Year 1 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

January 2022

3600 Glenwood Avenue, Suite 100
Raleigh, NC 27612

Corporate Headquarters
6575 W Loop S #300
Bellaire, TX 77401
Main: 713.520.5400

January 31, 2022

Harry Tsomides
NC DEQ Division of Mitigation Services
5 Ravenscroft Drive, Suite 102
Asheville, NC 28801

RE: Apple Valley Site: Year 1 Monitoring Report

Listed below are comments provided by DMS on January 14, 2022 regarding the Apple Valley Site: Year 1 Monitoring Report and RES' responses.

Thank you for noting the pasture grass throughout the floodplain and in some areas, DMS noticed this and also observed some bare areas (or grassy areas with very few small stems) during a recent site visit. IRT had also commented on fescue during their mitigation plan review; was fescue fully treated throughout the easement during construction? As you note, please continue to monitor these areas, one option may be to protect surviving planted trees through targeted mowing/trimming around each tree collar, in earlier years this may help the smaller planted trees avoid getting outcompeted. Supplemental planting may also help. Areas of concern should be mapped accordingly in future years if there are apparent issues.
Thank you for your comment. Grading and ripping were the primary treatment control for fescue during construction. As stated in the Year 1 monitoring report, RES believes there is high tree survivability throughout the project. If needed in future monitoring years, RES will consider targeted mowing/trimming around the tree collars of shade-compromised stems. Areas where supplemental planting or seeding is needed will be depicted on the Current Conditions figure.

Please add a footnote to Table 1 about the additional buffer credit method.
Done.

Thank you for being proactive about updating the stream gage; yes it is unlikely this site only received one bank full event this past year. What recording frequency are you going to pre-set on the new Hobo?
The recording frequency for the new HOBO will be one reading per hour, per day. A total of 24 readings each day.

DMS observed large patches of rooted herbaceous vegetation in the channel; what species is this? You noted by email this could be Iris spp., however has this been verified and if not what is it? Are you confident this will disappear and/or not affect channel stability/function?
The herbaceous vegetation in the channel may be southern blue flag, *Iris virginica*. Due to the time of year when monitoring took place, characteristics helpful for identification were limited. RES plans to conduct a more thorough investigation of the species, collecting samples for identification, the next time we are on site (most likely when the new HOBO is installed in Spring 2022). Another potential species could include panic grass, *Panicum virgatum,* as it is similar in appearance, has a dense, clumping growth habit, and can tolerate wet-flooding conditions. Either species could be introduced via the adjacent landscapes surrounding the conservation easement, or seed could have established in the channel, flowing in from the

277-acre drainage area. This species will continue to be monitored with the expectation that surrounding trees, both livestaked and planted, will continue to grow along the banks, shading out the in-channel vegetation. Currently, it has not posed any negative affect to channel stability or function. If it is identified as a problematic species, it will be treated accordingly to ensure the stability and function of the channel.

On the GW gage graphs – It would be helpful to show a few more details on the graphs. Please indicate which line is the criteria level. It appears to be a similar line style as the rain levels. Also, it would be helpful to list the date of the growing season on the graph, and during which maximum period the criteria were attained, or that criteria were not attained; and other notes as needed.
The criteria level (Jurisdictional Water Table) has been depicted with a red dashed line and added to the legend for reference. The growing season dates have been added to each groundwater well graph (Mar. 26 – Nov. 8). A bracketed note with the maximum hydroperiod (with an indication of whether or not the criteria was met) has been added to the graphs.

A few signs were noticed where the aluminum nails were bent, and many signs had aluminum nails that are already rusting. Recommend not using aluminum nails in treated wood posts in the future, and consider re-drilling the signs at some point with a more weather proof type of bolt/nail/roofing nail/screw, as there are multiple homes and maintained yards bordering the project.
RES will take these suggestions into consideration in the future. Thank you.

Digital deliverables

Please include a figure in the report displaying the overbank continuous stage recorder data.
A figure displaying data for the overbank continuous stage recorder has been included in **Appendix E**.

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**.**

1.3 Project 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	Four bankfull events occurring in separate years
			Cross sections: Surveyed in Years 1, 2, 3, 5 and 7	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

1.4 Project 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.

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**

1.5 Stream 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.

1.6 Construction 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 1 Monitoring Performance (MY1)

The Apple Valley year 1 monitoring activities were performed in July and December 2021. All year 1 monitoring data is present below and in the appendices. The Project is on track to meeting vegetation, stream, and wetland interim success criteria. Drone imagery was taken on November 17, 2021 and can be found in **Appendix B**.

Vegetation

Setup and monitoring of four fixed vegetation plots and one random vegetation plot were completed in December 2021. Vegetation data is found in **Appendix C**, associated photos and plot locations are in **Appendix B**. MY1 monitoring data indicates that all plots are exceeding the interim success criteria of 320 planted stems per acre. Planted stem densities ranged from 364 to 1,052 planted stems per acre with a mean of 647 planted stems per acre across all plots. Fixed plots ranged from 445 to 1004 stems per acre. The random vegetation plot (RVP1) also met the interim success criteria with 364 planted stems per acre. In MY1, visually spotting the short trees after leaf drop can be difficult (they are not mapped with stakes and flagging as in the fixed plots), which in this case led to an

overall lower stems number. RES observed similar tree density across the site and believes there is similar in the random areas as there are in the fixed plots. No volunteer stems were noted in the plots during Year 1 monitoring. A total of eight species were documented within the plots. The average stem height in the plots was 1.9 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. and *Ludwigia alternifolia* suggesting that wetlands are becoming well established throughout the site. There were a few residual and introduced patches of pasture grass from previous land use as well as surrounding fields scattered throughout the floodplain and in some areas, the channel; however, as the planted trees and livestakes on site continue to mature, they will work to shade out the undesirable vegetation. Very few bare/low stem areas were observed during MY1. The areas that were noticed will continue to be monitored and if needed, supplemental bareroot and livestake planting will occur.

Stream Geomorphology

Cross section and geomorphology data collection for MY1 was conducted on July 28, 2021. Summary tables and cross section plots are in **Appendix D**. Overall, the Year 1 cross sections and profile relatively match the proposed design. The cross section plot overlays (**Appendix D**) displaying both as-built and MY1 conditions, show little to no deviation from one another in both channel and floodplain profile. The Year 1 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.

Stream Hydrology

One stage recorder was installed on January 20, 2021 along AV1. It is in place to document bankfull events throughout each monitoring year. The stage recorder on AV1 recorded one bankfull event on March 25, 2021, reading a maximum bankfull height of 0.032 feet above the top of bank. Upon data download, it was discovered that the stage recorder had only been reading twice per day. RES believes that there were more bankfull events during MY0 and MY1; however, due to the malfunction of the gauge, it likely missed certain readings. A new HOBO will be launched correctly, reading once per hour, 24 hours per day, to replace the current one in winter 2022. The gauge location can be found on **Figure 2**, photos are in **Appendix B**, and Stream Overbank Hydrograph in **Appendix E**.

