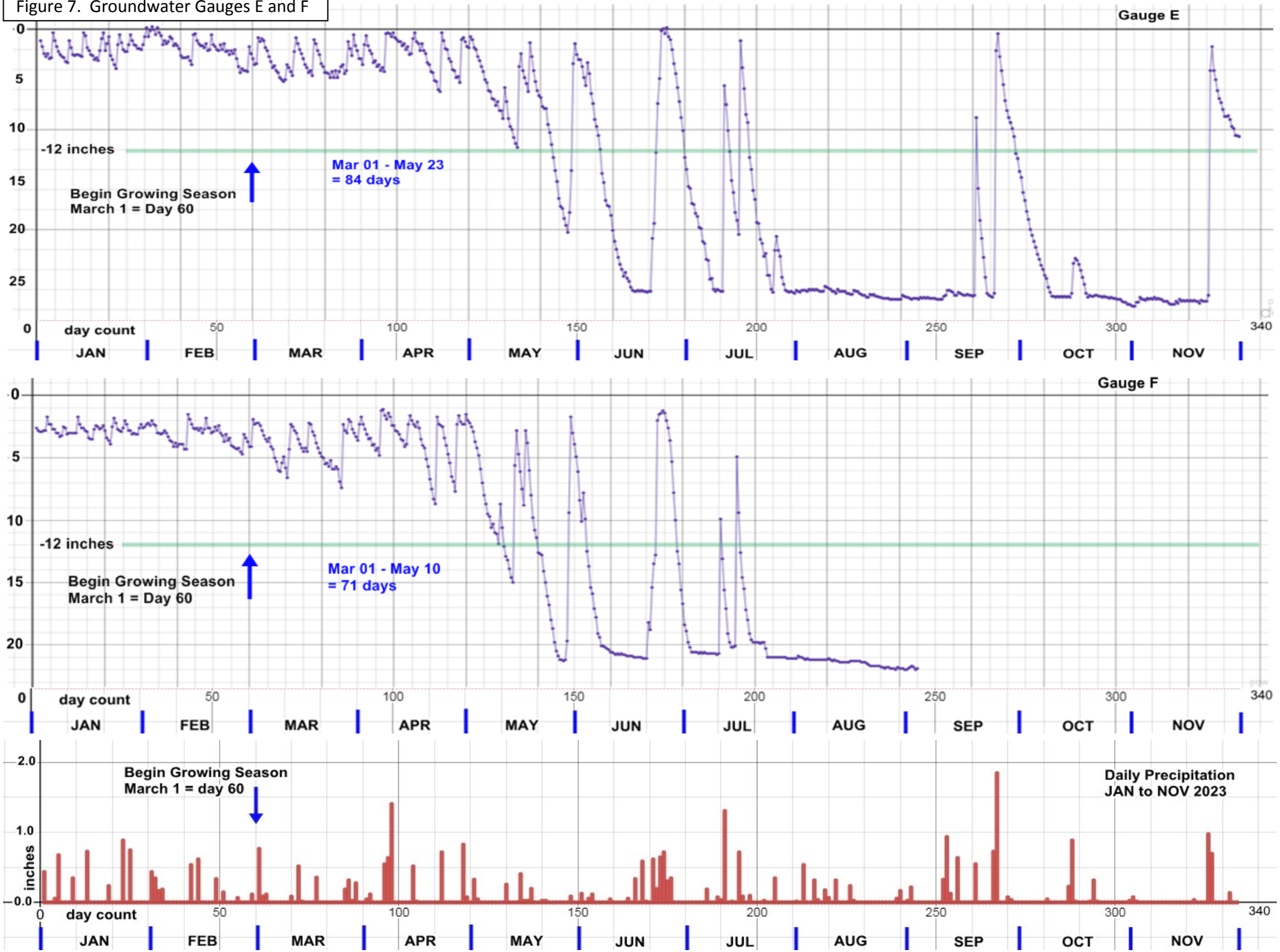
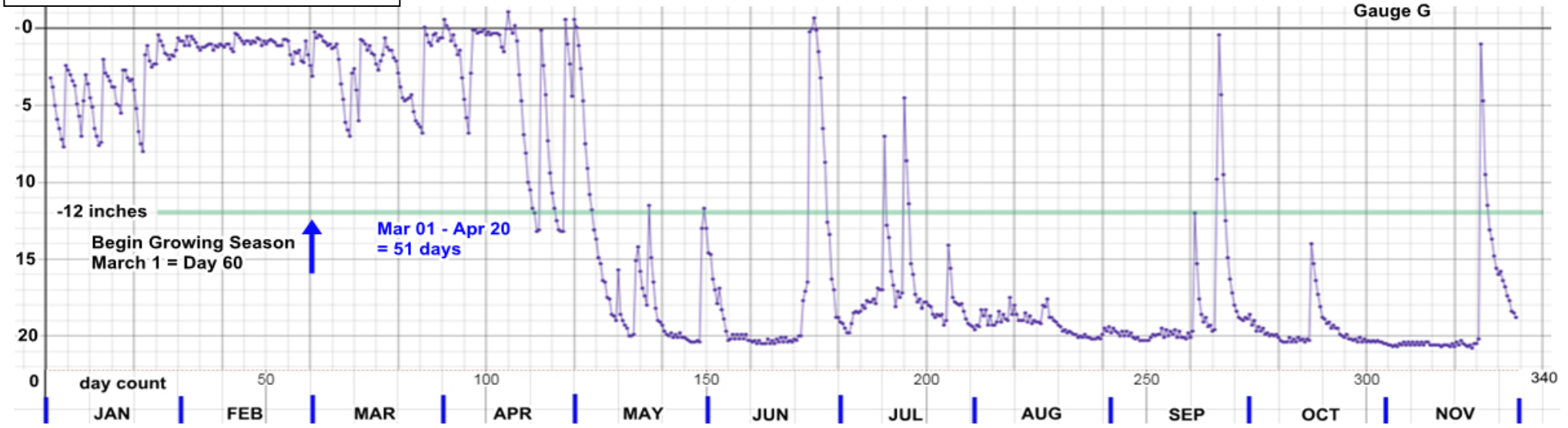
