Year 3 Monitoring Report

FINAL

APPLE VALLEY PROJECT

NCDMS Project #100063 (Contract #7531)
USACE Action ID: SAW-2018-01150
DWR Project #20181028

Henderson County, North Carolina
French Broad River Basin
HUC 06010105

Provided by:

Resource Environmental Solutions, LLC
For Environmental Banc & Exchange, LLC

Provided for:
NC Department of Environmental Quality
Division of Mitigation Services

February 2024

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February 1, 2024

Harry Tsomides
NC DEQ Division of Mitigation Services
2090 U.S 70 Highway
Swannanoa, NC 28778

RE: Apple Valley Site: Year 3 Monitoring Report

Listed below are comments provided by DMS on January 18, 2024 regarding the Apple Valley Site: Year 3 Monitoring Report and RES' responses.

Boundary encroachments (tree cutting and related fence damages) and fencing deficiencies (falling down/loose fencing along much of the eastern boundary along the subdivision back yards) were noted during DMS's site visit on 12/19/2023; and email follow up details and map sent to RES. Please indicate what RES' corrective plan is to address these issues, discuss briefly in the report, and include locations on the CCPV.
RES will send out a crew to re-mark the boundary and install new signage along this portion of the easement. A tree cutting is expected to prevent a tree from the easement falling into the neighbor's yard. Debris from tree cutting will be dispersed within the easement. The easement portion of focus has been marked on the CCPV.

Please include the year of the aerial imagery; is this the most recent available? The aerial imagery looks blurred and possibly outdated; update if available.
The aerial imagery has been updated to imagery taken in 2023 provided by NC OneMap.

Bankfull event table – if possible, please list each individual bankfull event as a separate line item.
Table 13b was created to show the individual bankfull events that have occurred within the current monitoring year.

Can a 30-70 rainfall graph be provided along with the table? This would be helpful.
The 30-70 rainfall graph that was generated by the Antecedent Precipitation Tool was included in the report. Please let us know if this is not sufficient.

Digital Support File Comments
Looks good, no comments.
Great. Thank you!

Table of Contents

1.0 Project Summary

1.1 Project Location and Description

The Apple Valley Project ("Project") is located within a rural watershed in Henderson County, North Carolina approximately eight miles northeast of the town of Hendersonville. Water quality stressors affecting the Project included livestock production, agricultural practices, lack of riparian buffer, ditching, channel encroachment, and land-use practices. The Project presents stream restoration generating 1,487.490 Cold Stream Mitigation Units (SMU) and wetland restoration and enhancement generating 2.900 Riparian Wetland Mitigation Units (WMU).

The Project's total easement area is 6.42 acres within the overall drainage area of 277 acres. Grazing livestock historically had access to the stream reach and riparian wetlands within the Project. The lack of riparian buffer vegetation, deep-rooted vegetation, and unstable channel characteristics contributed to the degradation of stream banks while livestock grazing negatively impacted soil formation and vegetation in wetlands.

The stream design approach for the Project was to combine the analog method of natural channel design with analytical methods to evaluate stream flows and hydraulic performance of the channel and floodplain. The analog method involved the use of a reference reach, or "template" stream, adjacent to, nearby, or previously in the same location as the design reach. The template parameters of the analog reach were replicated to create the features of the design reach. The analog approach is useful when watershed and boundary conditions are similar between the design and analog reaches. Hydraulic geometry was developed using analytical methods to identify the design discharge. The wetland approach was closely tied to the stream restoration in that wetland hydrology and vegetation have been re-established as a product of restoring the natural stream system and riparian area along with other hydrologic improvement activities.

The Project has been constructed and planted and will be monitored on a regular basis throughout the seven-year post-construction monitoring period, or until performance standards are met. The Project will be transferred to the NCDEQ Stewardship Program. This party shall serve as conservation easement holder and long-term steward for the property and will conduct periodic inspection of the site to ensure that restrictions required in the conservation easement are upheld. Funding will be supplied by the responsible party on a yearly basis until such time an endowment is established.

1.2 Project Goals and Objectives

Through the comprehensive analysis of the Project's maximum functional uplift using the Stream Functions Pyramid Framework, specific, attainable goals and objectives will be realized by the Project. These goals clearly address the degraded water quality and nutrient input from farming that were identified as major watershed stressors in the 2009 French Broad River RBRP. These goals and objectives reflect those stated in the Apple Valley Project Final Mitigation Plan.

The Project goals are:

- Improve water transport from watershed to the channel in a non-erosive manner in a stable channel;
- Improve flood flow attenuation on-site and downstream by allowing for overbank flows and connection to the floodplain;
- Improve instream habitat;
- Reduce sediment, nutrient, and fecal coliform inputs into stream system;
- Restore hydrology to riparian wetlands in the floodplain;
- Enhance hydrology in existing riparian wetlands;
- Restore native floodplain and wetland vegetation; and
- Indirectly support the goals of the 2009 French Broad RBRP to improve water quality and to reduce sediment and nutrient loads, especially in the Mud Creek watershed.

The Project goals were addressed through the following project objectives:

- Designed and reconstructed the stream channel to convey bankfull flows while maintaining stable dimension, profile, and planform;
- Added in-stream structures and bank stabilization measures to protect the restored stream;
- Installed habitat features such as brush toes, woody materials, and pools of varying depths to the restored stream;
- Filled existing drainage features in the floodplain to slow water drawdown and re-establish wetland hydrology;
- Removed fill materials on the upstream end of the project to unbury the hydric soils there;
- Ripped floodplain soil prior to planting to increase surface roughness and infiltration, to improve wetland hydrology;
- Increased forested riparian buffers to at least 30 feet on both sides of the channel along the Project reach with a hardwood riparian plant community;
- Installed approximately 1,810 linear feet of livestock exclusion fencing along the easement boundary to ensure livestock will no longer have stream access;
- Treated exotic invasive species; and
- Established a permanent conservation easement on the Project that excludes future livestock from the stream channel and its associated buffers and prevent future land-use changes.

Functional uplift, benefits, and improvements within the Project area, as based on the Function Based Framework, are outlined in the Final Mitigation Plan**.**

1.3Project Success Criteria

The success criteria for the Project follows the 2016 USACE Wilmington District Stream and Wetland Compensatory Mitigation Update, the Apple Valley Project Final Mitigation Plan, and subsequent agency guidance. Cross section and vegetation plot monitoring takes place in Years 0, 1, 2, 3, 5, and 7. Stream hydrology, wetland 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.

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. Channel stability should be demonstrated through a minimum of four bankfull events documented in the seven-year monitoring period.

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 Restoration Success Criteria

The NRCS provides a current WETS table for Henderson County upon which to base a normal rainfall amount and average growing season. The closest comparable data station was determined to be WETS station Hendersonville 1 NE in Hendersonville, NC (NRCS, n.d.). This station is located off 7th Avenue East near the intersection with Dana Road approximately 8 miles south-southwest of the Project. The growing season for Henderson County is 227 days long, extending from March 26 to November 8, and is based on a daily minimum temperature greater than 28 degrees Fahrenheit occurring in five of ten years.

The target hydroperiod and performance standard for re-established wetlands is 12 percent (approximately 28 days) as approved in the Final Mitigation Plan. However, because of the surface roughening and shallow depressions, a range of hydroperiods with areas of seasonal inundation is expected.

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 six feet at the end of Year 5, and the final vegetative success criteria is 210 trees per acre with an average height of eight feet at the end of Year 7. Volunteer trees are counted, identified to species, and included in the yearly monitoring reports, but are not included in the success criteria of total planted stems until

they are present in the plot for greater than two 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.

Level	Treatment	Objective	Monitoring Metric	Performance Standard
1 ***Hydrology***	Convert land-use of Project reach from pasture to riparian forest	Improve the transport of water from the watershed to the Project reach in a non-erosive way	NA	NA
2 ***Hydraulic***	Reduce bank height ratios and increase entrenchment ratios by reconstructing the channel to mimic reference reach conditions	Improve flood bank connectivity by reducing bank height ratios and increase entrenchment ratios	Pressure transducer flow monitoring gauge: Inspected quarterly Cross sections: Surveyed in Years 1, 2, 3, 5 and 7	Four bankfull events occurring in separate years
				Entrenchment ratio shall be above 2.2 within the restored reach (C and E)
				Bank height ratio shall not exceed 1.2
3 ***Geomorphology***	Establish a riparian buffer to reduce erosion and sediment transport into the project stream. Establish stable banks with livestakes, erosion control matting, and other in stream structures.	Reduce erosion rates and channel stability to reference reach conditions Improve bedform diversity (pool spacing, percent riffles, etc. Increase buffer width to 30 feet	As-built stream profile	NA
			Cross sections: Surveyed in Years 1, 2, 3, 5 and 7	Entrenchment ratio shall be no less than 2.2 within restored the reach
				Bank height ratio shall not exceed 1.2
			Visual monitoring: Performed at least semiannually	Identify and document significant stream problem areas; i.e. erosion, degradation, aggradation, etc.
			Vegetation plots: Surveyed in Years 1, 2, 3, 5 and 7	MY 1-3: 320 trees/acre MY 5: 260 trees/acre (6 ft tall) MY 7: 210 trees/acre (8 ft tall)
4 ***Physicochemical***	Exclude livestock from riparian areas with exclusion fence or conservation easement, and plant a riparian buffer	*Unmeasurable Objective/Expected Benefit* Establish native hardwood riparian buffer and exclude livestock.	Vegetation plots: Surveyed in Years 1, 2, 3, 5 and 7 (*indirect measurement*)	MY 1-3: 320 trees/acre MY 5: 260 trees/acre (6 ft tall) MY 7: 210 trees/acre (8 ft tall)
			Visual assessment of established fencing and conservation signage: Performed at least semiannually (*indirect measurement*)	Inspect fencing and signage. Identify and document any damaged or missing fencing and/or signs

1.4Project Components

The Project area is comprised of a contiguous 6.42-acre easement involving one unnamed tributary (AV1), totaling 1,437 LF, which drains into Clear Creek which eventually drains into the French Broad River. Associated with the stream are riparian wetlands that total 3.043 acres: W1, W2, and W3.

Through stream restoration, the Project presents 1,437 LF of proposed stream, generating 1,487.490 Cold SMUs. To account for areas of more or less than minimum 30-foot buffer widths, credits were adjusted using the USACE Wilmington District Stream Buffer Credit Calculator. Through wetland re-establishment and enhancement, the Project also presents 2.900 Riparian WMU. The stream and wetland mitigation components are summarized below. Mitigation credits presented below are based upon the Approved Mitigation Plan.

Stream Mitigation			
Mitigation Approach	**Linear Feet**	**Ratio**	**Cold SMU**
Restoration	1,437	1	1,437.000
Total	**1,437**		**1,437.000**
		Non-standard Buffer Width Adjustment	**50.490***
		Total Adjusted SMUs	**1,487.490**

* Credit adjustment for Non-standard Buffer Width calculation using the Wilmington District Stream Buffer Credit Calculator issued by the USACE in January 2018. See section 6.6 for further information.

Wetland Mitigation			
Mitigation Approach	**Acreage**	**Ratio**	**WMU**
Re-establishment	2.755	1	2.755
Enhancement	0.288	2	0.144
Total	**3.043**		**2.900**

1.5Stream and Wetland Design/Approach

The stream component of the Project included priority I restoration. Stream restoration incorporated the design of a single-thread meandering channel, with parameters based on data taken from reference sites, 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 design stability.

The following stream treatment was performed on the Project reach:

Reach AV1
An offline priority I restoration approach was used for the reach to address eroding banks and channel entrenchment. Restoration activities included:

- Re-grading a new single thread channel in the existing floodplain;
- Installing log and rock structures to provide grade control and habitat;
- Establishing a riffle-pool sequence throughout the reach;

- Installing brush toe protection on meander bends;
- Filling the existing channel;
- Livestock exclusion; and
- Riparian planting.

The wetland component of the Project included wetland re-establishment and enhancement. The following wetland treatments were performed on Project wetlands:

W1/W2
Wetlands W1 and W2 were enhanced through hydrologic improvement and the planting of native vegetation. Pre-existing hydrology was impacted by channel incision, and as such, priority one stream restoration raises the groundwater table and improves the hydrology to these wetlands. Surface roughening through shallow soil ripping will improve infiltration and slow runoff through these areas, further improving hydrology. The area was also planted with a native hardwood community. Finally, fencing out livestock and establishing a permanent conservation easement for the Project protects these areas in perpetuity.

W3
The pre-existing hydric soil area was re-established as a functioning riparian wetland by restoring hydrology and planting native vegetation. Hydrology throughout this area was impacted by channel incision and constructed drainage improvements. Through a combination of priority one stream restoration, plugging and filling the old stream channel, and filling the constructed drainage features, hydrology was restored. Surface roughening through shallow soil ripping improved infiltration and slowed runoff through the floodplain, further improving hydrology. Surface roughening also created microtopography and shallow depressional areas, re-establishing more natural conditions and establishing habitat diversity. The area was also planted with a native hardwood community. Finally, fencing out livestock and establishing a permanent conservation easement for the Project protects this area in perpetuity.

1.6Construction and As-Built Conditions

Stream and wetland construction was completed in September 2020 and planting was completed in December 2020. The Apple Valley Project was built to design plans and guidelines. The as-built stream length was exactly the same as proposed in the mitigation plan however, the as-built wetland size was 0.021 acres smaller than proposed. This change was due to a minor channel alignment adjustment, made after Final Mitigation Plan submittal, to avoid impacting upstream parcel during construction.

The only planting plan change was the removal of black gum (*Nyssa sylvatica*). This change was based on bare root availability. Quantities of the other species on the planting list were increased to compensate for the removal of black gum. Minor monitoring device location changes were made during as-built installation; however, the quantities remained as proposed in the Final Mitigation Plan.

1.7 Year 3 Monitoring Performance (MY3)

The Apple Valley year 3 monitoring activities were performed in May and September 2023. All year 3 monitoring data is present below and in the appendices. The Project is on track to meeting vegetation, stream, and wetland interim success criteria.

Vegetation

Monitoring of four fixed vegetation plots and one random vegetation plot was completed in September 2023. Vegetation data is found in **Appendix C**, associated photos and plot locations are in **Appendix B**. MY3 monitoring data indicates that all plots are exceeding the interim success criteria of 320 planted stems per acre. Planted stem densities ranged from 405 to 1,012 planted stems per acre with a mean of 637 planted stems per acre across all plots. The random vegetation plot (RVP1) also met the interim success criteria with 607 planted stems per acre. A total of seven planted species were documented within the plots. Volunteer stems were noted in the two plots during Year 3 monitoring, raising the total species count to eight, throughout all plots. The average stem height in the plots was 4.3 feet.

Visual assessment of vegetation outside of the monitoring plots indicates that the herbaceous vegetation is becoming well established throughout the project. A fair amount of wetland vegetation was present throughout all wetland areas, including *Juncus* sp., *Ludwigia alternifolia, Vernonia noveboracensis, Eupatorium perfoliatum, Impatiens capensis, Ludwigia alternifolia,* and *Persicaria sagittata* suggesting that wetlands are becoming well established throughout the site. Photos of the vegetation surrounding the groundwater wells can be found in **Appendix B**. Treatment of noxious and invasive species in 2022 was successful and no new areas of noxious or invasive species were noted during year three monitoring. The easement boundary was examined during year three monitoring; signs and fencing along the eastern boundary were found to be in poor condition and will be replaced during MY4. Additionally, any trees that are in danger of falling and damaging the repaired fence will be cut down and the debris will be dispersed within the easement.