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. Groundwater Well 1 remains where originally installed and Groundwater Well 2 was moved during baseline monitoring as proposed. Groundwater Well 3 and the ambient pressure gauge were destroyed during construction and reinstalled during baseline monitoring. Due to the loss of the ambient pressure gauge, there is no pre-construction well data available before January 2021. MY1 data showed hydroperiods ranged from six to 100 percent and that six of the eight groundwater wells met the minimum 12 percent hydroperiod success criteria. Two of the groundwater wells (GW4 and GW8) had a hydroperiod of six percent. Minor complications during the installation of GW4 could explain its lower hydroperiod. During as-built, in January 2021, the ground was very compact at the top of the Project (the current location of GW4), creating difficult conditions to dig a hole deep enough for the well. This could have led to issues with the settling and function of the pressure transducer if

the well was not dug deep enough. However, photo documentation of GW4 does not suggest that the well was installed improperly; in fact, the photo of GW4 shows the well surrounded with wetland vegetation (*Juncus* sp.) (**Appendix B**). GW8 at the bottom of the Project, also fell short of the success criteria. This failure could be attributed to its proximity to a ditch, south of the easement, running parallel to the road, possibly diverting water from the wetland. However, photo documentation of this well also shows it surrounded by wetland vegetation (*Juncus* sp. and *Ludwigia alternifolia*) (**Appendix B**). RES expects the hydroperiods to increase in subsequent years as the wetlands continue to establish and the surrounding vegetation matures. 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: **1yr 3mo**
Elapsed Time Since planting complete: **1yr**
Number of reporting Years[1]: **1**

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
Year 2 Monitoring		
Year 3 Monitoring		
Year 4 Monitoring		
Year 5 Monitoring		
Year 6 Monitoring		
Year 7 Monitoring		

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

Table 3. Project Contacts Table 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	Emily Ulman (910) 274-8231

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

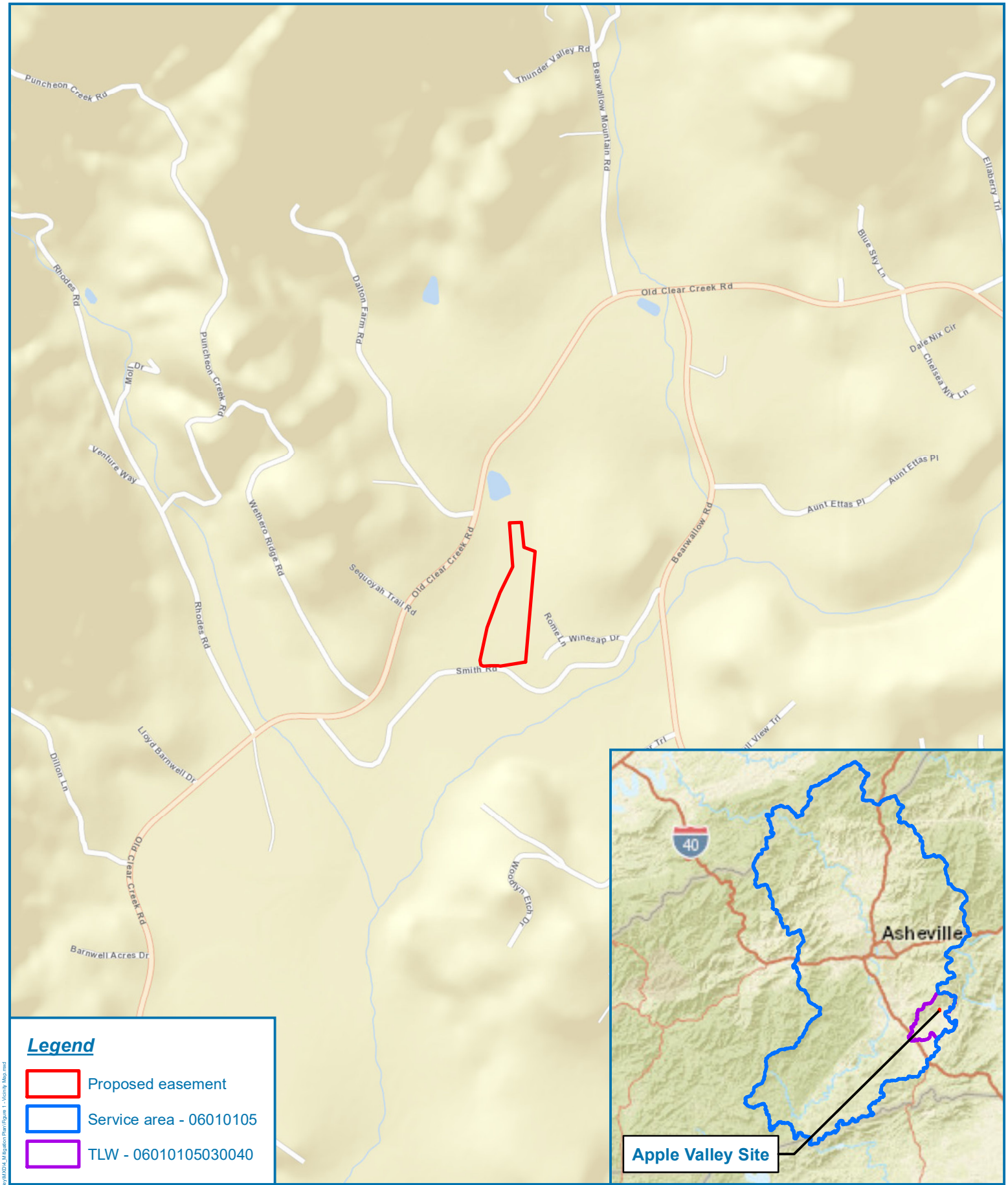


Figure 1 - Site Location Map

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

res

N E S W

0 50 100
Feet

Figure 2

Current Conditions
Plan View

MY1 2021

Apple Valley
Mitigation Site

Henderson County, NC

Date: 12/9/2021	Drawn by: EJU
Lat: 35.416453	Long: -82.364224

LEGEND

- Conservation Easement
- Vegetation Plot
- Random Vegetation Plot

Wetland Mitigation

- Re-establishment
- Enhancement
- Top of Bank
- Filled Old Channel

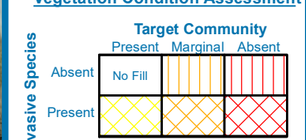
Stream Mitigation

- Restoration
- No Credit
- Structure
- Cross Section
- Filled Ditch/Swale

Well Hydroperiod

- >12%
- 5-12%
- Rain Gauge/Ambient
- Stage Recorder

Vegetation Condition Assessment



Visual Stream Stability Assessment

Assessment Date: 12/07/2021

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: 12/07/2021

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 MY1 Fixed Vegetation Monitoring Plot Photos

Vegetation Plot 1 (12/7/2021)

Vegetation Plot 2 (12/7/2021)

Vegetation Plot 3 (12/7/2021)

Vegetation Plot 4 (12/7/2021)

Apple Valley MY1 Random Vegetation Monitoring Plot Photo

Random Vegetation Plot 1 (12/7/2021)

Apple Valley Monitoring Device Photos

Stage Recorder AV1

Apple Valley MY1 Drone Footage (November 17, 2021)

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	647	0	647	Yes	1.8
2	445	0	445	Yes	1.6
3	728	0	728	Yes	2.0
4	1052	0	1052	Yes	1.9
R1	364	0	364	Yes	2.8
Project Avg	**647**	0	**647**	**Yes**	**1.9**

Table 9. Stem Count Total and Planted by Plot Species

Apple Valley			Current Plot Data (MY1 2021)														Annual Means					
			100063-01-0001			100063-01-0002			100063-01-0003			100063-01-0004			100063-01-R1			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
Betula nigra	river birch	Tree							5	5	5				5	5	5	10	10	10	22	22	22
Celtis laevigata	sugarberry	Tree										2	2	2				2	2	2	10	10	10
Cephalanthus occidentalis	common buttonbush	Shrub				6	6	6	3	3	3							9	9	9	18	18	18
Diospyros virginiana	common persimmon	Tree	2	2	`							5	5	5				7	7	7	6	6	6
Fraxinus pennsylvanica	green ash	Tree							1	1	1							1	1	1			
Liriodendron tulipifera	tuliptree	Tree																			2	2	2
Platanus occidentalis	American sycamore	Tree				4	4	4	9	9	9	1	1	1	4	4	4	18	18	18	31	31	31
Quercus montana	chestnut oak	Tree	5	5	5							6	6	6				11	11	11	12	12	12
Quercus rubra	northern red oak	Tree	9	9	9	1	1	1				12	12	12				22	22	22	23	23	23
		Stem count	16	16	14	11	11	11	18	18	18	26	26	26	9	9	9	80	80	80	124	124	124
		size (ares)	1			1			1			1			1			5			5		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.12			0.12		
		Species count	3	3	2	3	3	3	4	4	4	5	5	5	2	2	2	8	8	8	8	8	8
		Stems per ACRE	647	647	567	445	445	445	728	728	728	1052	1052	1052	364	364	364	647	647	647	1004	1004	1004