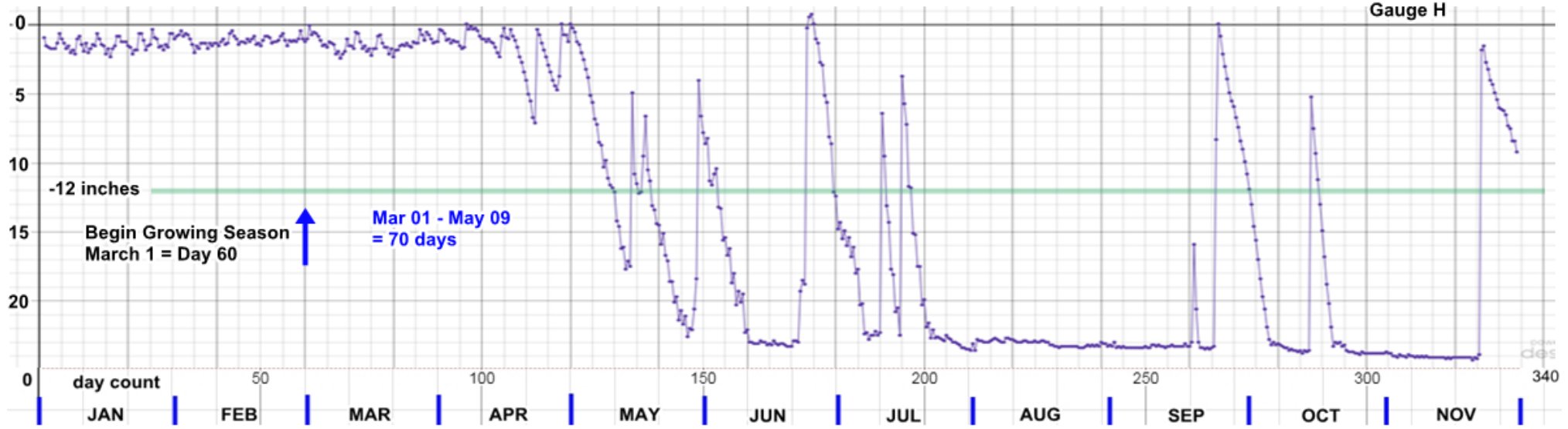