Stream Geomorphology

Cross section and geomorphology data collection for MY3 was conducted on May 10, 2023. Summary tables and cross section plots are in **Appendix D**. Overall, the Year 3 cross sections and profile relatively match the proposed design. The cross section plot overlays (**Appendix D**) displaying as-built, MY1, MY2, and MY3 data, show stable conditions in both channel and floodplain profile. The Year 3 conditions show that shear stress and velocities have been reduced for the restoration reach. The reach was designed as a gravel bed channel and remain classified as a gravel bed channel 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. Despite treatment in 2022 with Roundup Custom (EPA Regulation No. 524-343), the channel is still heavily vegetated within the riffles. Instead of another round of herbicide application RES will plant livestakes along the more densely

vegetated areas of the stream to shade out the instream vegetation. Planting will take place before the 2024 growing season.

Stream Hydrology

One stage recorder was installed on January 20, 2021, along AV1; however, the automatic recording pressure transducers (HOBO device) was originally programed to collect readings twice a day, as opposed to once every hour—the correct interval. The original HOBO was replaced with a new one, reading at the proper intervals, on May 11, 2022. It is in place to document bankfull events throughout each monitoring year. The stage recorder on AV1 recorded six bankfull events during MY3, with the highest reading on August 28, 2023, reading a maximum bankfull height of 0.79 feet above the top of bank. The gauge location can be found on **Figure 2** and photos are in **Appendix B**.

Wetland Hydrology

A total of eight groundwater wells with automatic recording pressure transducers were installed throughout the wetland areas; three (Groundwater Wells 1-3) were installed pre-construction and five (Groundwater Wells 4-8) were installed on January 20, 2021. Two additional wells (Groundwater Wells 9 and 10) were installed on May 9th, 2023. MY3 data showed hydroperiods ranging from three to 100 percent and that five of the 10 groundwater wells met the minimum 12 percent hydroperiod success criteria. Three wells that passed in MY2 failed to meet the 12% growing criteria in MY3. This is likely due to the dry conditions that were present in the area for the majority of 2023. February, March, and June-October all displayed lower than normal levels of precipitation, and no month displayed higher than normal amounts of precipitation. Groundwater well 8 continues to display especially low hydrology, with only three percent of the growing season displaying wetland hydrology. Groundwater Wells 9 and 10 were installed in Wetland 3 between GW1 and GW8 to provide supplementary information in this area. GW 9 had a 6% hydroperiod and GW 10 had a 16% hydroperiod. Vegetation around GW8 is primarily hydrophytic vegetation including *Juncus sp., Polygonum sagittatum*, and *Impatiens capensis;* suggesting a relatively frequent state of wet conditions (**Appendix B**). This groundwater well is situated at the bottom of the Project, in close proximity to a ditch, south of the easement, running parallel to the road, possibly diverting water from the wetland. Based on the success of GW10, and the presence of obligate wetland species RES expects the hydroperiod of GW8 and GW9 to increase in subsequent years of normal precipitation levels. However, RES does expect that both wells will display lower hydroperiods on average than the rest of the site by nature of their location. Daily rain data was obtained using the USACE Antecedent Precipitation Tool, which takes a location weighted average of precipitation data from surrounding stations. Groundwater well locations can be found on **Figure 2** and the data is in **Appendix E**.

2.0 Methods

Stream cross section 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 eight 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 four fixed monitoring plots and one random monitoring plot. 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 to be taken from the origin each monitoring year. The random plot is to be collected in locations where there are no permanent vegetation plots. Random plot will most likely be collected in the form of 100 square meter belt transects with variable dimensions. Tree species and height will be recorded for each planted stem and the transects will be 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. Seven have been installed within the wetland restoration crediting area and one within an enhancement area to serve as a reference wetland. 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.

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). Apple Valley Project Final Mitigation Plan.

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

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

Appendix A

Background Tables

Table 1. Apple Valley Project (ID-100063) - Mitigation Assets and Components

Project Segment	Existing Footage or Acreage	Mitigation Plan Footage or Acreage	Migitation Category	Restoration Level	Priority Level	Mitigation Ratio (X:1)	Mitigation Plan Credits		As-Built Footage or Acreage	Comments
AV1	1,574	1,437	Cold	R	1	1.00000	1437.000		1437	Full channel restoration, riparian planting, livestock exclusion, permanent conservation easement
Wetland W1	0.275	0.275	RNR	E		2.00000	0.1375		0.275	Improved hydrology via P1 stream restoration, planting, livestock exclusion, permanent conservation easement
Wetland W2	0.013	0.013	RNR	E		2.00000	0.0065		0.013	Improved hydrology via P1 stream restoration, planting, livestock exclusion, permanent conservation easement
Wetland W3	0	2.755	RNR	REE		1.00000	2.755		2.734	Restored hydrology via P1 stream restoration, planting, livestock exclusion, permanent conservation easement

Project Credits

Restoration Level	Stream			Riparian Wetland	Non-rip Wetland	Coastal Marsh
	Warm	Cool	Cold			
Restoration			1,437.000			
Re-establishment				2.755		
Rehabilitation						
Enhancement				0.144		
Enhancement I						
Enhancement II						
Creation						
Preservation						
NSBW			50.49*			
TOTALS			**1,487.490**	**2.900**		

*Credit adjustment for Non-standard Buffer Width calculation using the Wilmington District Stream Buffer Credit Calculator issued by the USACE in January 2018.

Table 2. Project Activity and Reporting History
Apple Valley Mitigation Project

Elapsed Time Since grading complete:	**3yr 2mo**
Elapsed Time Since planting complete:	**2yr 11mo**
Number of reporting Years[1]:	**3**

Activity or Deliverable	Data Collection Complete	Completion or Delivery
Restoration Plan	NA	Nov-19
Final Design – Construction Plans	NA	Jun-20
Stream Construction	NA	Sep-20
Site Planting	NA	Dec-20
As-built (Year 0 Monitoring – baseline)	Jan-21	Mar-21
Year 1 Monitoring	Stream: Jul-21 Veg: Dec-21	Dec-21
Invasive Species Treatment	NA	Aug-22
Year 2 Monitoring	Stream: Jun-22 Veg: Oct-22	Nov-22
Year 3 Monitoring	Stream: May-23 Veg: Sep-23	Dec-23
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 Apple Valley Mitigation Project	
Designer Primary project design POC	RES / 3600 Glenwood Ave., Suite 100, Raleigh, NC 27612 Dan Sweet, PLA
Construction Contractor Construction contractor POC	KBS Earthwork Inc. / 5616 Coble Church Rd., Julian, NC 27283 Kory Strader
Survey Contractor Survey contractor POC	WSP USA / 434 Fayetteville St, Suite 1500, Raleigh, NC 27601 Clint Benow, PLS
Planting Contractor Planting contractor POC	Shenandoah Habitats David Coleman
Monitoring Performers	RES / 3600 Glenwood Ave, Suite 100, Raleigh, NC 27612
Monitoring POC	Katie Obenauf 336.705.3041

Table 4. Project Background Information			
Project Name	Apple Valley Project		
County	Henderson		
Project Area (acres)	6.42		
Project Coordinates (latitude and longitude)	35.417132, -82.363875		
Planted Acreage (Acres of Woody Stems Planted)	6.09		
Project Watershed Summary Information			
Physiographic Province	66j - Broad Basins		
River Basin	French Broad		
USGS Hydrologic Unit 8-digit	06010105	USGS Hydrologic Unit 14-digit	06010105030040
DWR Sub-basin	04-03-02		
Project Drainage Area (Acres and Square Miles)	277 acres (0.43 sq mi)		
Project Drainage Area Percentage of Impervious Area	5%		
CGIA Land Use Classification	Managed herbaceous cover		
Reach Summary Information			
Parameters	**AV1**		
Length of reach (linear feet)	1437		
Valley confinement (Confined, moderately confined, unconfined)	Moderately confined		
Drainage area (Acres and Square Miles)	277 ac (0.43 sq mi)		
Perennial, Intermittent, Ephemeral	Perennial		
NCDWR Water Quality Classification	None		
Stream Classification (existing)	E4 / C4		
Stream Classification (proposed)	C4		
Evolutionary trend (Simon)	II		
FEMA classification	Zone X (Minimal Risk)		
Wetland Summary Information			
Parameters	**Wetland 1**	**Wetland 2**	**Wetland 3**
Size of Wetland (acres)	0.275	0.013	2.755
Wetland Type (non-riparian, riparian riverine or riparian non-riverine)	Riparian Non-riverine	Riparian Non-riverine	Riparian Non-riverine
Mapped Soil Series	Codorus loam (Arkaqua)	Codorus loam (Arkaqua)	Codorus loam (Arkaqua)
Drainage class	Somewhat poorly	Somewhat poorly	Somewhat poorly
Soil Hydric Status	Yes (Per LSS)	Yes (Per LSS)	Yes (Per LSS)
Source of Hydrology	Groundwater and surface flow	Groundwater and surface flow	Groundwater, surface flow, and stream flooding
Restoration or enhancement method (hydrologic, vegetative etc.)	Hydrologic enhancement & vegetative restoration	Hydrologic enhancement & vegetative restoration	Hydrologic & vegetative restoration

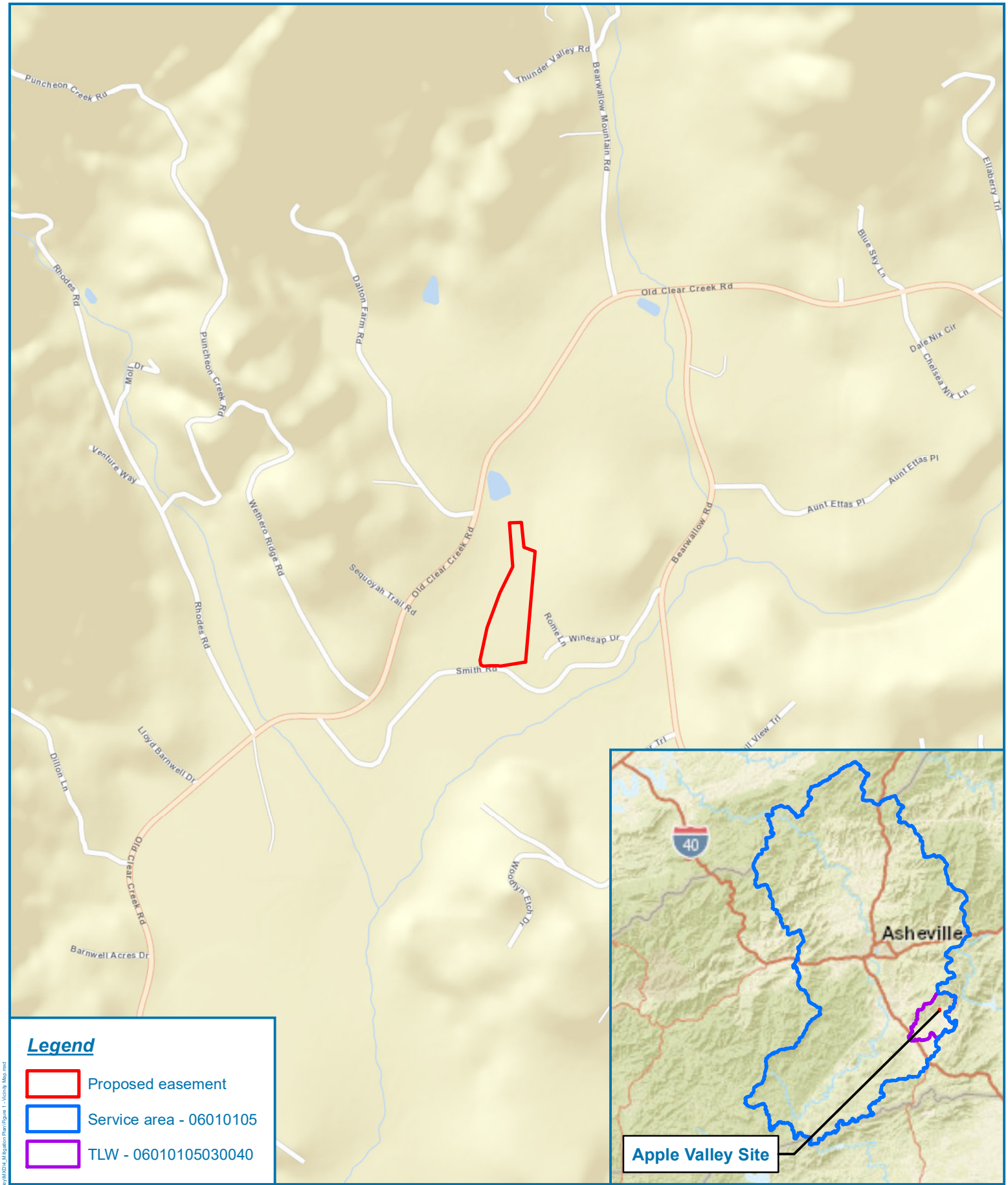


Figure 1 - Site Location Map

Apple Valley Project

Henderson County, North Carolina

Date:	5/7/2019
Drawn by:	SCF
Checked by:	JRM
	1 inch = 1,000 feet

res

Document Path: S:\@RES GIS\Projects\NC\Apple Valley\MX004_Mitigation Plan\Figure 1 - Vicinity Map.mxd

Appendix B

Visual Assessment Data

Fence Repair

GW5
GW4
GW1
GW10
GW7
GW6
GW3
GW9
GW8
GW2
AV1

1
2
3
4
5
6
7

Restoring a resilient earth for a modern world

N E S W

0 50 100
Feet

Figure 2 - MY3 CCPV 2023

Apple Valley Mitigation Project

Henderson County, North Carolina

Date: 2/1/2024	Drawn by: KTO
1 inch = 100 feet	Checked by: RTM

Legend

- Conservation Easement
- Fence Repair

Wetland Mitigation

- Re-establishment
- Enhancement
- Top of Bank
- Filled Old Channel
- Vegetation Plot (>320 Stems/Acre)
- Random Veg Plot (>320 Stems/Acre)

Stream Mitigation

- Restoration
- No Credit
- Cross Section
- Structures
- Filled Ditch/Swale
- Stage Recorder
- Ambient Gauge

Groundwater Wells

- >12%
- 5-12%
- <5%

Visual Stream Stability Assessment

Assessment Date: 11/10/2023

Reach	AV1
Assessed Stream Length	1437
Assessed Bank Length	2874

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.	18	18		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)	20	20		100%

Table 6 Vegetation Condition Assessment

Assessment Date: 11/10/2023

Planted Acreage[1] **6.09**

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] **6.33**

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	0	0.00	0.0%
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.