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						2187.9	2188.1						2182.9	2182.9						2182.5	2182.6						2179.0	2179.0					
Bankfull Width (ft)[1]	11.0	10.2						NA	-	-	-	-	-	-	10.7	10.9						NA	-	-	-	-	-	-	8.3	11.1					
Floodprone Width (ft)[1]	40.0	>42.8						NA	-	-	-	-	-	-	>49.7	>49.8						NA	-	-	-	-	-	-	>49.9	>50.1					
Bankfull Max Depth (ft)[2]	1.5	1.5						2.1	1.2						1.1	1.2						2.1	2.1						1.3	1.2					
Low Bank Elevation (ft)	2188.28	2188.3						2187.9	2188.0						2182.9	2182.9						2182.5	2182.5						2179.0	2178.9					
Bankfull Cross Sectional Area (ft^2)[2]	10.7	9.1						14.4	13.4						7.1	7.3						12.5	11.4						8.3	7.3					
Bankfull Entrenchment Ratio[1]	>3.6	>4.2						NA	-	-	-	-	-	-	>4.6	>4.6						NA	-	-	-	-	-	-	>4.2	>4.5					
Bankfull Bank Height Ratio[1]	1.0	0.9						NA	-	-	-	-	-	-	1.0	1.0						NA	-	-	-	-	-	-	1.0	0.9					

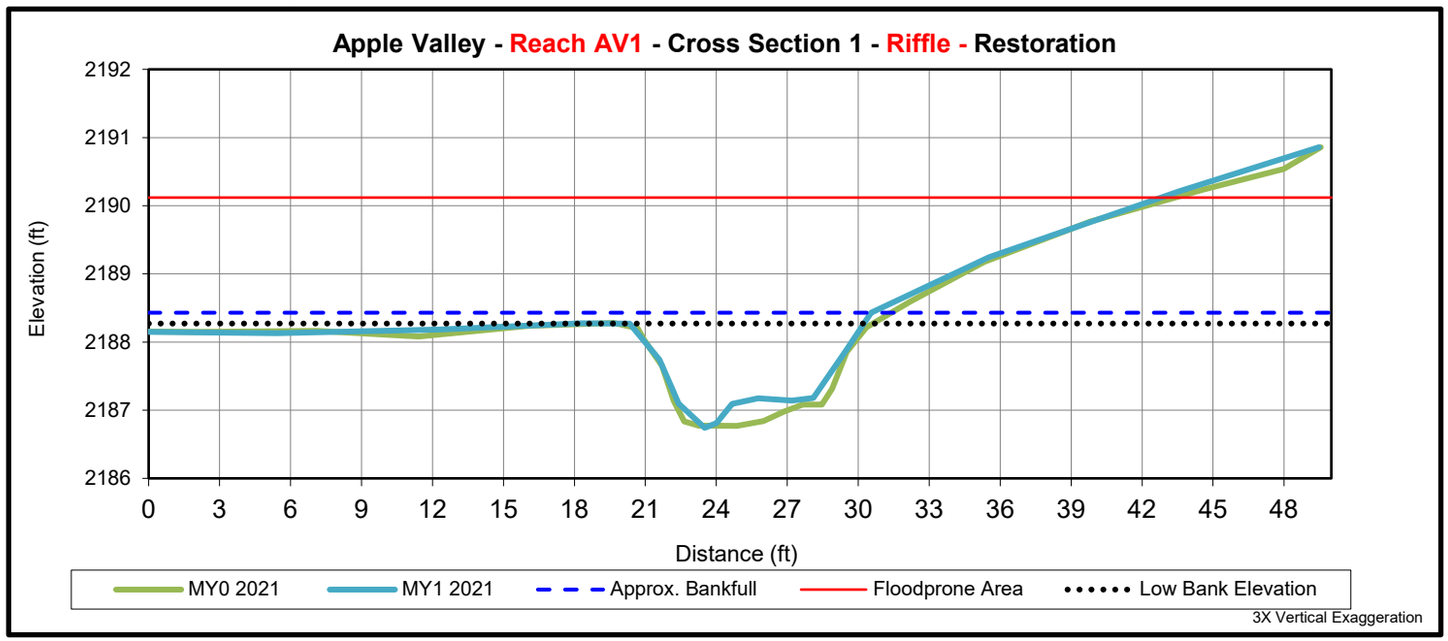
	Cross Section 6 (Pool)							Cross Section 7 (Riffle)							Cross Section 8 (Pool)						
	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	2178.8	2178.7						2176.1	2176.1						2175.7	2175.9					
Bankfull Width (ft)[1]	NA	-	-	-	-	-	-	12.4	10.9						NA	-	-	-	-	-	-
Floodprone Width (ft)[1]	NA	-	-	-	-	-	-	>49.6	>49.8						NA	-	-	-	-	-	-
Bankfull Max Depth (ft)[2]	2.1	2.5						1.5	1.5						2.3	2.2					
Low Bank Elevation (ft)	2178.8	2178.8						2176.1	2176.1						2175.7	2175.7					
Bankfull Cross Sectional Area (ft^2)[2]	12.6	13.7						9.6	9.1						12.3	10.4					
Bankfull Entrenchment Ratio[1]	NA	-	-	-	-	-	-	>4.0	>4.6						NA	-	-	-	-	-	-
Bankfull Bank Height Ratio[1]	NA	-	-	-	-	-	-	1.0	1.0						NA	-	-	-	-	-	-