Figure 7. Groundwater Gauges G and H





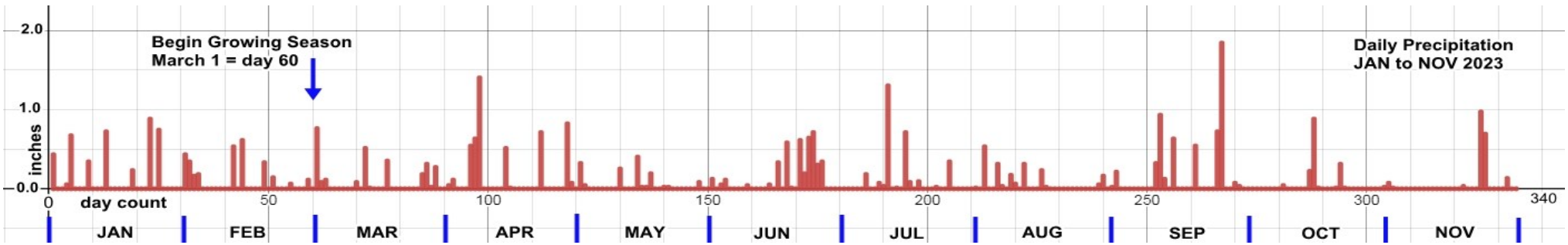


Figure 7. Groundwater Gauges I and J