Apple Valley MY3 Fixed Vegetation Monitoring Plot Photos

Vegetation Plot 1 (09/27/2023)

Vegetation Plot 2 (09/27/2023)

Vegetation Plot 3 (09/27/2023)

Vegetation Plot 4 (09/27/2023)

Apple Valley MY3 Random Vegetation Monitoring Plot Photo

Random Vegetation Plot 1 (09/27/2023)

Apple Valley Monitoring Device Photos

Groundwater Well 1 (11/28/2023)

Groundwater Well 2 (11/28/2023)

Groundwater Well 3 (11/28/2023)

Groundwater Well 4 (11/28/2023)

Groundwater Well 5 (11/28/2023)

Groundwater Well 6 (11/28/2023)

Groundwater Well 7 (11/28/2023)

Groundwater Well 8 (11/28/2023)

Groundwater Well 9 (11/28/2023)

Groundwater Well 10 (11/28/2023)

Stage Recorder AV-1 (11/28/2023)

Appendix C

Vegetation Plot Data

Table 7. Planted Species Summary

Common Name	Scientific Name	Mitigation Plan %	As-Built %	Total Stems Planted
Buttonbush	*Cephalanthus occidentalis*	10	15	1,000
River Birch	*Betula nigra*	15	15	1,000
Sycamore	*Platanus occidentalis*	15	15	1,000
Northern Red Oak	*Quercus rubra*	15	15	1,000
Persimmon	*Diospyros virginiana*	10	10	700
Chestnut Oak	*Quercus montana*	5	10	700
Yellow Poplar	*Liriodendron tulipifera*	10	10	700
Sugarberry	*Celtis laevigata*	10	10	700
Blackgum	*Nyssa sylvatica*	10	0	0
			Total	6,800
			Planted Area	6.09
			As-built Planted Stems/Acre	1,117

Table 8. Vegetation Plot Mitigation Success Summary

Plot #	Planted Stems/Acre	Volunteer Stems/Acre	Total Stems/Acre	Success Criteria Met?	Average Planted Stem Height (ft)
1	607	40	647	Yes	3.1
2	405	40	445	Yes	3.4
3	526	0	526	Yes	5.0
4	1012	81	1093	Yes	4.5
R1	607	0	607	Yes	5.2
Project Avg	**631**	**32**	**664**	**Yes**	4.3

Table 9. Stem Count Total and Planted by Plot Species

EEP Project Code 100063. Project Name: Apple Valley

Apple Valley			Current Plot Data (MY3 2023)															Annual Means											
			100063-01-0001			100063-01-0002			100063-01-0003			100063-01-0004			R1			MY3 (2023)			MY2 (2022)			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	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer rubrum	red maple	Tree			1			1						1						3									
Betula nigra	river birch	Tree				2	2	2							2	2	2	4	4	4	7	7	7	5	5	5	21	21	21
Celtis laevigata	sugarberry	Tree										1	1	1				1	1	1	1	1	1	2	2	2	6	6	6
Cephalanthus occidentalis	common buttonbush	Shrub				6	6	6	4	4	4				2	2	2	12	12	12	13	13	13	9	9	9	9	9	9
Diospyros virginiana	common persimmon	Tree	3	3	3							7	7	8	2	2	2	12	12	13	9	9	9	7	7	7	5	5	5
Fraxinus pennsylvanica	green ash	Tree																						1	1	1			
Liriodendron tulipifera	tuliptree	Tree																									2	2	2
Platanus occidentalis	American sycamore	Tree				2	2	2	9	9	9				7	7	7	18	18	18	14	14	14	14	14	14	19	19	19
Prunus serotina	black cherry	Tree																					5						
Quercus montana		Tree	4	4	4							8	8	8				12	12	12	12	12	13	11	11	11	12	12	12
Quercus rubra	northern red oak	Tree	8	8	8							9	9	9	2	2	2	19	19	19	18	18	18	22	22	22	23	23	23
Rhus typhina	Staghorn Sumac	shrub																					3						
Salix nigra	black willow	Tree																					1						
		Stem count	15	15	16	10	10	11	13	13	13	25	25	27	15	15	15	78	78	82	74	74	84	71	71	71	97	97	97
		size (ares)	1			1			1			1			1			5			5			5			5		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.12			0.12			0.12			0.12		
		Species count	3	3	4	3	3	4	2	2	2	4	4	5	5	5	5	7	7	8	7	7	10	8	8	8	8	8	8
		Stems per ACRE	607	607	647	405	405	445	526	526	526	1012	1012	1093	607	607	607	631	631	664	599	599	680	575	575	575	785	785	785

Appendix D

Stream Measurement and

Geomorphology Data

Table 10. Baseline Stream Data Summary
Apple Valley Mitigation Site - Reach AV1

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)		---	---	---	6.4	8.2	8.2	9.9	---	2	---	---	7.5	---	---	1	---	10.0	---	8.3	10.6	10.9	12.4	1.7	4
Floodprone Width (ft)					30.0	30.0	30.0	30.0	---	2	---	---	>50	---	---	1	---	>30	---	40.0	47.3	49.7	49.9	4.9	4
Bankfull Mean Depth (ft)		---	---	---	0.8	1.0	1.0	1.1	---	2	---	---	1.0	---	---	1	---	0.8	---	---	---	---	---	---	---
[1]Bankfull Max Depth (ft)					1.3	1.4	1.4	1.4	---	2	---	---	1.4	---	---	1	---	1.0	---	1.1	1.4	1.4	1.5	0.2	4
Bankfull Cross Sectional Area (ft^2)		---	---	---	7.0	7.4	7.4	7.7	---	2	---	---	7.5	---	---	1	---	8.0	---	7.1	8.9	9.0	10.7	1.6	4
Width/Depth Ratio					5.8	9.3	9.3	12.8	---	2	---	---	7.6	---	---	1	---	12.5	---	---	---	---	---	---	---
Entrenchment Ratio					>2.2	2.6	2.6	3.0	---	2	---	---	>2.2	---	---	1	---	>2.2	---	3.6	4.1	4.1	4.6	0.4	4
[1]Bank Height Ratio					1.3	1.4	1.4	1.4	---	2	---	---	1.0	---	---	1	---	1.0	---	1.0	1.0	1.0	1.0	0.0	4
Profile																									
Riffle Length (ft)					---	---	---	---	---	---	8	---	---	8	---	---	10	---	30	8.6	17.7	16.7	37.5	7.4	19
Riffle Slope (ft/ft)					---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.04	0.9	0.7	2.5	0.6	20
Pool Length (ft)					---	---	---	---	---	---	14	---	---	14	---	---	33	---	75	33.1	53.5	47.8	111.1	18.9	19
Pool Max depth (ft)					---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pool Spacing (ft)					---	---	---	---	---	---	30	---	---	30	---	---	30	---	50	43.6	72.0	67.0	123.0	20.3	18
Pattern																									
Channel Beltwidth (ft)					---	---	---	---	---	---	23	---	---	40	---	---	20	---	60	20	---	---	60	---	---
Radius of Curvature (ft)					---	---	---	---	---	---	7.5	---	---	24.2	---	---	20	---	60	20	---	---	60	---	---
Rc:Bankfull width (ft/ft)					---	---	---	---	---	---	1	---	---	3.2	---	---	2.5	---	7.5	2.5	---	---	7.5	---	---
Meander Wavelength (ft)					---	---	---	---	---	---	35	---	---	46	---	---	70	---	140	70	---	---	140	---	---
Meander Width Ratio					---	---	---	---	---	---	3	---	---	5.3	---	---	8.8	---	17.5	8.8	---	---	17.5	---	---
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					E4/C4 moving to G4c						E4						C4			C4					
Bankfull Velocity (fps)		---	---	---	---						---						---			---					
Bankfull Discharge (cfs)		---	---	---	---												---			---					
Valley length (ft)					1240						246						1240			1240					
Channel Thalweg length (ft)					1574						289						1437			1437					
Sinuosity (ft)					1.27						1.17						1.16			1.16					
Water Surface Slope (Channel) (ft/ft)					---						---						---			---					
Channel slope (ft/ft)					0.01						0.009						0.011			0.011					
[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: Apple Valley #100063

	Cross Section 1 (Riffle)							Cross Section 2 (Pool)							Cross Section 3 (Riffle)							Cross Section 4 (Pool)							Cross Section 5 (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]	2188.3	2188.4	2188.6	2188.6				2187.9	2188.1	2188.0	2188.3				2182.9	2182.9	2183.1	2183.0				2182.5	2182.6	2182.5	2182.5				2179.0	2179.0	2179.0	2179.1			
Bankfull Width (ft)[1]	11.0	10.2	10.7	10.4				-	-	-	-				10.7	10.9	10.1	10.0				-	-	-					8.3	11.1	12.5	11.3			
Floodprone Width (ft)[1]	40.0	>42.8	>45.4	>46.3				-	-	-	-	-	-	-	>49.7	>49.8	>49.8	>49.6				-	-	-	-	-	-	-	>49.9	>50.1	>49.9	>49.9			
Bankfull Max Depth (ft)[2]	1.5	1.5	1.3	1.6				2.1	1.2	1.6	1.6				1.1	1.2	0.8	1.1				2.1	2.1	2.7	2.8				1.3	1.2	1.0	1.1			
Low Bank Elevation (ft)	2188.28	2188.3	2188.0	2188.3				2187.9	2188.0	2187.7	2187.9				2182.9	2182.9	2182.9	2182.9				2182.5	2182.5	2182.6	2182.7				2179.0	2178.9	2178.8	2178.8			
Bankfull Cross Sectional Area (ft^2)[2]	10.7	9.1	5.1	8.2				14.4	13.4	8.2	10.4				7.1	7.3	5.3	6.3				12.5	11.4	13.6	14.6				8.3	7.3	5.9	5.8			
Bankfull Entrenchment Ratio[1]	>3.6	>4.2	>4.3	>4.4				-	-	-	-	-	-	-	>4.6	>4.6	>4.9	>4.9				-	-	-	-	-	-	-	>4.2	>4.5	>4.0	>4.4			
Bankfull Bank Height Ratio[1]	1.0	0.9	0.7	0.9				-	-	-	-	-	-	-	1.0	1.0	0.8	0.9				-	-	-	-	-	-	-	1.0	0.9	0.8	0.8			

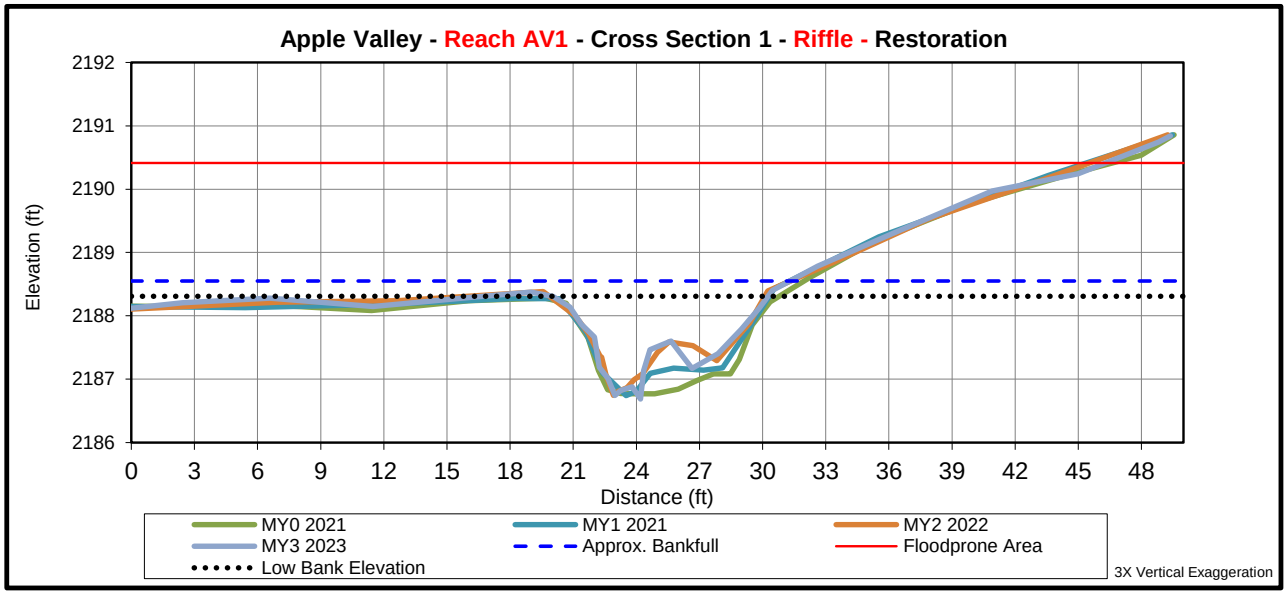
	Cross Section 6 (Pool)							Cross Section 7 (Riffle)							Cross Section 8 (Pool)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	2178.8	2178.7	2178.8	2178.8				2176.1	2176.1	2176.3	2176.2				2175.7	2175.9	2175.8	2175.6			
Bankfull Width (ft)[1]	-	-	-					12.4	10.9	12.3	12.2				-	-	-				
Floodprone Width (ft)[1]	-	-	-	-	-	-	-	>49.6	>49.8	>49.9	>49.7				-	-	-	-	-	-	-
Bankfull Max Depth (ft)[2]	2.1	2.5	2.1	2.4				1.5	1.5	1.1	1.5				2.3	2.2	3.1	3.1			
Low Bank Elevation (ft)	2178.8	2178.8	2178.4	2178.7				2176.1	2176.1	2176.2	2176.2				2175.7	2175.7	2175.8	2175.8			
Bankfull Cross Sectional Area (ft^2)[2]	12.6	13.7	8.3	11.6				9.6	9.1	8.2	9.9				12.3	10.4	12.7	14.0			
Bankfull Entrenchment Ratio[1]	-	-	-	-	-	-	-	>4.0	>4.6	>4.1	>4.1				-	-	-	-	-	-	-
Bankfull Bank Height Ratio[1]	-	-	-	-	-	-	-	1.0	1.0	0.9	1.0				-	-	-	-	-	-	-