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

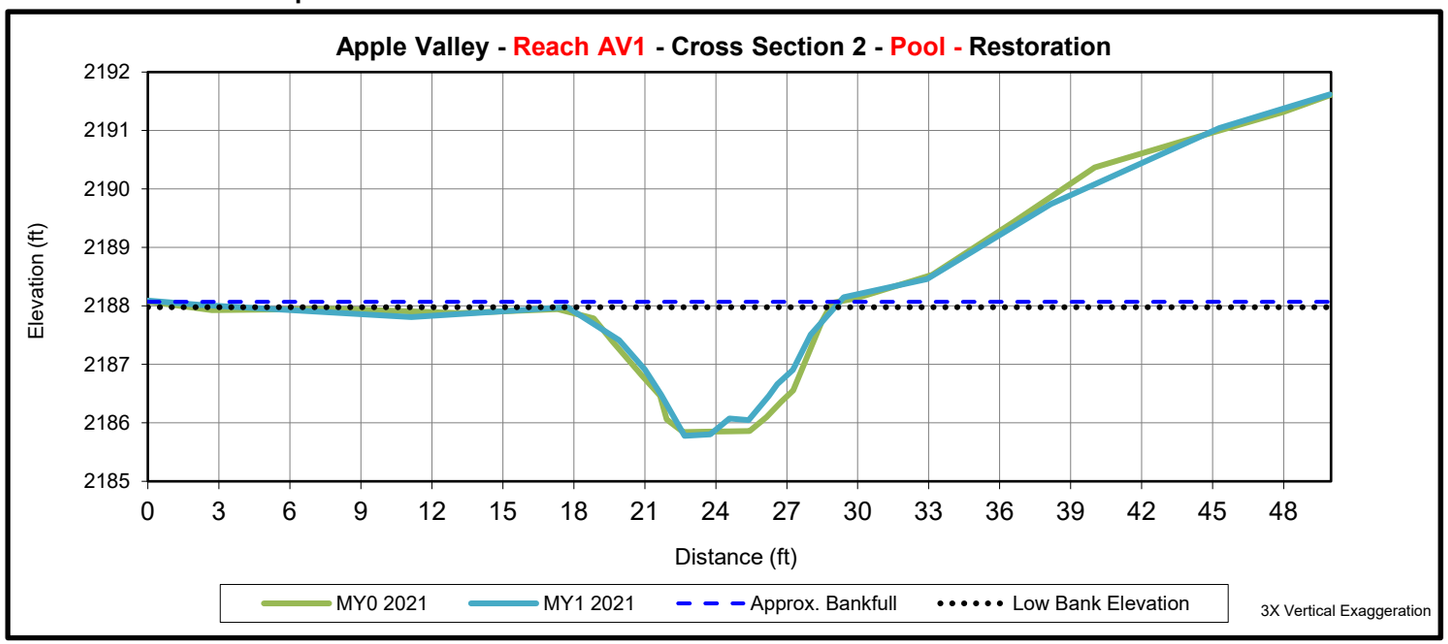


	Cross Section 1 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	2188.28	2188.4					
Bankfull Width (ft)[1]	11.0	10.2					
Floodprone Width (ft)[1]	40.0	>42.8					
Bankfull Max Depth (ft)[2]	1.5	1.5					
Low Bank Elevation (ft)	2188.28	2188.3					
Bankfull Cross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

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

Upstream

Downstream

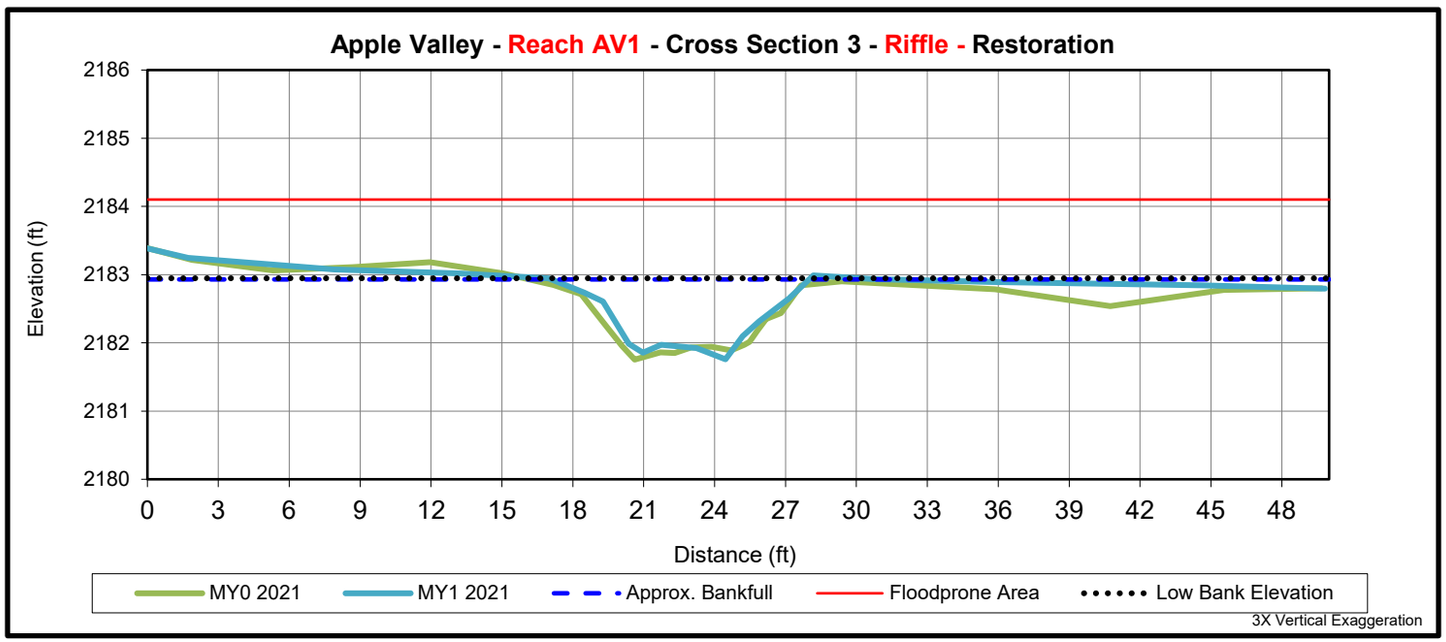


	Cross Section 2 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	2187.95	2188.1					
Bankfull Width (ft)[1]	NA	N/A					
Floodprone Width (ft)[1]	NA	N/A					
Bankfull Max Depth (ft)[2]	2.1	1.2					
Low Bank Elevation (ft)	2187.95	2188.0					
Bankfull Cross Sectional Area (ft^2)[2]	14.4	13.4					
Bankfull Entrenchment Ratio[1]	NA	N/A					
Bankfull Bank Height Ratio[1]	NA	N/A					

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

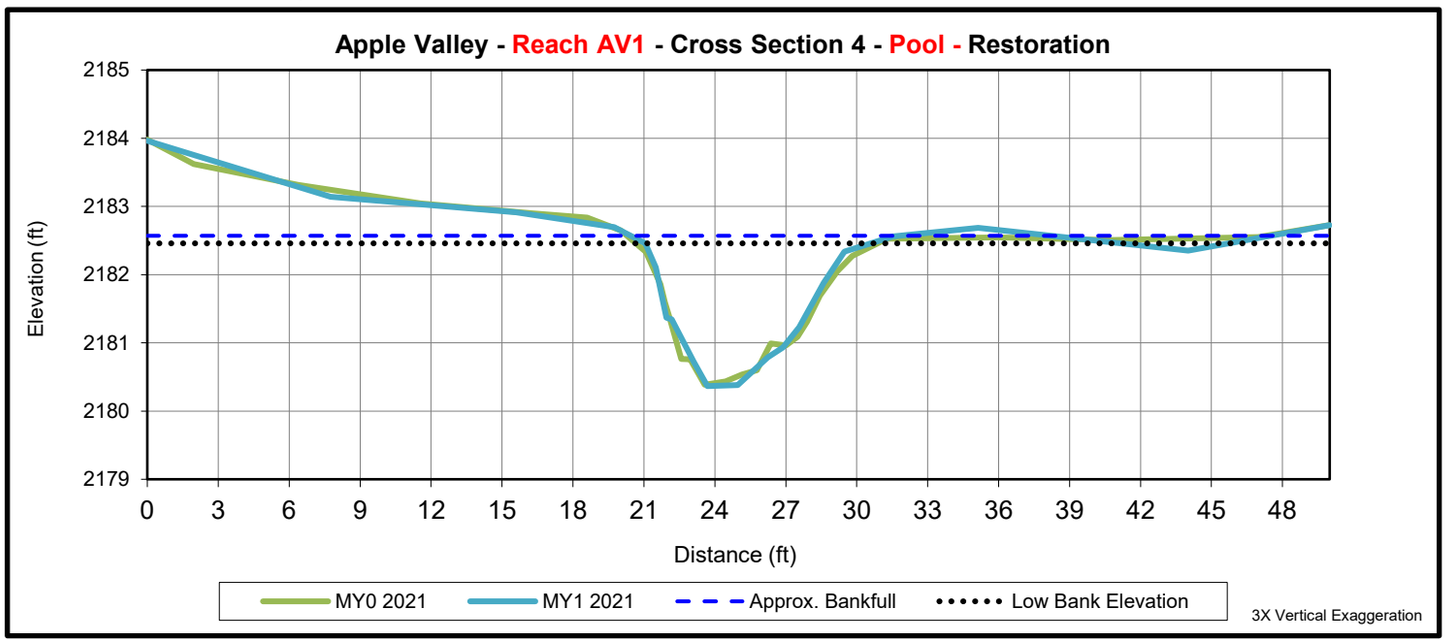


	Cross Section 3 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	2182.85	2182.9					
Bankfull Width (ft)[1]	10.7	10.9					
Floodprone Width (ft)[1]	>49.7	>49.8					
Bankfull Max Depth (ft)[2]	1.1	1.2					
Low Bank Elevation (ft)	2182.85	2182.9					
Bankfull Cross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