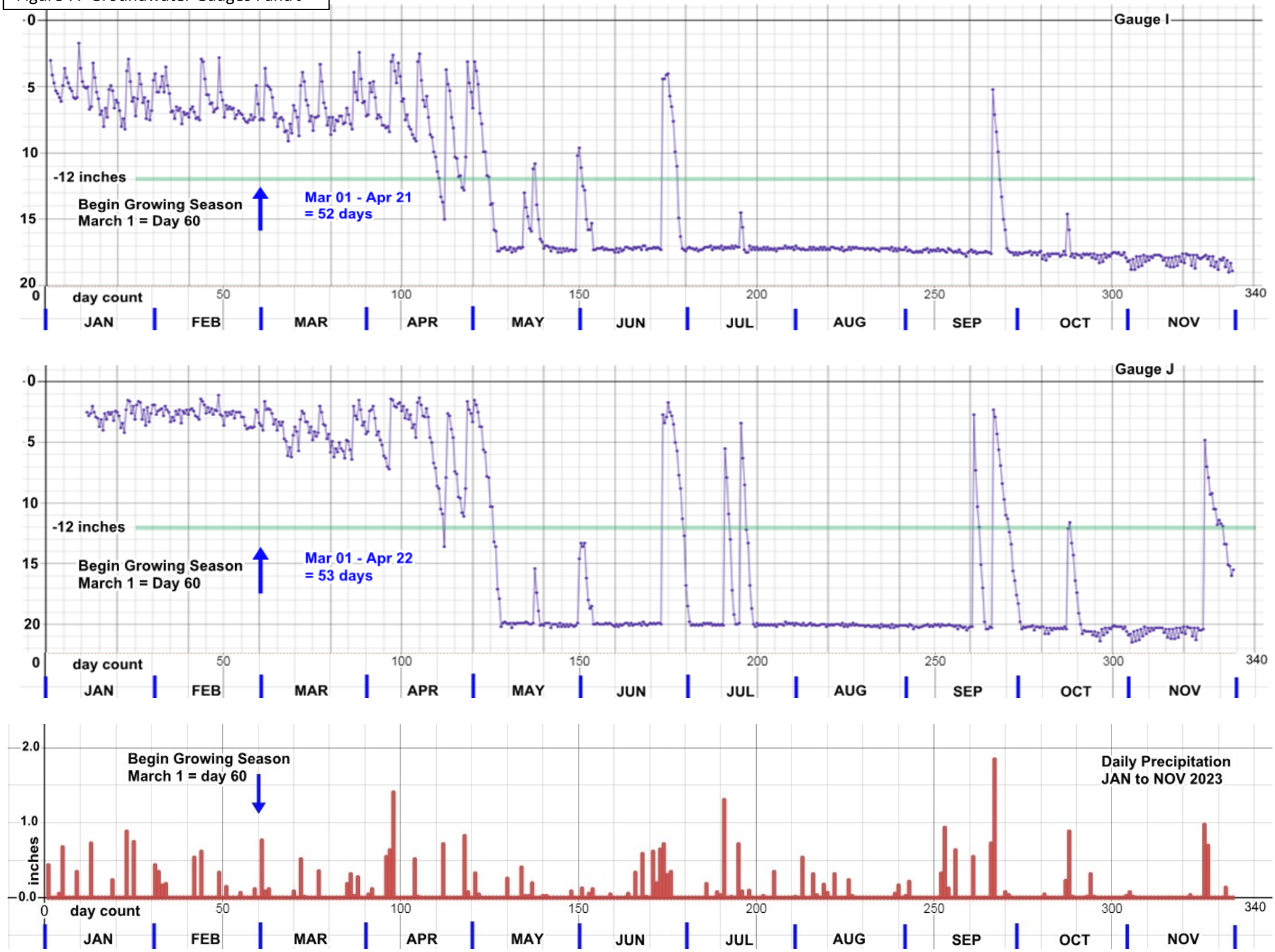
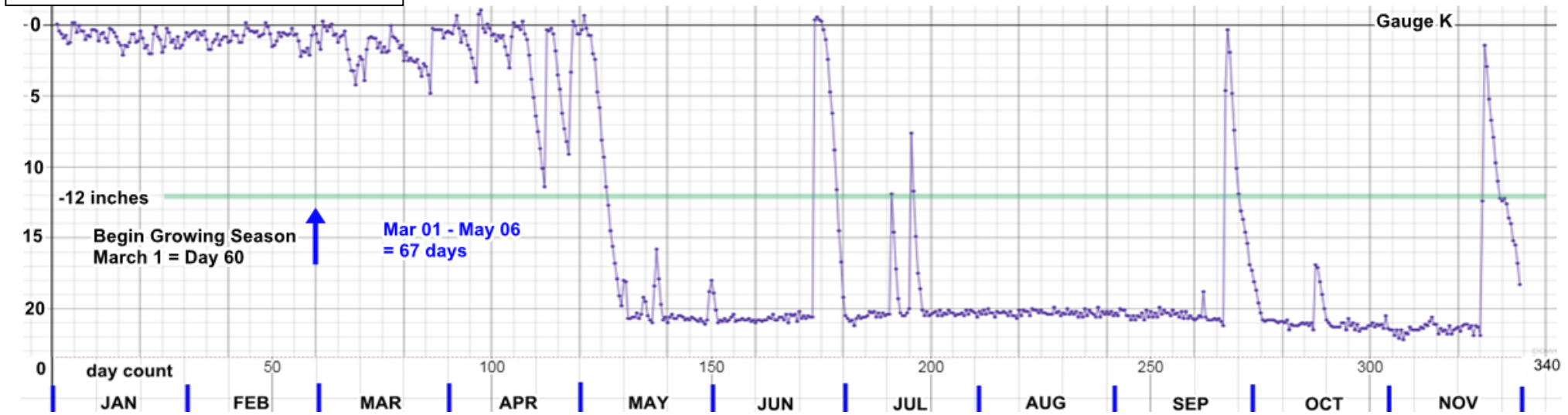
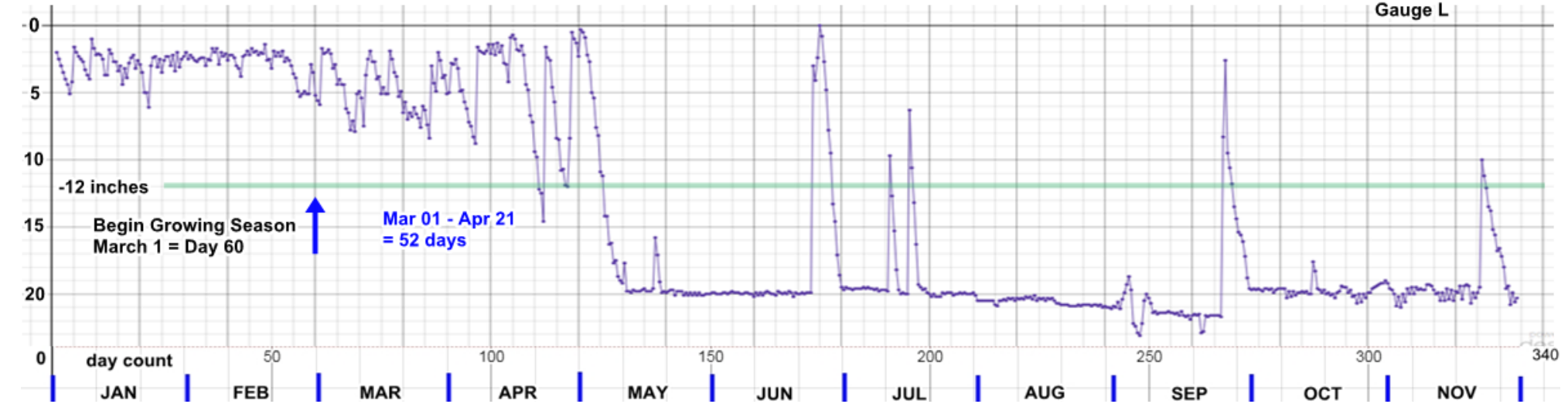