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

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

Upstream

Downstream

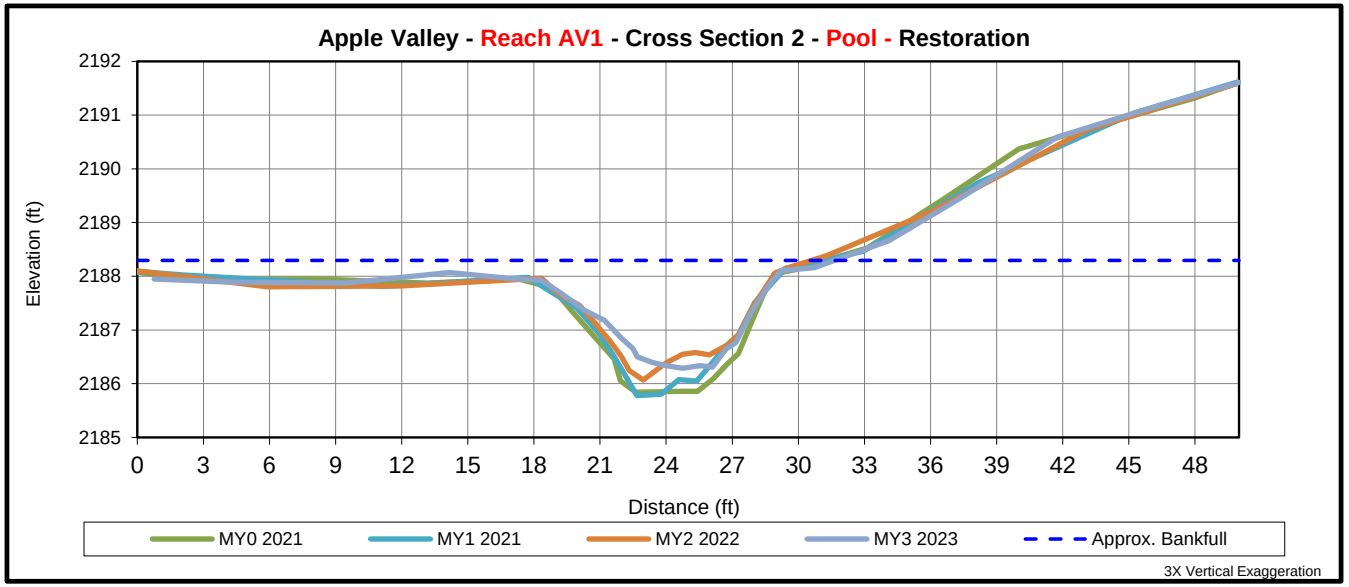


	Cross Section 1 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA	2188.28	2188.4	2188.6	2188.6			
Bankfull Width (ft)[1]	11.0	10.2	10.7	10.4			
Floodprone Width (ft)[1]	40.0	>42.8	>45.4	>46.3			
Bankfull Max Depth (ft)[2]	1.5	1.5	1.3	1.6			
Low Bank Elevation (ft)	2188.28	2188.3	2188.0	2188.3			
Bankfull Cross Sectional Area (ft^2)[2]	10.7	9.1	5.1	8.2			
Bankfull Entrenchment Ratio[1]	>3.6	>4.2	>4.3	>4.4			
Bankfull Bank Height Ratio[1]	1.0	0.9	0.7	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

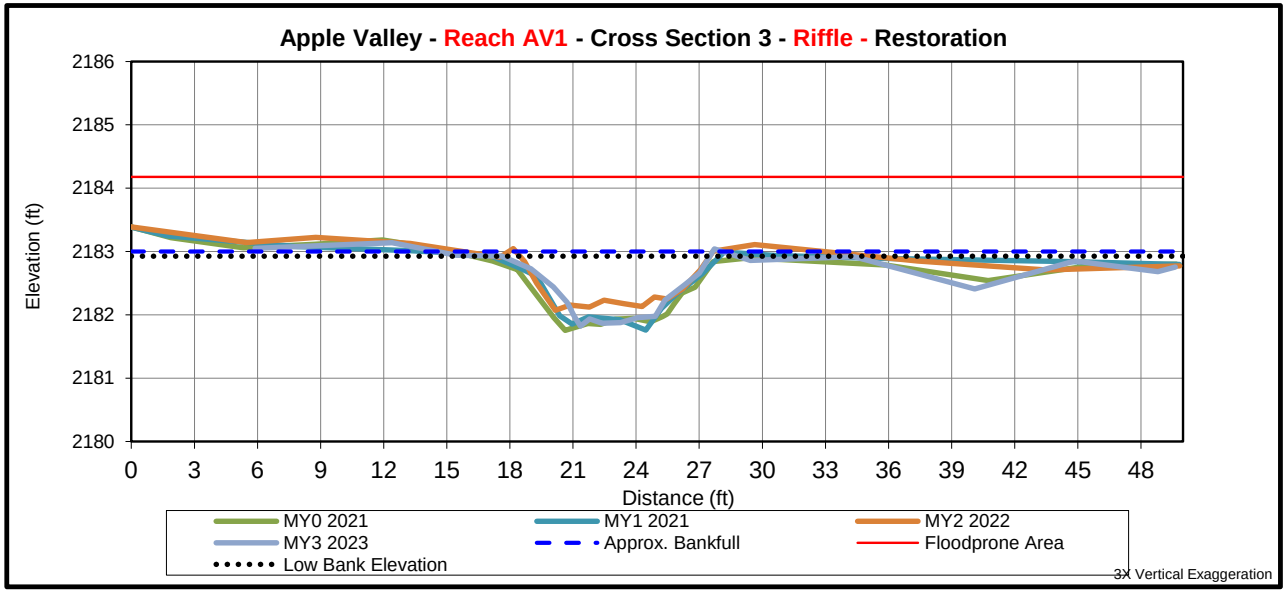


	Cross Section 2 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	2187.95	2188.1	2188.0	2188.3			
Bankfull Width (ft)[1]	-	-	-	-			
Floodprone Width (ft)[1]	-	-	-	-			
Bankfull Max Depth (ft)[2]	2.1	1.2	1.6	1.6			
Low Bank Elevation (ft)	2187.95	2188.0	2187.7	2187.9			
Bankfull Cross Sectional Area (ft^2)[2]	14.4	13.4	8.2	10.4			
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

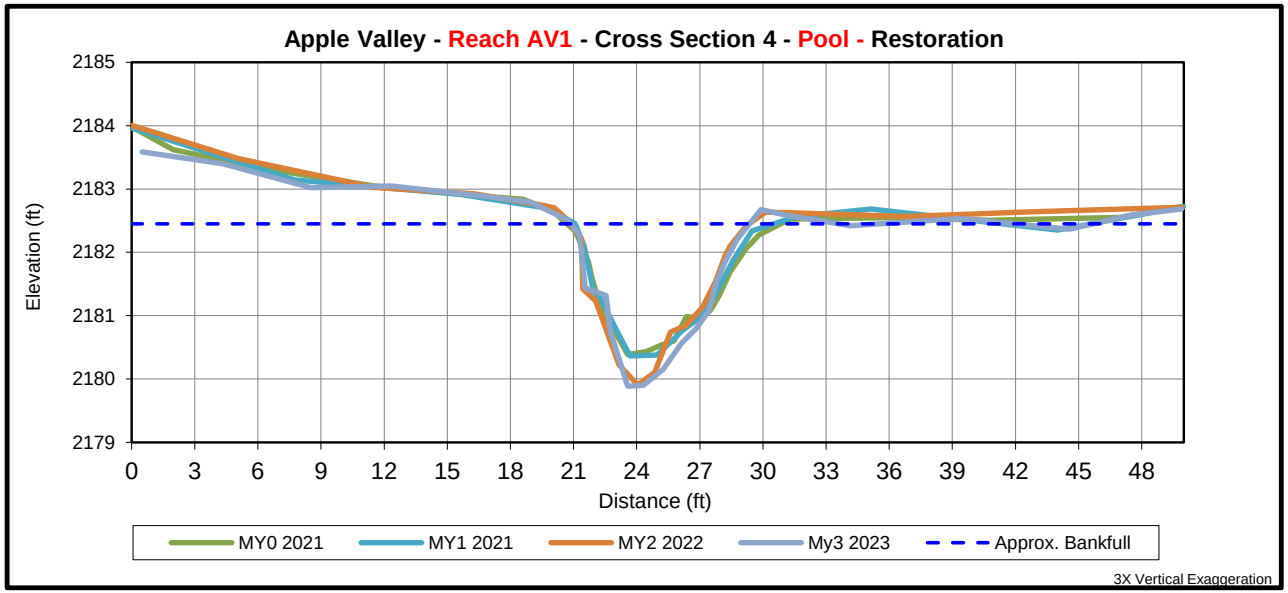


	Cross Section 3 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	2182.85	2182.9	2183.1	2183.0			
Bankfull Width (ft)[1]	10.7	10.9	10.1	10.0			
Floodprone Width (ft)[1]	>49.7	>49.8	>49.8	>49.6			
Bankfull Max Depth (ft)[2]	1.1	1.2	0.8	1.1			
Low Bank Elevation (ft)	2182.85	2182.9	2182.9	2182.9			
Bankfull Cross Sectional Area (ft^2)[2]	7.1	7.3	5.3	6.3			
Bankfull Entrenchment Ratio[1]	>4.6	>4.6	>4.9	>4.9			
Bankfull Bank Height Ratio[1]	1.0	1.0	0.8	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

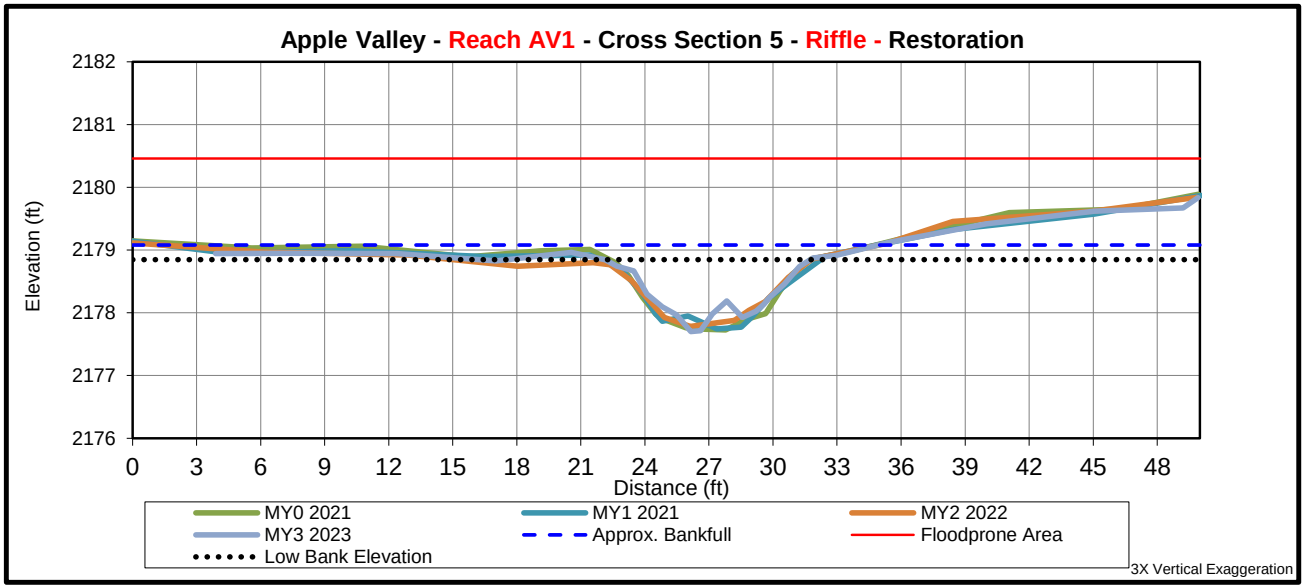


	Cross Section 4 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	2182.53	2182.6	2182.5	2182.5			
Bankfull Width (ft)[1]	-	-	-				
Floodprone Width (ft)[1]	-	-	-	-			
Bankfull Max Depth (ft)[2]	2.1	2.1	2.7	2.8			
Low Bank Elevation (ft)	2182.53	2182.5	2182.6	2182.7			
Bankfull Cross Sectional Area (ft^2)[2]	12.5	11.4	13.6	14.6			
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

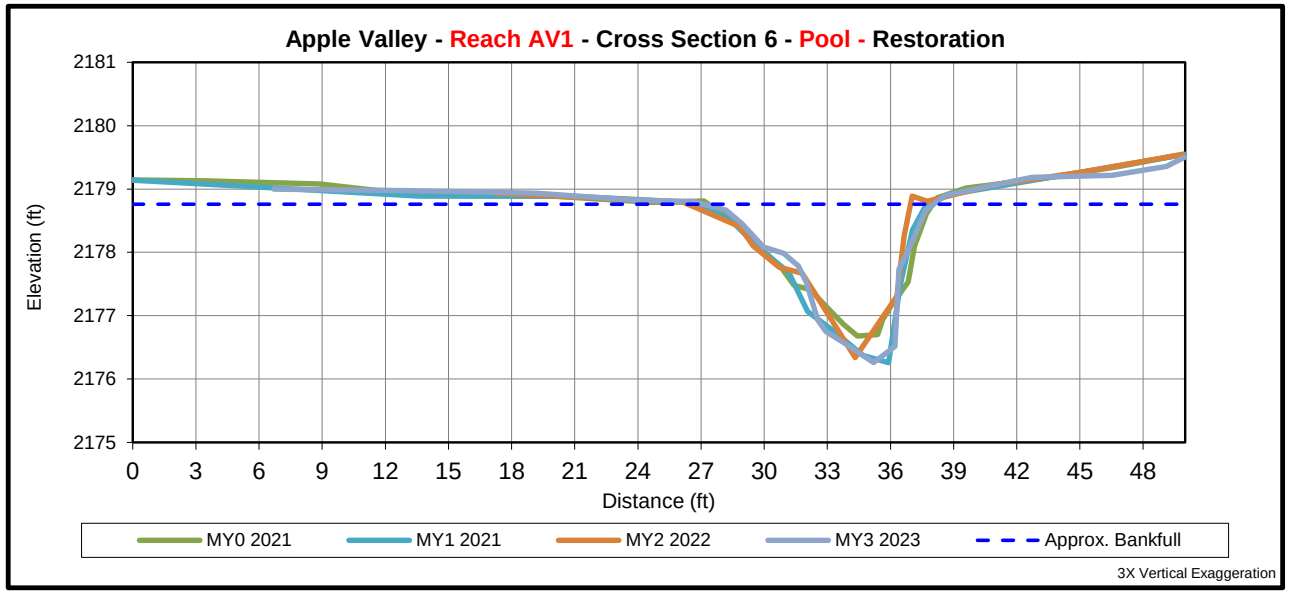


	Cross Section 5 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	2178.98	2179.0	2179.0	2179.1			
Bankfull Width (ft)[1]	8.3	11.1	12.5	11.3			
Floodprone Width (ft)[1]	>49.9	>50.1	>49.9	>49.9			
Bankfull Max Depth (ft)[2]	1.3	1.2	1.0	1.1			
Low Bank Elevation (ft)	2178.98	2178.9	2178.8	2178.8			
Bankfull Cross Sectional Area (ft^2)[2]	8.3	7.3	5.9	5.8			
Bankfull Entrenchment Ratio[1]	>4.2	>4.5	>4.0	>4.4			
Bankfull Bank Height Ratio[1]	1.0	0.9	0.8	0.8			