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

Upstream

Downstream

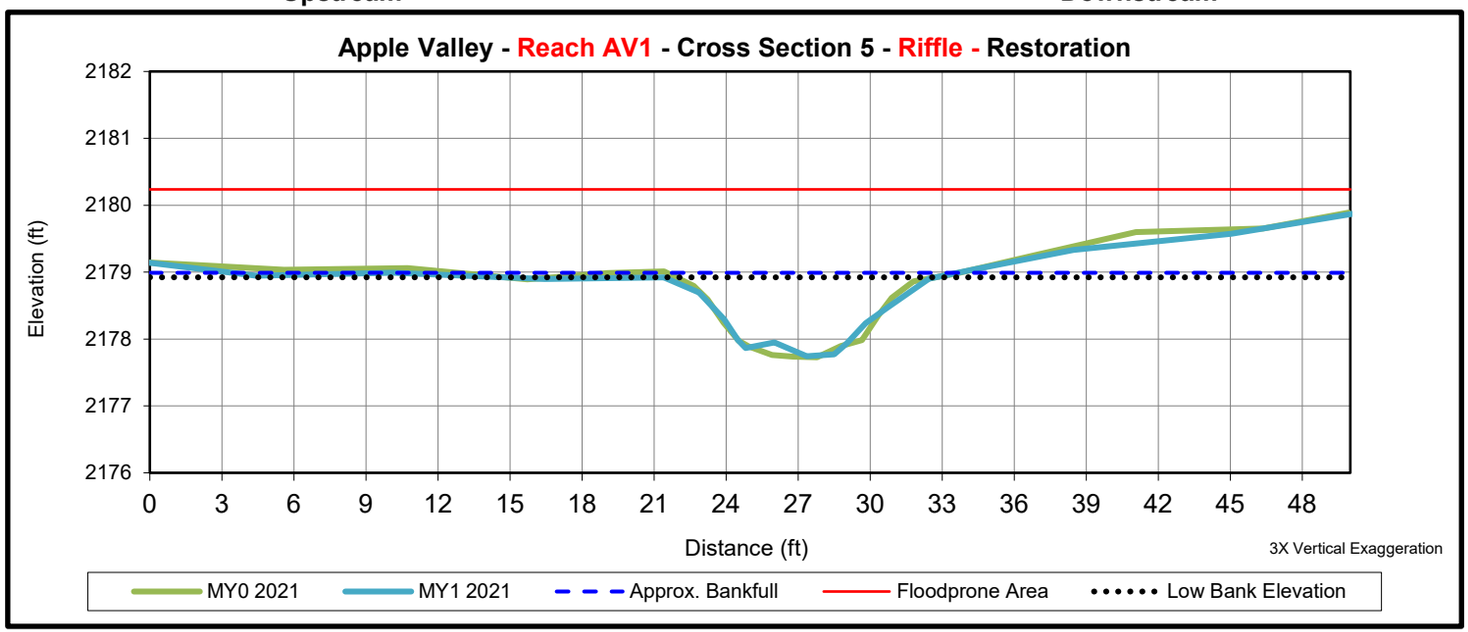


	Cross Section 4 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	2182.53	2182.6					
Bankfull Width (ft)[1]	NA	N/A					
Floodprone Width (ft)[1]	NA	N/A					
Bankfull Max Depth (ft)[2]	2.1	2.1					
Low Bank Elevation (ft)	2182.53	2182.5					
Bankfull Cross Sectional Area (ft^2)[2]	12.5	11.4					
Bankfull Entrenchment Ratio[1]	NA	N/A					
Bankfull Bank Height Ratio[1]	NA	N/A					

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

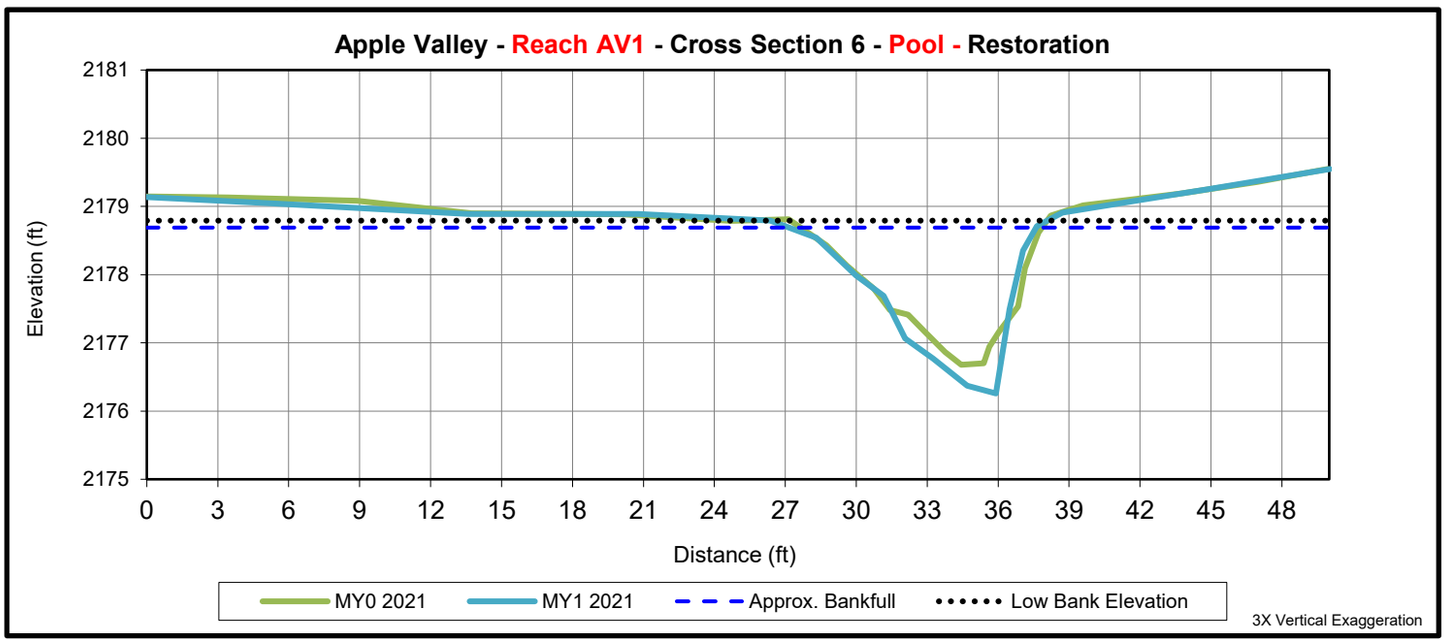


	Cross Section 5 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	2178.98	2179.0					
Bankfull Width (ft)[1]	8.3	11.1					
Floodprone Width (ft)[1]	>49.9	>50.1					
Bankfull Max Depth (ft)[2]	1.3	1.2					
Low Bank Elevation (ft)	2178.98	2178.9					
Bankfull Cross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