Figure 7. Groundwater Gauges K and L





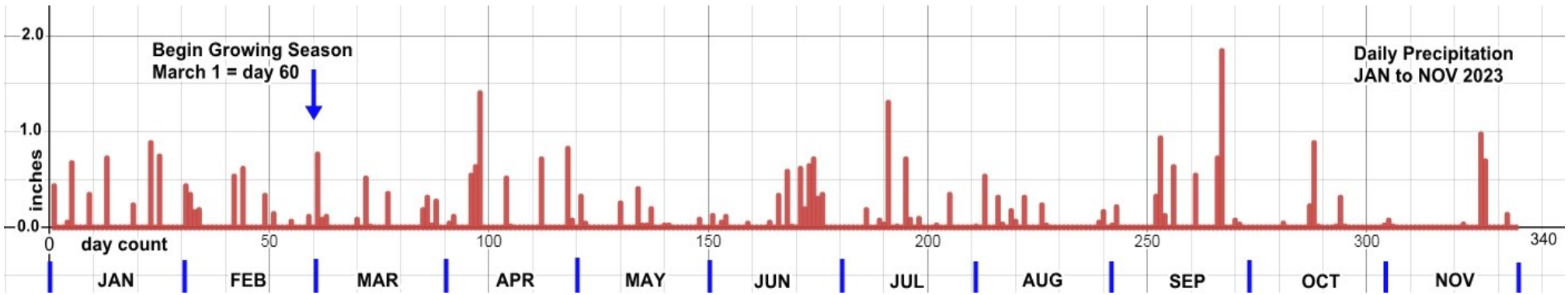


Figure 7. Groundwater Gauge - Reference Well

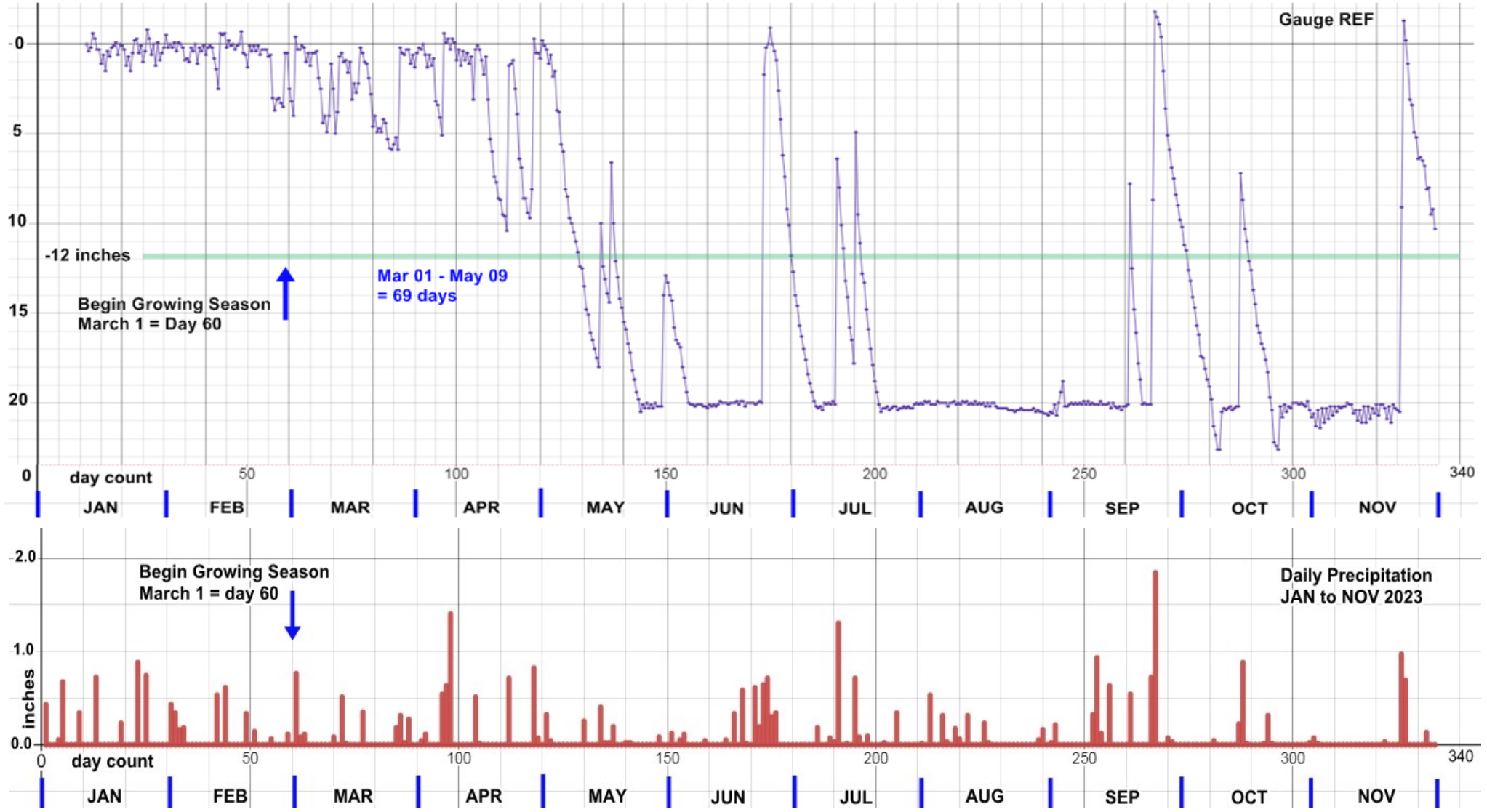


Table 8. Hydrologic Success Attainment 2016 - 2023, Groundwater Wells

Maximum Consecutive Days in Growing Season with Water Table above -12.0 inches

	2016 MY0				2017 MY1				2018 MY2				2019 MY3			
WELL	start	end	days	% GS	start	end	days	% GS	start	end	days	% GS	start	end	days	% GS
A	4/27	5/27	31	12	4/23	5/16	24	10	3/1	5/4	65	26	3/1	4/3	34	14
B *	4/28	5/9	12	5	4/23	5/16	24	10	3/1	6/7	99	40	3/1	5/1	62	25
C *	6/23	7/11	19	8	4/23	5/21	29	12	3/1	5/14	75	30	3/1	4/24	55	22
D	4/27	5/16	20	8	3/13	4/11	30	12	3/1	5/12	73	29	3/1	4/30	61	25
E	4/23	6/2	41	17	4/24	5/17	24	10	3/1	5/3	64	26	3/1	4/30	61	25
F	3/1	3/20	20	8	3/31	4/10	11	4	3/1	5/3	64	26	3/1	4/25	56	23
G	4/27	5/15	19	8	3/31	4/13	14	6	3/1	5/9	70	28	3/1	4/28	59	24
H	3/1	4/7	38	15	4/23	5/17	25	10	3/1	6/9	101	41	3/1	5/4	65	26
I	4/22	5/12	21	8	4/23	5/20	28	11	3/1	5/3	64	26	3/1	4/24	55	22
J	4/28	5/16	19	8	5/22	6/2	12	5	3/1	5/12	73	29	3/1	5/1	62	25
K	4/27	5/11	15	6	3/31	4/10	11	4	3/1	5/2	63	25	3/1	4/25	56	23
L	na	na	na	na	3/1	6/10	102	41	3/1	6/15	107	43	3/1	5/1	62	25
Ref	4/1	6/14	75	30	3/1	6/9	101	41	3/1	5/14	75	30	3/1	5/14	75	30