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

Upstream

Downstream

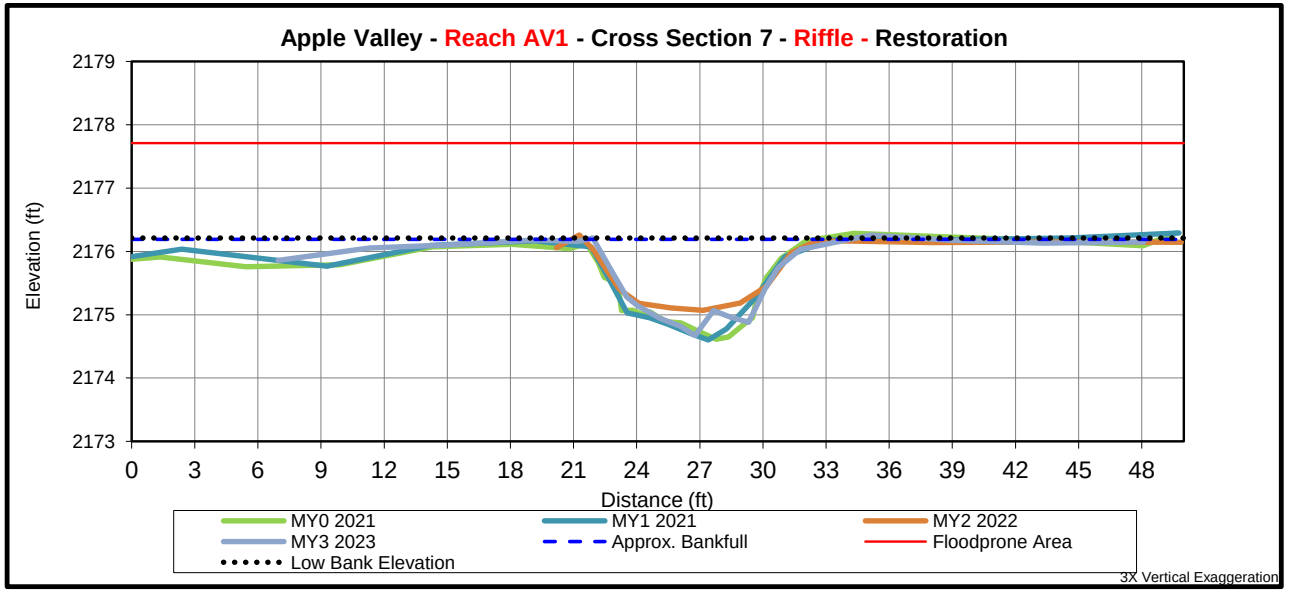


	Cross Section 6 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	2178.81	2178.7	2178.8	2178.8			
Bankfull Width (ft)[1]	-	-	-				
Floodprone Width (ft)[1]	-	-	-	-			
Bankfull Max Depth (ft)[2]	2.1	2.5	2.1	2.4			
Low Bank Elevation (ft)	2178.81	2178.8	2178.4	2178.7			
Bankfull Cross Sectional Area (ft^2)[2]	12.6	13.7	8.3	11.6			
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

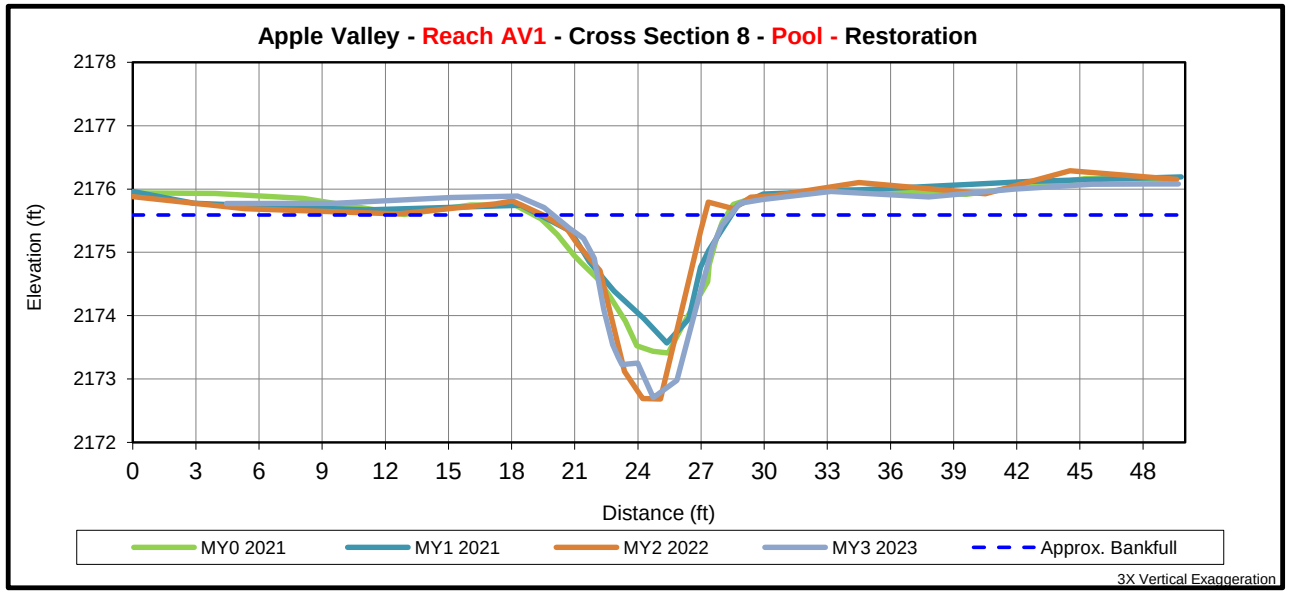


	Cross Section 7 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	2176.12	2176.1	2176.3	2176.2			
Bankfull Width (ft)[1]	12.4	10.9	12.3	12.2			
Floodprone Width (ft)[1]	>49.6	>49.8	>49.9	>49.7			
Bankfull Max Depth (ft)[2]	1.5	1.5	1.1	1.5			
Low Bank Elevation (ft)	2176.12	2176.1	2176.2	2176.2			
Bankfull Cross Sectional Area (ft^2)[2]	9.6	9.1	8.2	9.9			
Bankfull Entrenchment Ratio[1]	>4.0	>4.6	>4.1	>4.1			
Bankfull Bank Height Ratio[1]	1.0	1.0	0.9	1.0			

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

Upstream

Downstream



	Cross Section 8 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	2175.74	2175.9	2175.8	2175.6			
Bankfull Width (ft)[1]	-	-	-				
Floodprone Width (ft)[1]	-	-	-	-			
Bankfull Max Depth (ft)[2]	2.3	2.2	3.1	3.1			
Low Bank Elevation (ft)	2175.74	2175.7	2175.8	2175.8			
Bankfull Cross Sectional Area (ft^2)[2]	12.3	10.4	12.7	14.0			
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

Appendix E

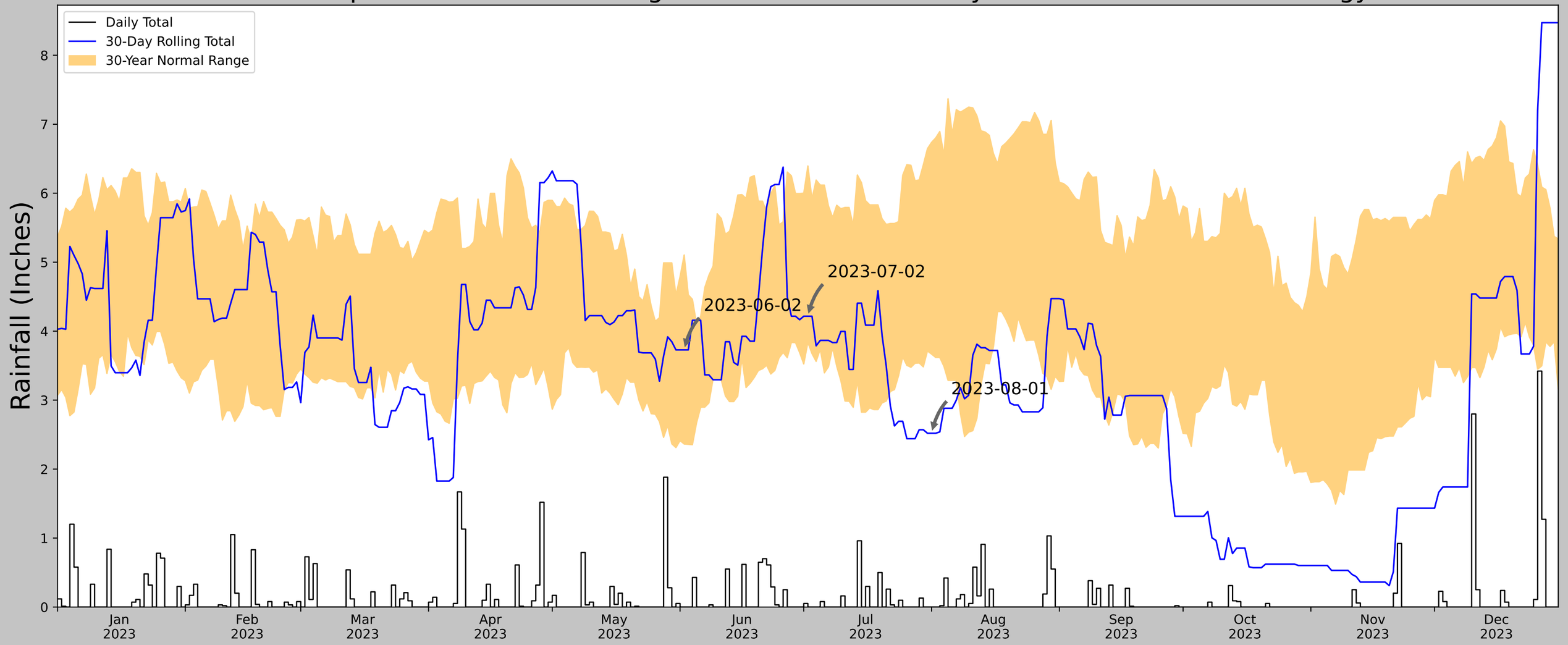
Hydrology Data

Table 12. Rainfall Summary MY3 2023

Month	Average	Normal Limits		Project Location Precipitation*
		30 Percent	70 Percent	
October	4.09	1.89	5.00	1.14
November	4.45	2.85	5.36	3.71
December	5.19	3.67	6.14	1.95
January	5.08	3.38	6.09	4.74
February	4.41	2.92	5.28	1.71
March	4.98	3.40	5.95	3.08
April	4.83	3.42	5.72	4.32
May	4.35	2.68	5.26	3.02
June	4.94	3.21	5.94	2.65
July	5.68	3.52	6.87	2.49
August	5.64	3.75	6.76	2.78
September	4.82	2.62	5.88	1.31
October	4.09	1.89	5.00	0.24
November	4.45	2.85	5.36	1.27
December	5.19	3.67	6.14	-
Total Annual **	58.47	51.88	65.32	27.62
Above 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 Asheville AP, East Flat Rock 0.5 NNE, Flat Rock 4.7 NE, Fletcher 2 NE, Hendersonville 1 NE, Hendersonville 1.0 SSW, Hendersonville 1.1 ESE, Hendersonville 1.4 SW, Hendersonville 2.4 NNE, Hendersonville 2.6 SSW, and Hendersonvlle 3.0 NNW.
**Total Annual represents the average total precipitation, annually, as calculated by the 30-year period. WETS data is from the Hendersonville 1 NE station from 1991-2021.

Antecedent Precipitation vs Normal Range based on NOAA's Daily Global Historical Climatology Network



Coordinates	35.42, -82.36
Observation Date	2023-08-01
Elevation (ft)	2222.864
Drought Index (PDSI)	Incipient wetness
WebWIMP H_2O Balance	Wet Season

30 Days Ending	30^{th} %ile (in)	70^{th} %ile (in)	Observed (in)	Wetness Condition	Condition Value	Month Weight	Product
2023-08-01	3.666929	6.737795	2.519685	Dry	1	3	3
2023-07-02	3.835433	6.395669	4.216536	Normal	2	2	4
2023-06-02	2.363386	5.105118	3.728347	Normal	2	1	2
Result							Drier than Normal - 9

US Army Corps of Engineers

ERDC ENGINEER RESEARCH & DEVELOPMENT CENTER

Figures and tables made by the Antecedent Precipitation Tool Version 2.0

Developed by:
U.S. Army Corps of Engineers and
U.S. Army Engineer Research and Development Center

Weather Station Name	Coordinates	Elevation (ft)	Distance (mi)	Elevation Δ	Weighted Δ	Days Normal	Days Antecedent
HENDERSONVILLE 1 NE	35.3297, -82.4492	2160.105	8.011	62.759	4.108	11169	90
HENDERSONVILLE 1.1 ESE	35.3149, -82.4452	2103.018	1.047	57.087	0.531	8	0
HENDERSONVILLE 2.4 NNE	35.3528, -82.4424	2097.113	1.641	62.992	0.842	2	0
HENDERSONVILLE 1.0 SSW	35.3073, -82.4665	2148.95	1.829	11.155	0.843	16	0
HENDERSONVILLE 1.4 SW	35.3053, -82.4764	2203.084	2.279	42.979	1.123	6	0
HENDERSONVILLE 3.0 NNW	35.3638, -82.4753	2120.079	2.778	40.026	1.361	1	0
FLAT ROCK 4.7 NE	35.3201, -82.3993	2189.961	2.89	29.856	1.387	40	0
HENDERSONVILLE 2.6 SSW	35.2883, -82.4828	2145.997	3.431	14.108	1.592	4	0
EAST FLAT ROCK 0.5 NNE	35.291, -82.4143	2125.0	3.32	35.105	1.611	2	0
FLETCHER 2 NE	35.45, -82.4833	2189.961	8.531	29.856	4.094	1	0
ASHEVILLE AP	35.4317, -82.5378	2118.11	8.636	41.995	4.249	104	0

Table 12. Rainfall Summary MY3 2023

Month	Average	Normal Limits		Project Location Precipitation*
		30 Percent	70 Percent	
October	4.09	1.89	5.00	1.14
November	4.45	2.85	5.36	3.71
December	5.19	3.67	6.14	1.95
January	5.08	3.38	6.09	4.74
February	4.41	2.92	5.28	1.71
March	4.98	3.40	5.95	3.08
April	4.83	3.42	5.72	4.32
May	4.35	2.68	5.26	3.02
June	4.94	3.21	5.94	2.65
July	5.68	3.52	6.87	2.49
August	5.64	3.75	6.76	2.78
September	4.82	2.62	5.88	1.31
October	4.09	1.89	5.00	0.24
November	4.45	2.85	5.36	1.27
December	5.19	3.67	6.14	-
Total Annual **	58.47	51.88	65.32	27.62
Above 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 Asheville AP, East Flat Rock 0.5 NNE, Flat Rock 4.7 NE, Fletcher 2 NE, Hendersonville 1 NE, Hendersonville 1.0 SSW, Hendersonville 1.1 ESE, Hendersonville 1.4 SW, Hendersonville 2.4 NNE, Hendersonville 2.6 SSW, and Hendersonvlle 3.0 NNW.
**Total Annual represents the average total precipitation, annually, as calculated by the 30-year period. WETS data is from the Hendersonville 1 NE station from 1991-2021.