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

Upstream

Downstream

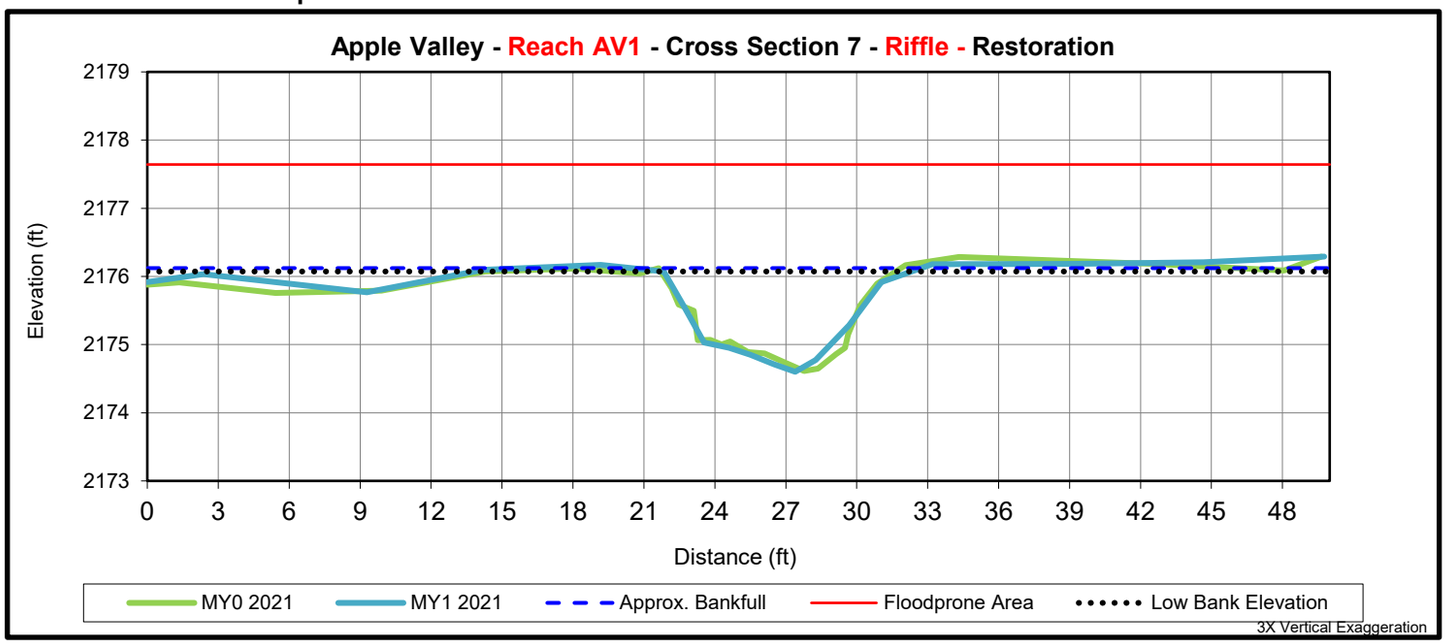


	Cross Section 6 (Pool)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	2178.81	2178.7					
Bankfull Width (ft)[1]	NA	N/A					
Floodprone Width (ft)[1]	NA	N/A					
Bankfull Max Depth (ft)[2]	2.1	2.5					
Low Bank Elevation (ft)	2178.81	2178.8					
Bankfull Cross Sectional Area (ft^2)[2]	12.6	13.7					
Bankfull Entrenchment Ratio[1]	NA	N/A					
Bankfull Bank Height Ratio[1]	NA	N/A					

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

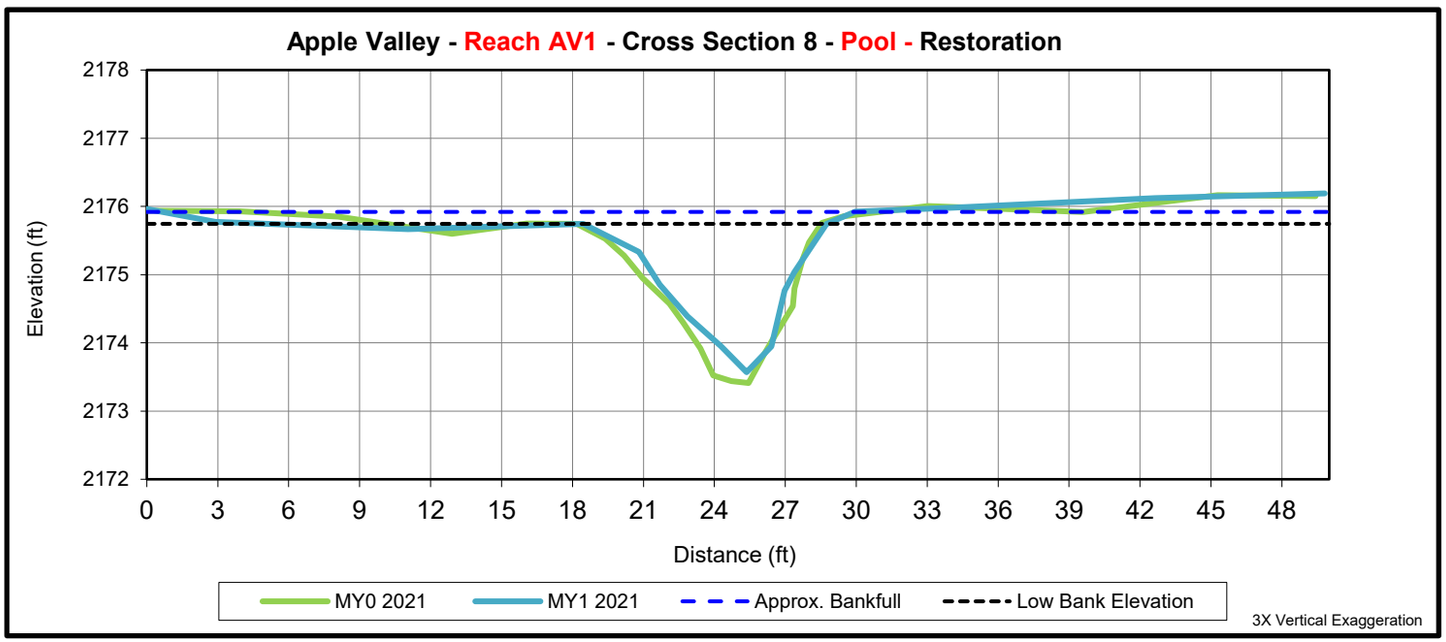


	Cross Section 7 (Riffle)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-XSA[1]	2176.12	2176.1					
Bankfull Width (ft)[1]	12.4	10.9					
Floodprone Width (ft)[1]	>49.6	>49.8					
Bankfull Max Depth (ft)[2]	1.5	1.5					
Low Bank Elevation (ft)	2176.12	2176.1					
Bankfull Cross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

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

Upstream

Downstream



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

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 MY1 2021

Month	Average	Normal Limits		On-Site Precipitation*	Fletcher Precipitation†
		30 Percent	70 Percent		
January	5.28	3.38	6.14	1.42	3.03
February	4.26	2.88	5.26	4.20	4.45
March	4.95	3.32	5.77	9.15	9.29
April	4.84	3.46	5.79	2.28	1.82
May	4.40	2.71	5.34	3.19	3.37
June	4.95	3.22	6.00	5.30	5.85
July	5.79	3.52	6.94	4.36	5.38
August	5.73	3.69	6.71	7.83	10.95
September	4.97	2.67	5.99	1.64	2.92
October	4.06	1.84	4.94	5.89	5.64
November	4.55	3.05	5.47	---	0.88
December	5.27	3.84	6.25	---	---
Total	59.05	37.58	70.60	45.26	53.58
Above Normal Limits	Below Normal Limits	Within Normal Limits			

*The on-site rain gauge malfunctioned in November and December

†The Ashevile Faa AP Fletcher gauge is located about 10 miles northwest of the site

Table 13. Documentation of Geomorphically Significant Flow Events

Year	Number of Bankfull Events	Maximum Bankfull Height (ft)	Date of Maximum Bankfull Event
Stage Recorder AV1			
MY1 2021	1	0.032	3/25/2021