Maximum Consecutive Days in Growing Season with Water Table above -12.0 inches

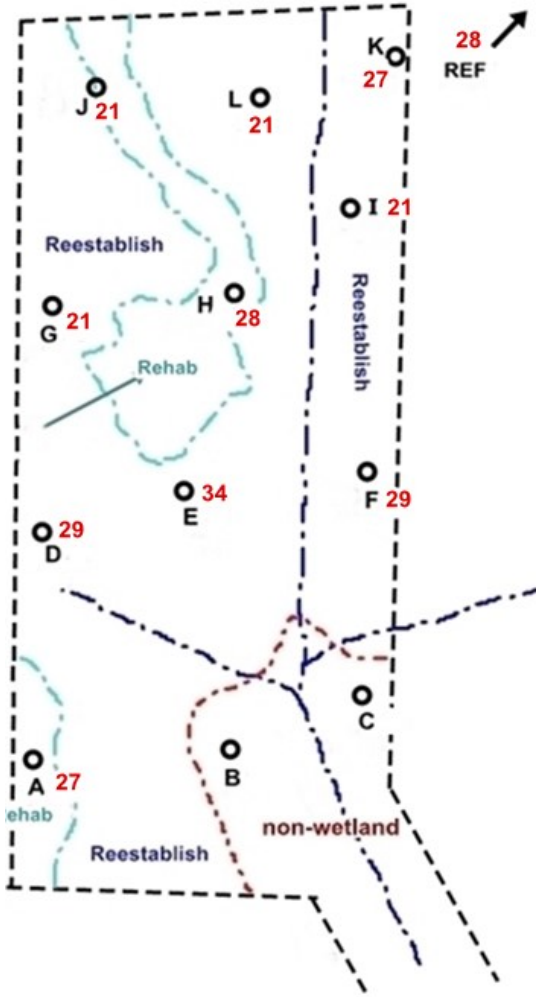
	2020 MY4				2021 MY5				2022 MY6				2023 MY7			
WELL	start	end	days	% GS	start	end	days	% GS	start	end	days	% GS	start	end	days	% GS
A	3/1	5/11	72	29	3/1	4/20	51	21	3/1	4/15	46	19	3/1	5/6	67	27
B *	3/1	5/14	75	30	3/1	4/18	49	20	NA	---	---	---	NA	---	---	---
C *	3/1	5/12	73	29	3/1	4/17	48	19	NA	---	---	---	NA	---	---	---
D	3/1	5/12	73	29	3/1	4/18	49	20	3/1	5/9	70	28	3/1	5/11	72	29
E	3/1	5/13	74	30	3/1	4/20	51	21	3/1	6/2	94	38	3/1	5/23	84	34
F	3/1	5/10	71	29	3/1	4/15	46	19	3/1	5/10	71	29	3/1	5/10	71	29
G	3/1	5/09	70	28	3/1	4/16	47	19	3/1	4/14	45	18	3/1	4/20	51	21
H	3/1	5/17	78	31	3/1	4/29	60	24	3/1	5/11	72	29	3/1	5/9	70	28
I	3/1	5/09	70	28	3/1	4/16	47	19	3/1	4/17	48	19	3/1	4/21	52	21
J	3/1	5/12	73	29	3/1	4/18	49	20	3/1	5/9	70	28	3/1	4/22	53	21
K	3/1	4/05	36	15	3/1	4/16	47	19	3/1	5/8	69	28	3/1	5/6	67	27
L	3/1	4/30	61	25	3/1	4/17	48	19	3/1	4/14	45	18	3/1	4/21	52	21
Ref	3/1	5/15	76	31	3/1	4/20	51	21	3/1	5/7	68	27	3/1	5/9	70	28

Growing Season = Mar 1 to Nov 3 (248 Days) based on soil temperature > 41° F.

Success criteria = 25 consecutive days WT < 12" below surface. Blue = Meets Criteria. Brown = Fails Criteria

* Gauges B and C are in non-credit areas and do not contribute to project success evaluation.

Yellow = Gauge failure; actual end of hydroperiod may have been later.



Percent of 2023 Growing Season with consecutive days of WT above -12 inches.