Table 13. Documentation of Geomorphically Significant Flow Events

Year	Bankfull Event	Height Over Bankfull (ft)	Date of Bankfull Event
Stage Recorder AV1			
MY1 2021	***1**	**0.032**	**3/25/2021**
MY2 2022	1	0.176	3/23/2022
	2	0.08	5/23/2022
	3	0.143	5/26/2022
	4	0.38	7/30/2022
	5	0.937	8/6/2022
	***6**	**1.061**	**9/5/2022**
	7	0.4225	11/11/2022
MY3 2023	1	0.0905	1/25/2023
	2	0.1185	2/17/2023
	3	0.0205	5/25/2023
	4	0.0645	6/21/2023
	5	0.1815	7/23/2023
	***6**	**0.7905**	**8/28/2023**

The stage recorder malfunctioned in 2021, and was replaced in May 2022

*Indicates the maximum bankful occurence in that monitoring year

Table 14. 2023 Max Hydroperiod

2023 Max Hydroperiod (Growing Season 26-Mar through 8-Nov, 227 days)					
Well ID	Consecutive		Cumulative		Occurrences
	Days	Hydrology (%)	Days	Hydroperiod (%)	
GW1	**228**	100%	228	100%	1
GW2	**108**	47%	166	73%	4
GW3	**206**	91%	206	91%	1
GW4	**11**	5%	66	29%	15
GW5	**228**	100%	228	100%	1
GW6	**26**	11%	63	28%	9
GW7	**24**	10%	63	28%	9
GW8	**6**	3%	53	23%	14
GW9	**13**	6%	63	28%	12
GW10	**37**	16%	101	44%	11

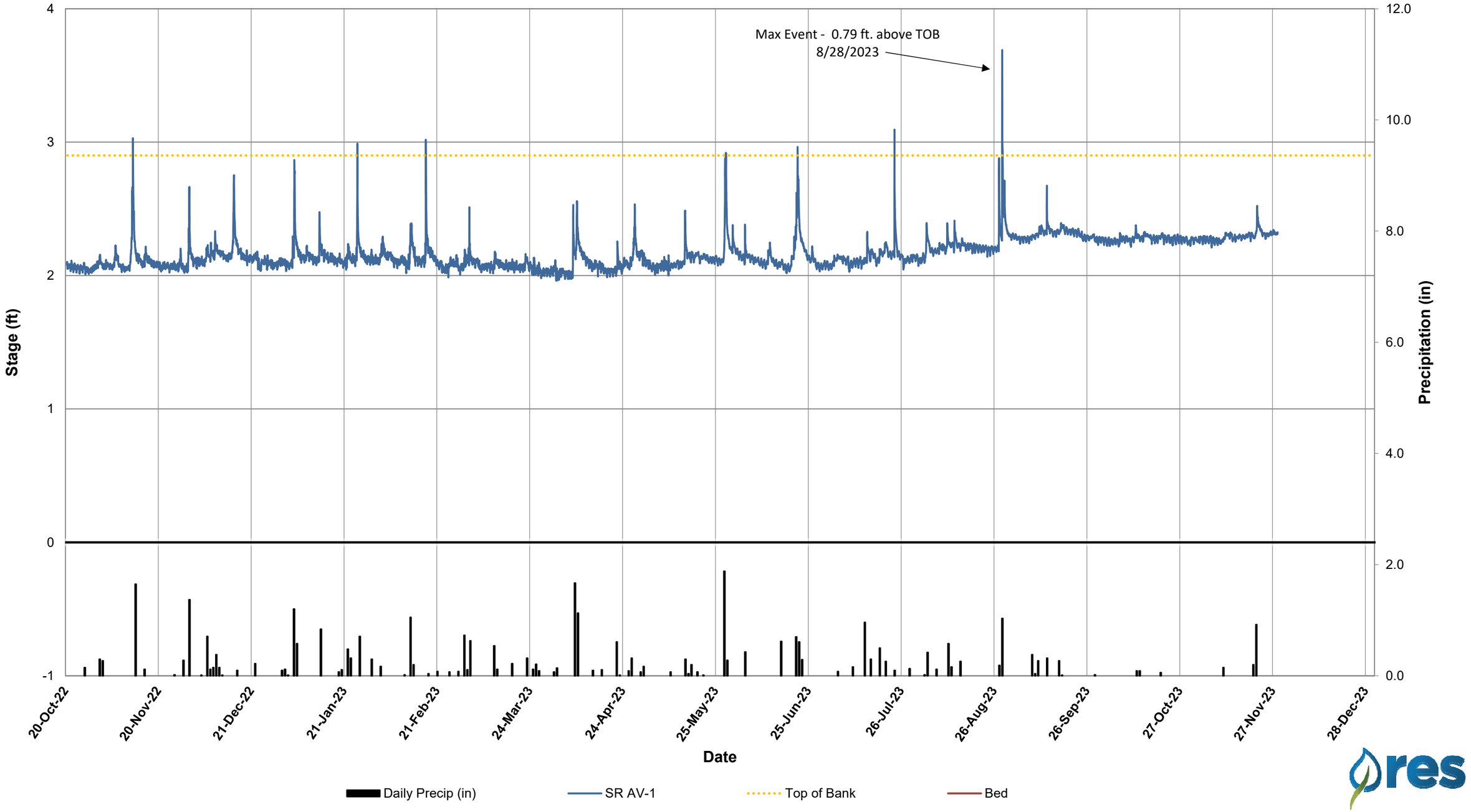
<5%	5-12%	>12%

Table 15. Summary of Groundwater Monitoring Results

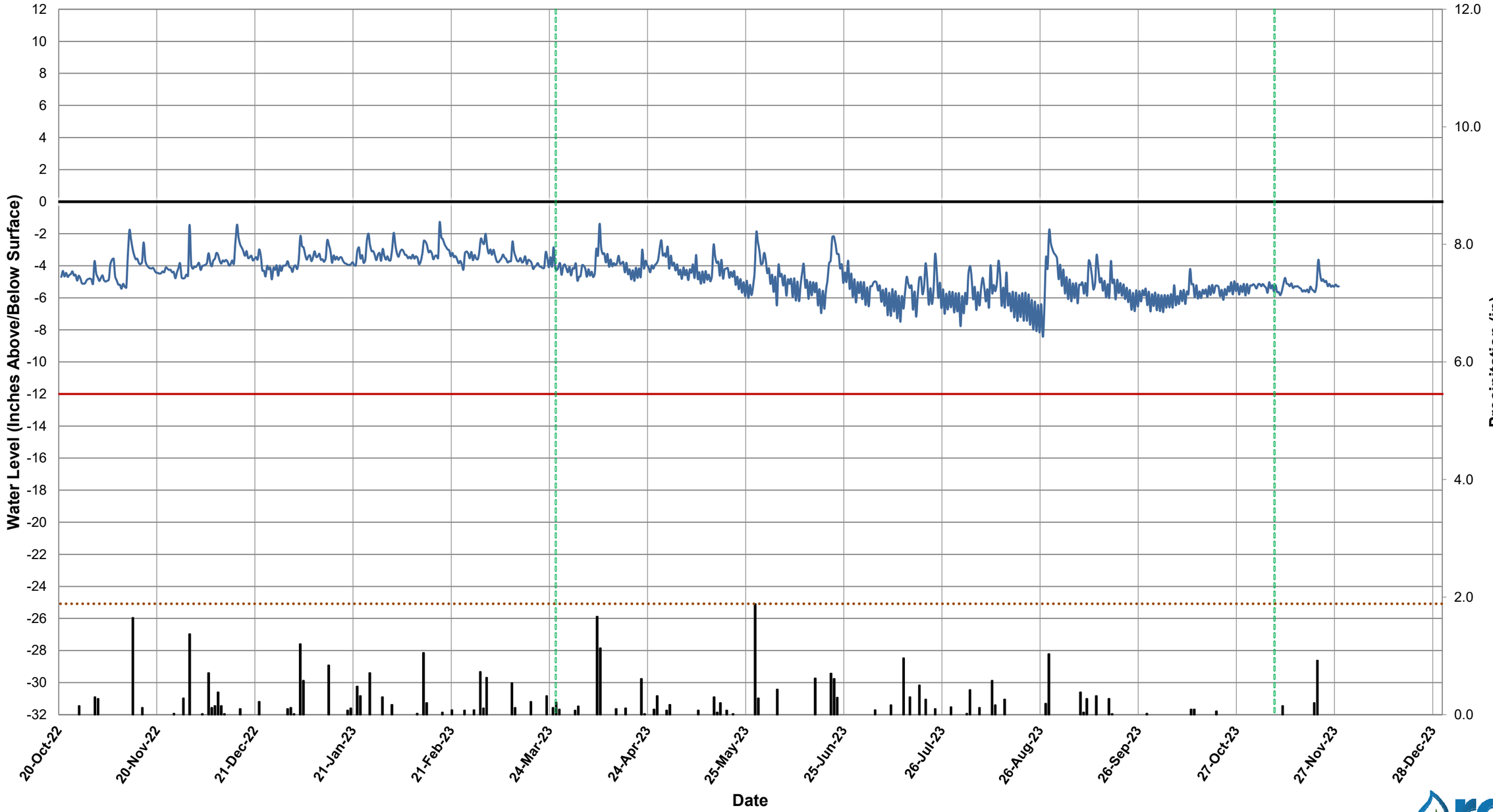
Summary of Groundwater Monitoring Results Apple Valley								
Well ID	Wetland ID	Hydroperiod (%)						
		Year 1 (2021)	Year 2 (2022)	Year 3 (2023)	Year 4 (2024)	Year 5 (2025)	Year 6 (2026)	Year 7 (2027)
GW1	W1	100	100	100				
GW2	W3	27	37	47				
GW3	W3	100	100	91				
GW4	W3	6	24	5				
GW5	W3	100	100	100				
GW6	W3	45	24	11				
GW7	W3	27	15	10				
GW8	W3	6	4	3				
GW9	W3	NA	NA	6				
GW10	W3	NA	NA	16				

GW9 and GW10 were installed in May 2023 and thus do not have data for the entire growing season.

MY3 Apple Valley AV1 Stage Recorder Graph



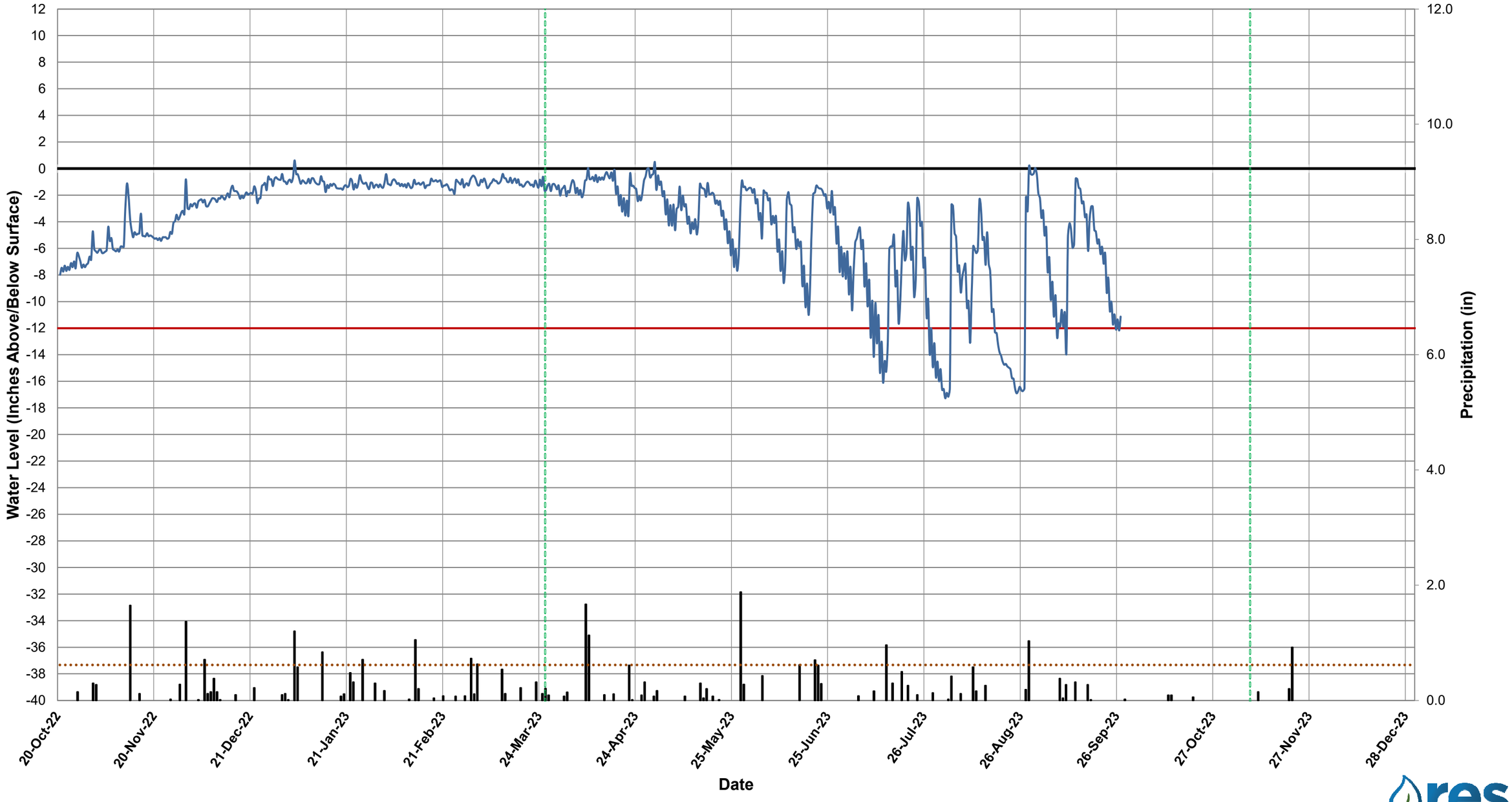
MY3 Apple Valley GW1



227 Consecutive Days of Hydrology
03/26/2023 - 11/08/2023

Daily Precip (in) | GW1 | Growing Season Start | Growing Season End | Logger Depth