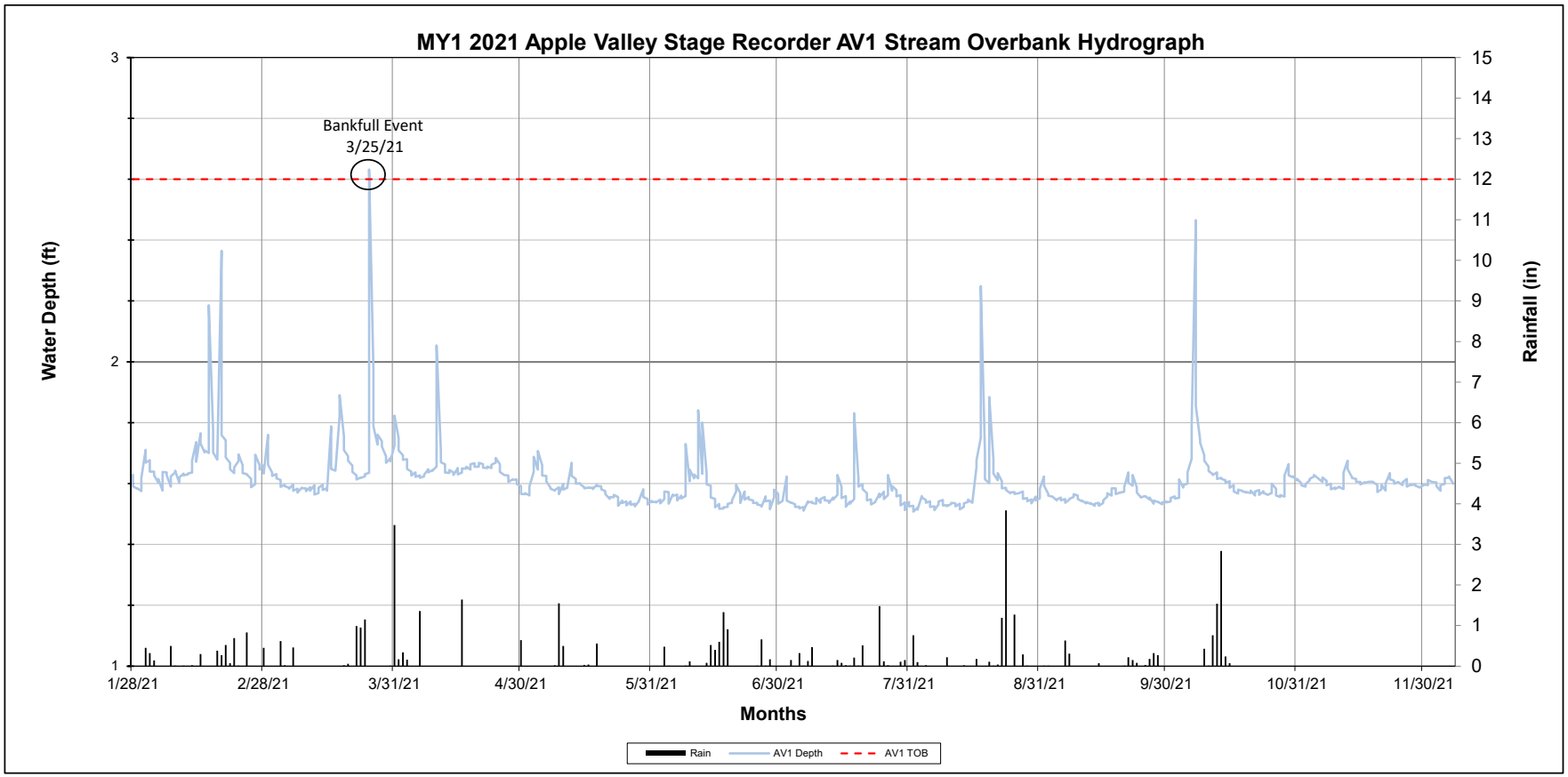
Table 14. 2021 Max Hydroperiod

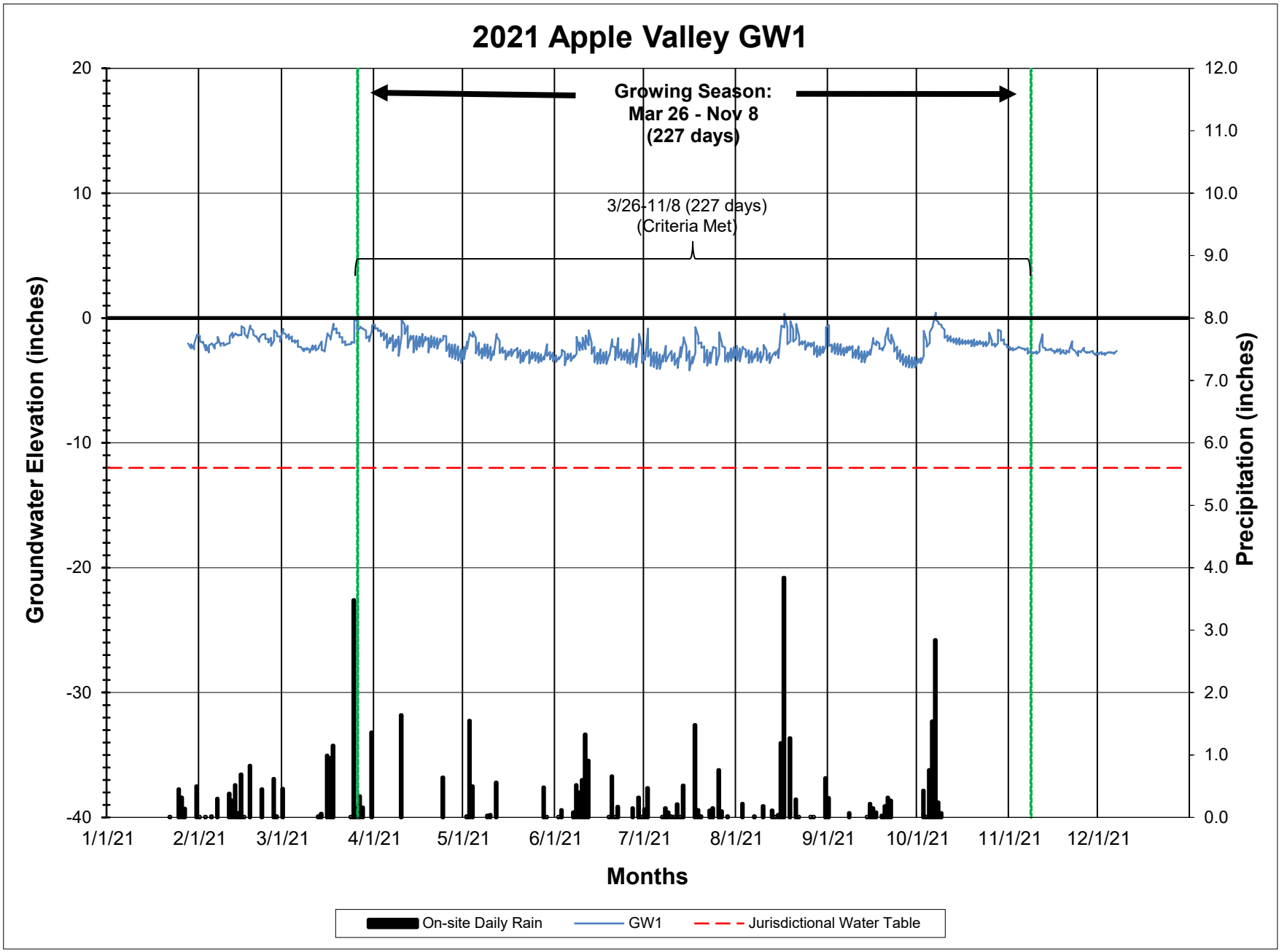
2021 Max Hydroperiod (Growing Season 26-Mar through 8-Nov, 227 days)					
Well ID	Consecutive		Cumulative		Occurrences
	Days	Hydroperiod (%)	Days	Hydroperiod (%)	
GW1	227	100	227	100	1
GW2	61	27	182	80	12
GW3	227	100	227	100	1
GW4	13	6	104	46	15
GW5	227	100	227	100	1
GW6	102	45	197	87	7
GW7	61	27	144	63	15
GW8	13	6	57	25	14