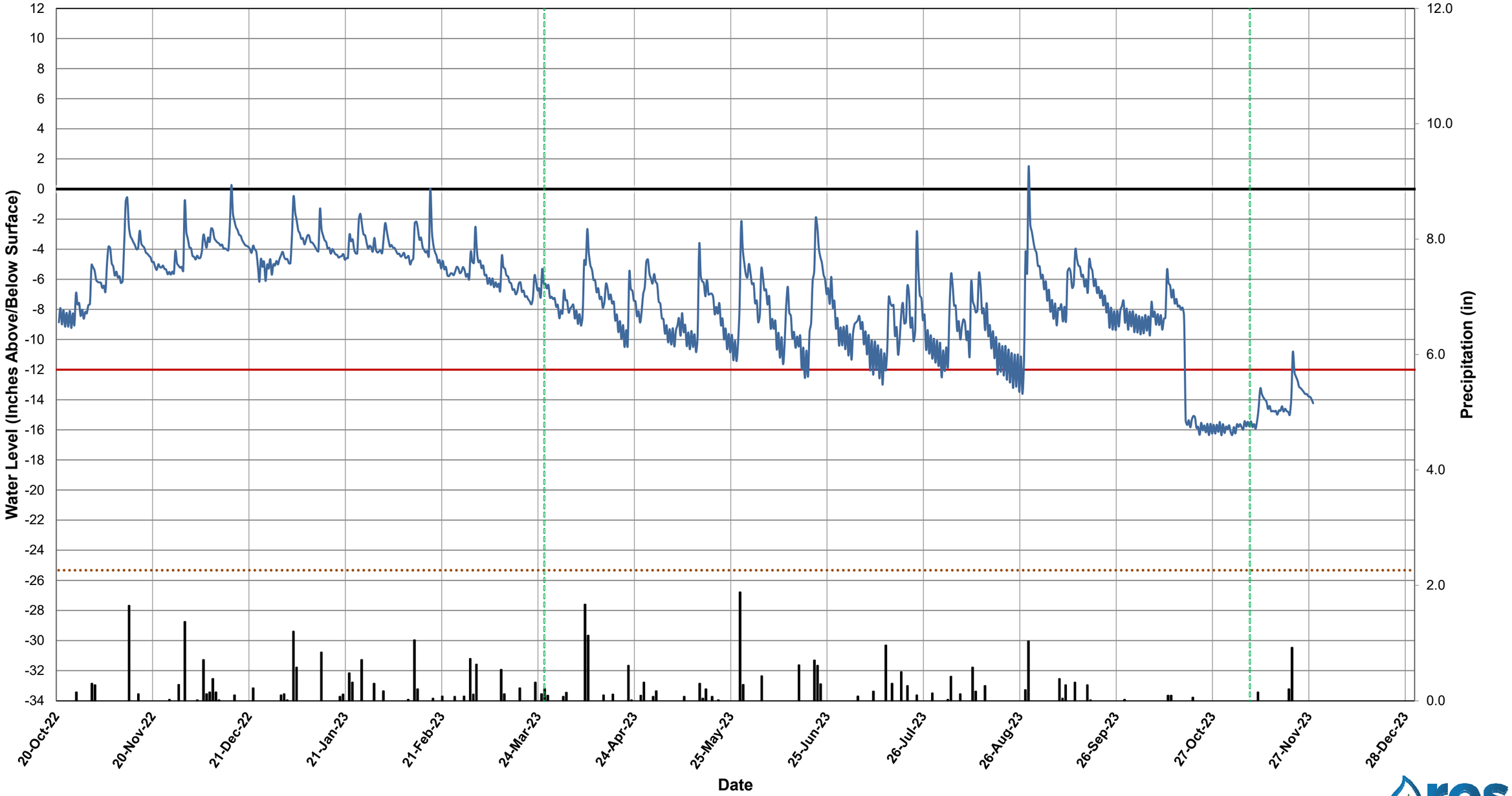
MY3 Apple Valley GW2



107 Consecutive Days of Hydrology
03/26/2023 - 07/11/2023

Daily Precip (in) | GW2 | Growing Season Start | Growing Season End | Logger Depth

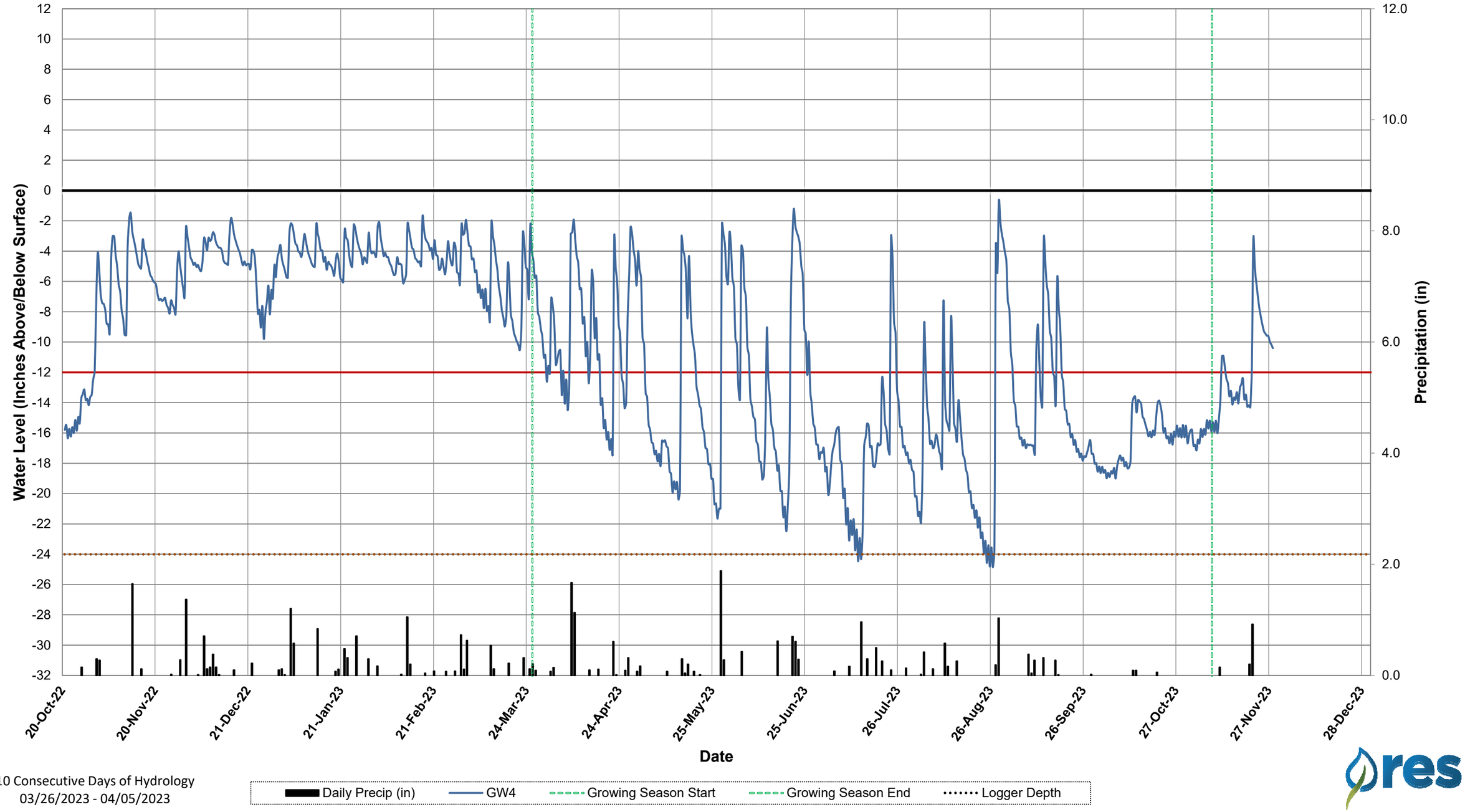
MY3 Apple Valley GW3



206 Consecutive Days of Hydrology
03/26/2023 - 10/17/2023

Daily Precip (in) | GW3 | Growing Season Start | Growing Season End | Logger Depth

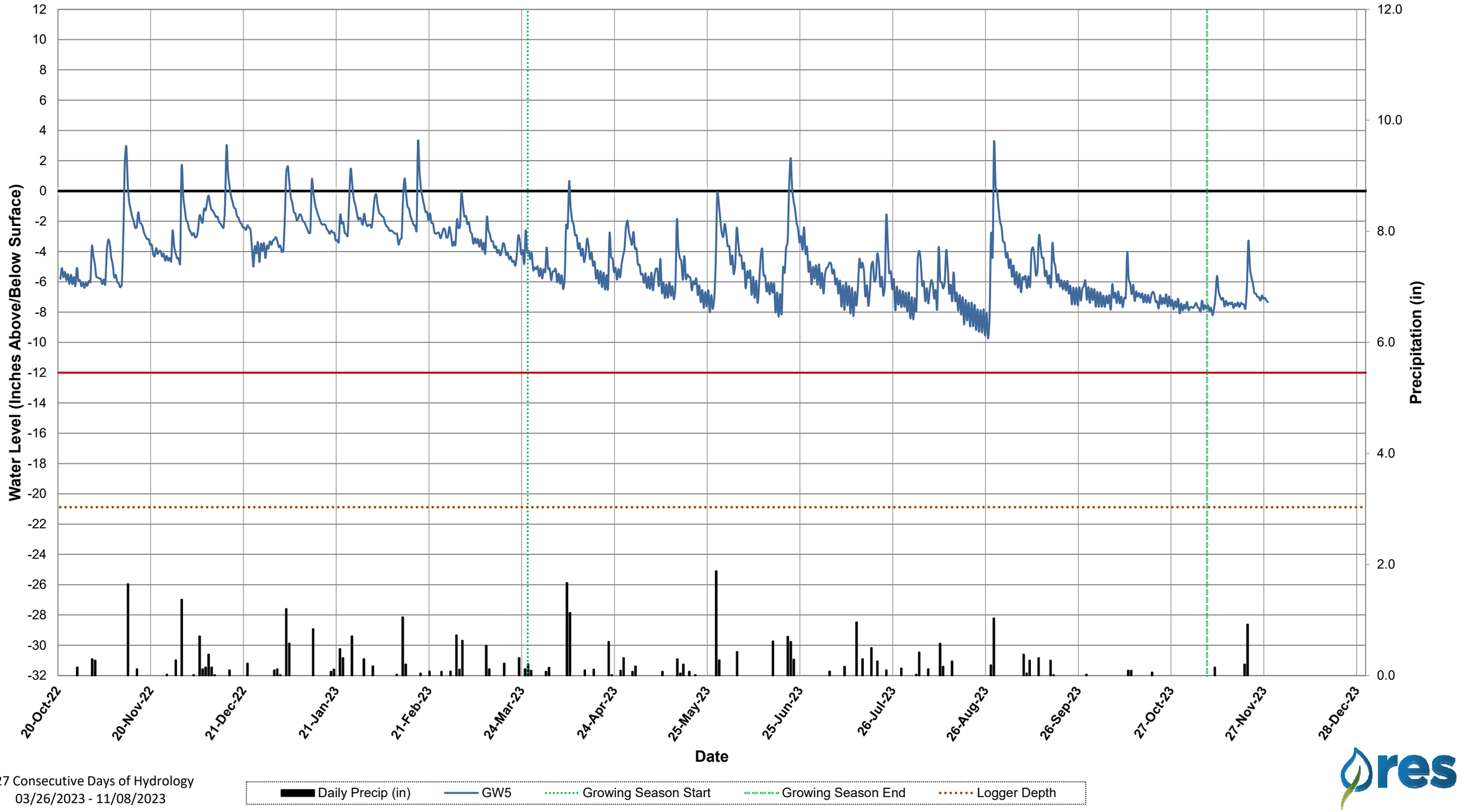
MY3 Apple Valley GW4



10 Consecutive Days of Hydrology
03/26/2023 - 04/05/2023

Daily Precip (in) | GW4 | Growing Season Start | Growing Season End | Logger Depth

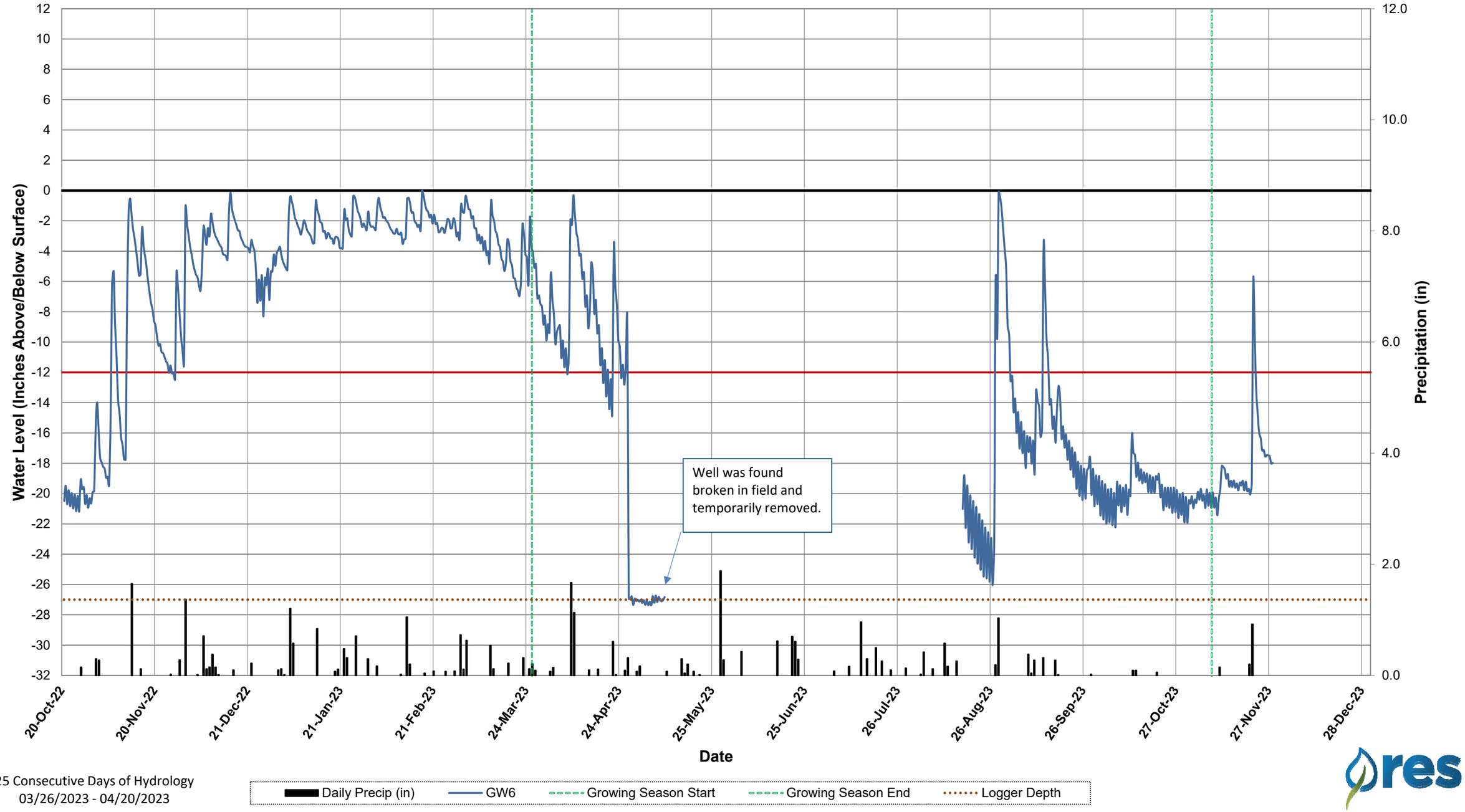
MY3 Apple Valley GW5



227 Consecutive Days of Hydrology
03/26/2023 - 11/08/2023

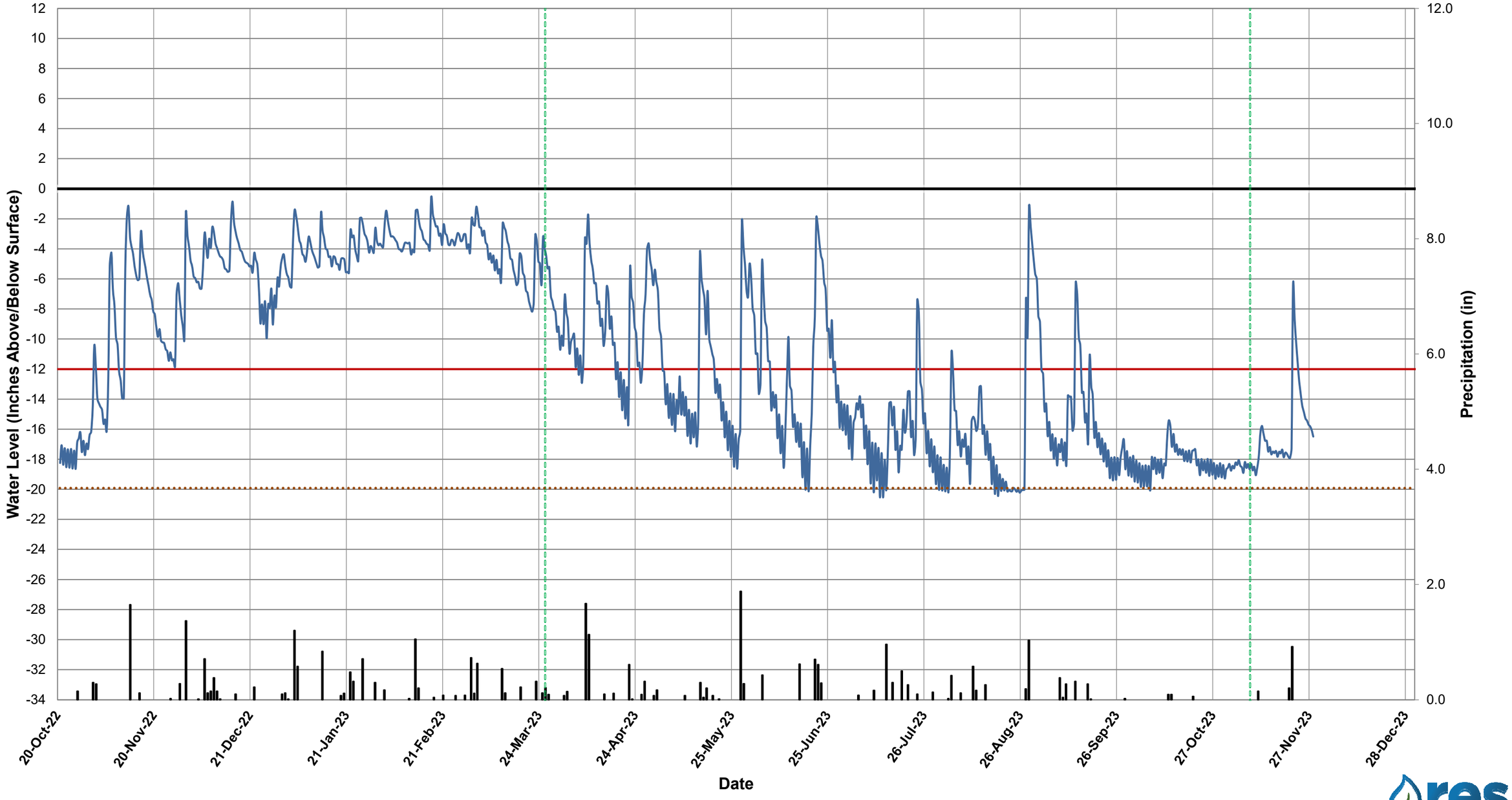
Daily Precip (in) | GW5 | Growing Season Start | Growing Season End | Logger Depth

MY3 Apple Valley GW6



25 Consecutive Days of Hydrology
03/26/2023 - 04/20/2023

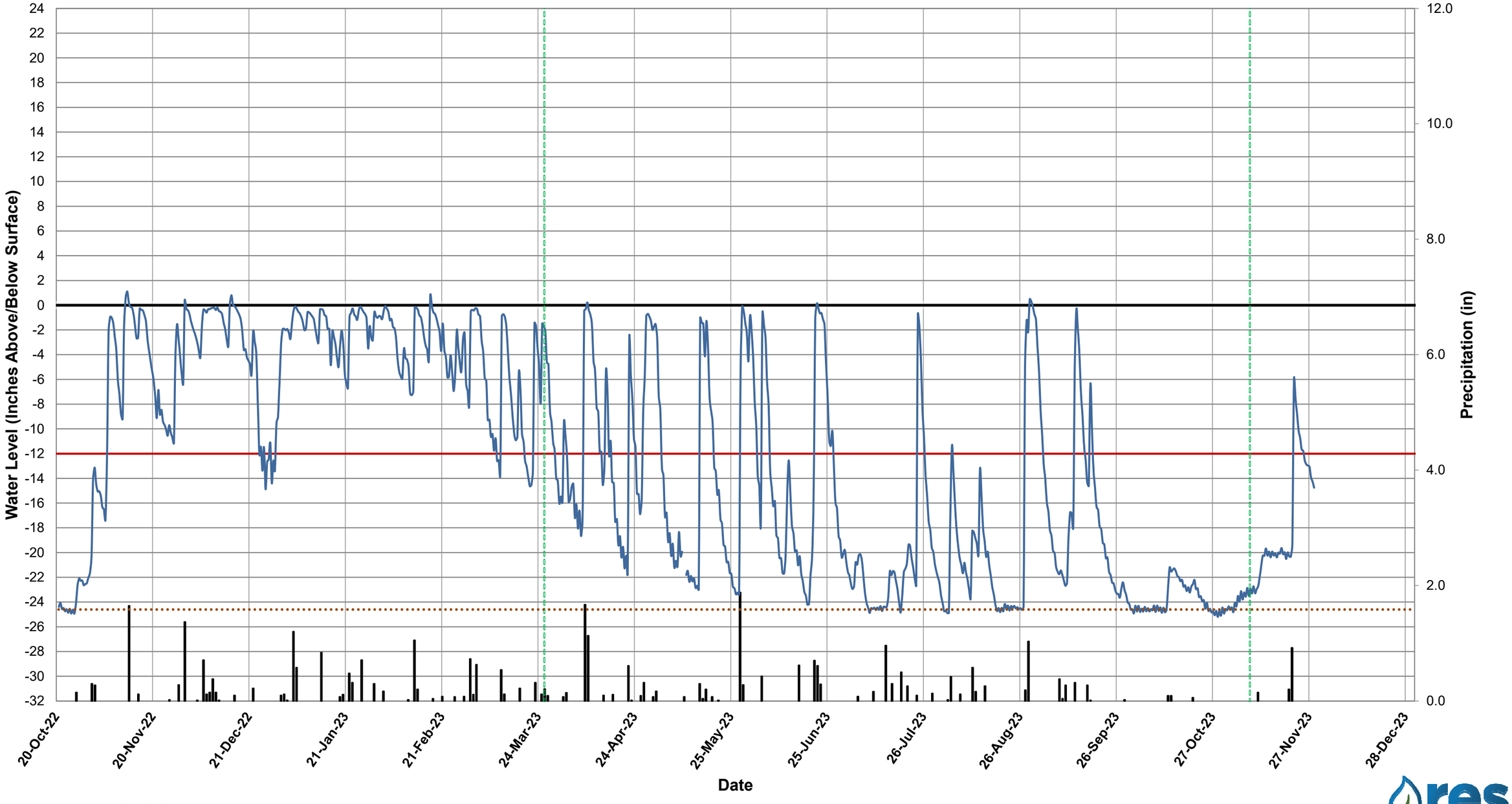
MY3 Apple Valley GW7



23 Consecutive Days of Hydrology
03/26/2023 - 04/18/2023

Daily Precip (in) | GW7 | Growing Season Start | Growing Season End | Logger Depth

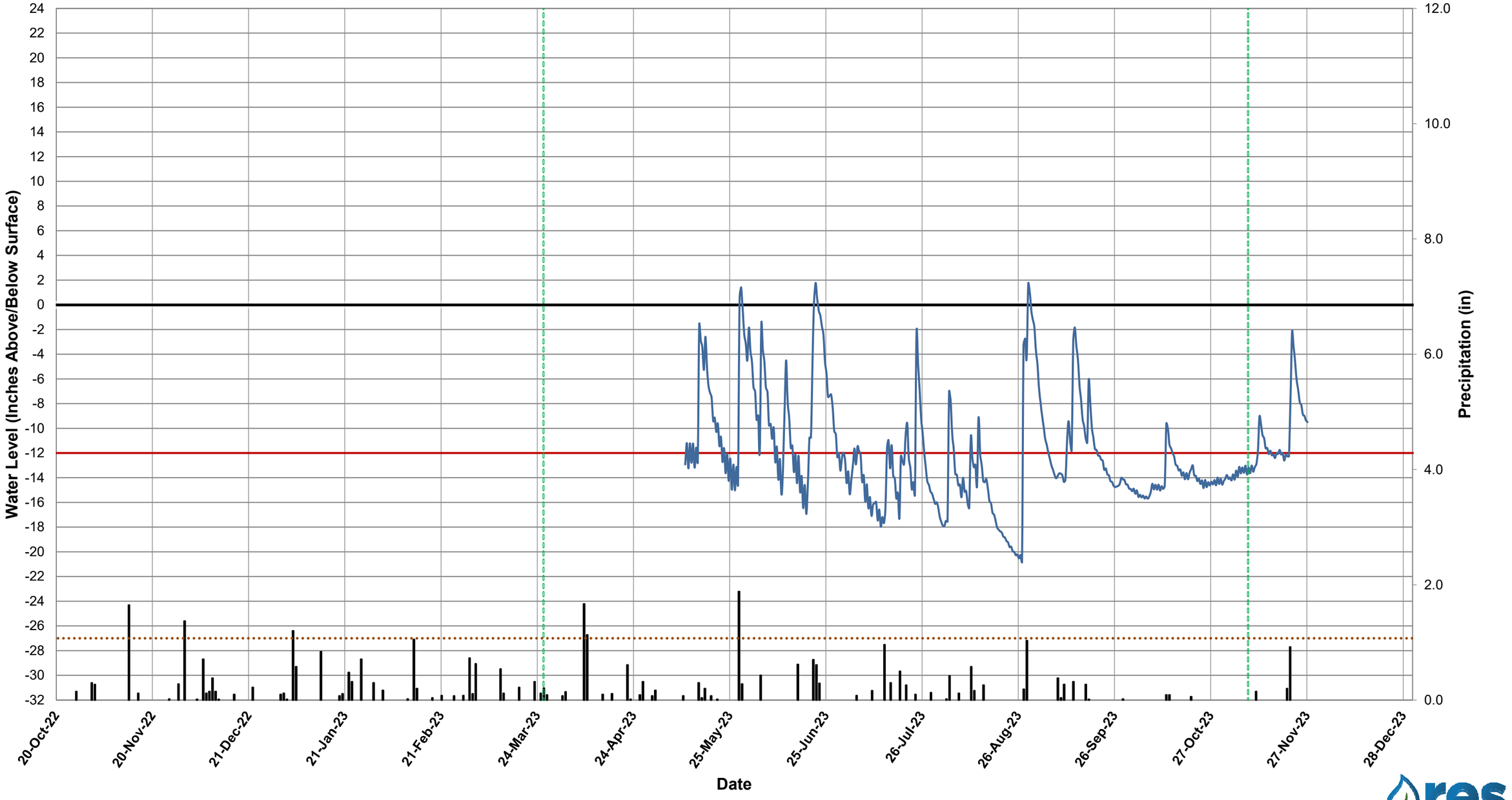
MY3 Apple Valley GW8



6 Consecutive Days of Hydrology
04/07/2023 - 04/13/2023

Daily Precip (in) | GW8 | Growing Season Start | Growing Season End | Logger Depth

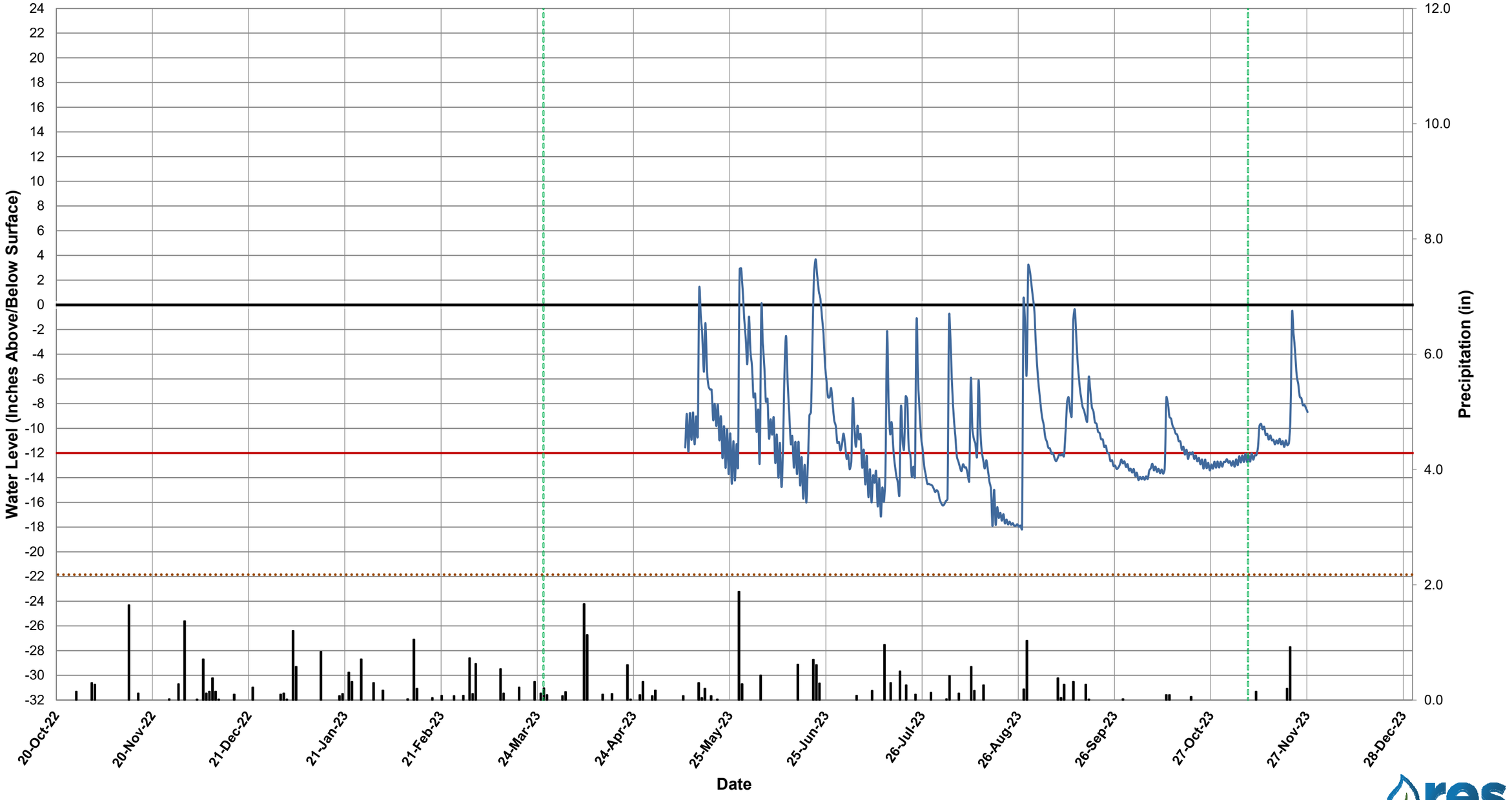
MY3 Apple Valley GW9



12 Consecutive Days of Hydrology
05/28/2023 - 06/09/2023

Daily Precip (in) | GW9 | Growing Season Start | Growing Season End | Logger Depth

MY3 Apple Valley GW10



37 Consecutive Days of Hydrology
05/10/2023 - 06/16/2023

Daily Precip (in) | GW10 | Growing Season Start | Growing Season End | Logger Depth