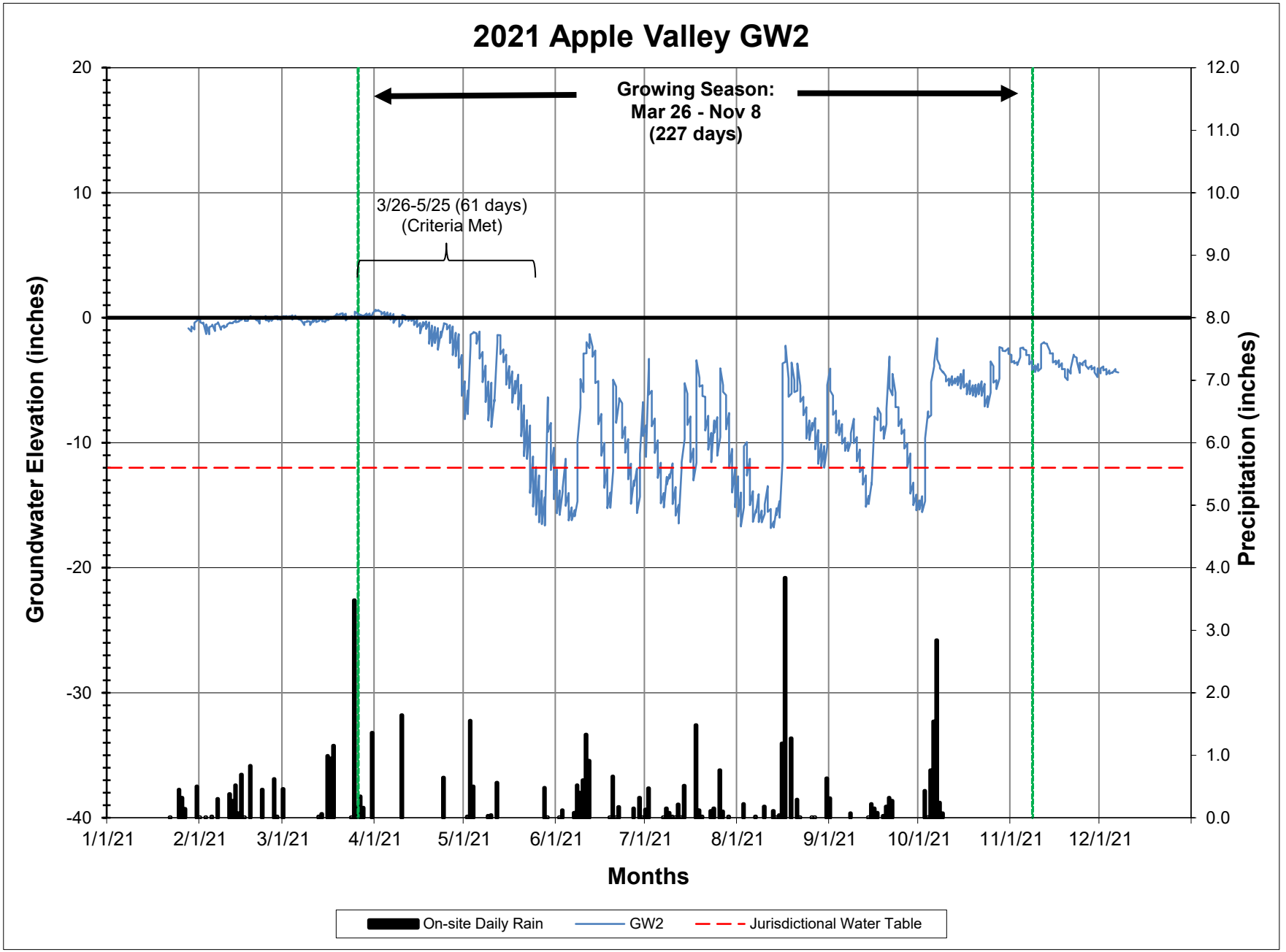
<5%	5-12%	>12%

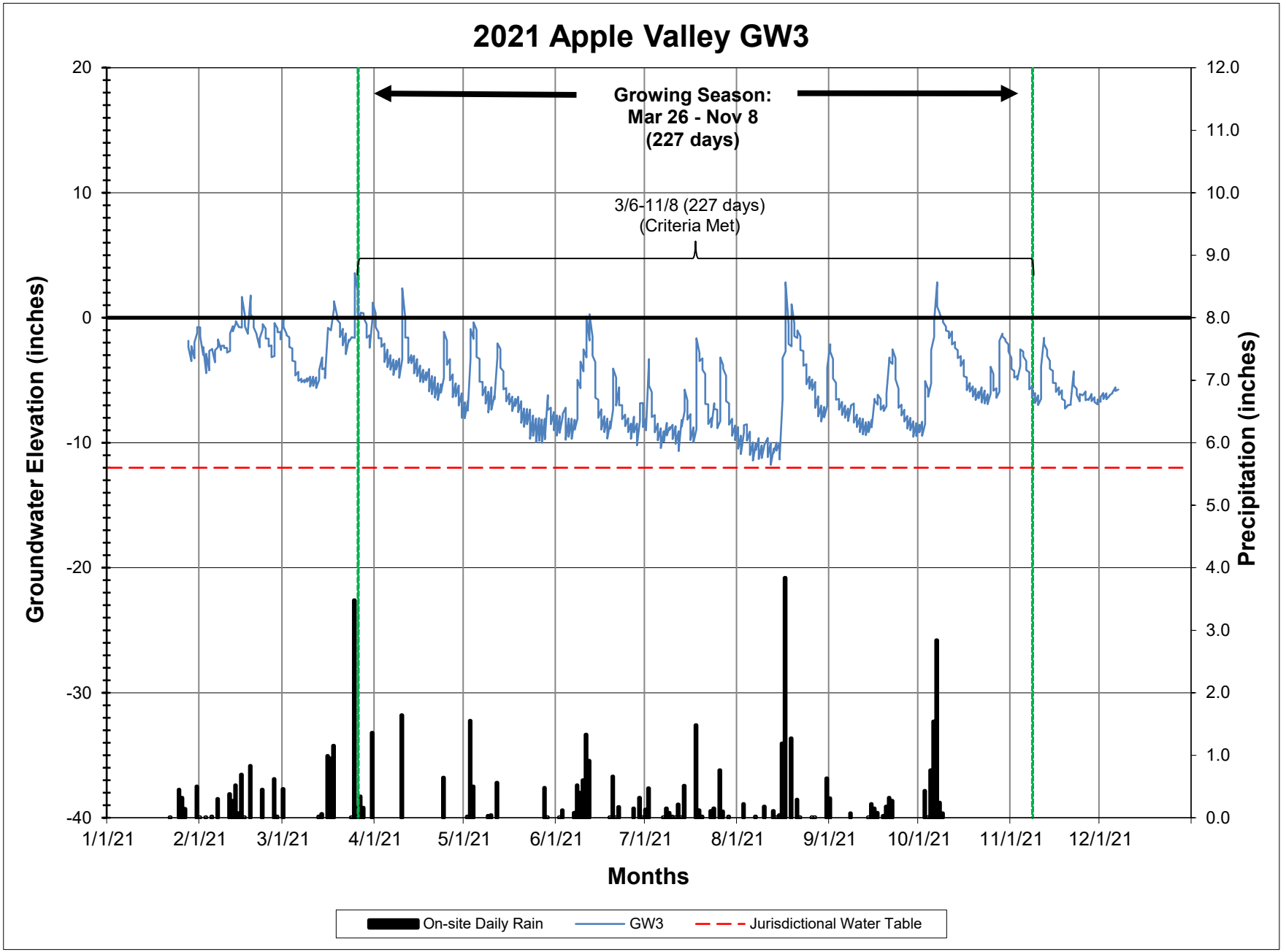
Table 15. Summary of Groundwater Monitoring Results

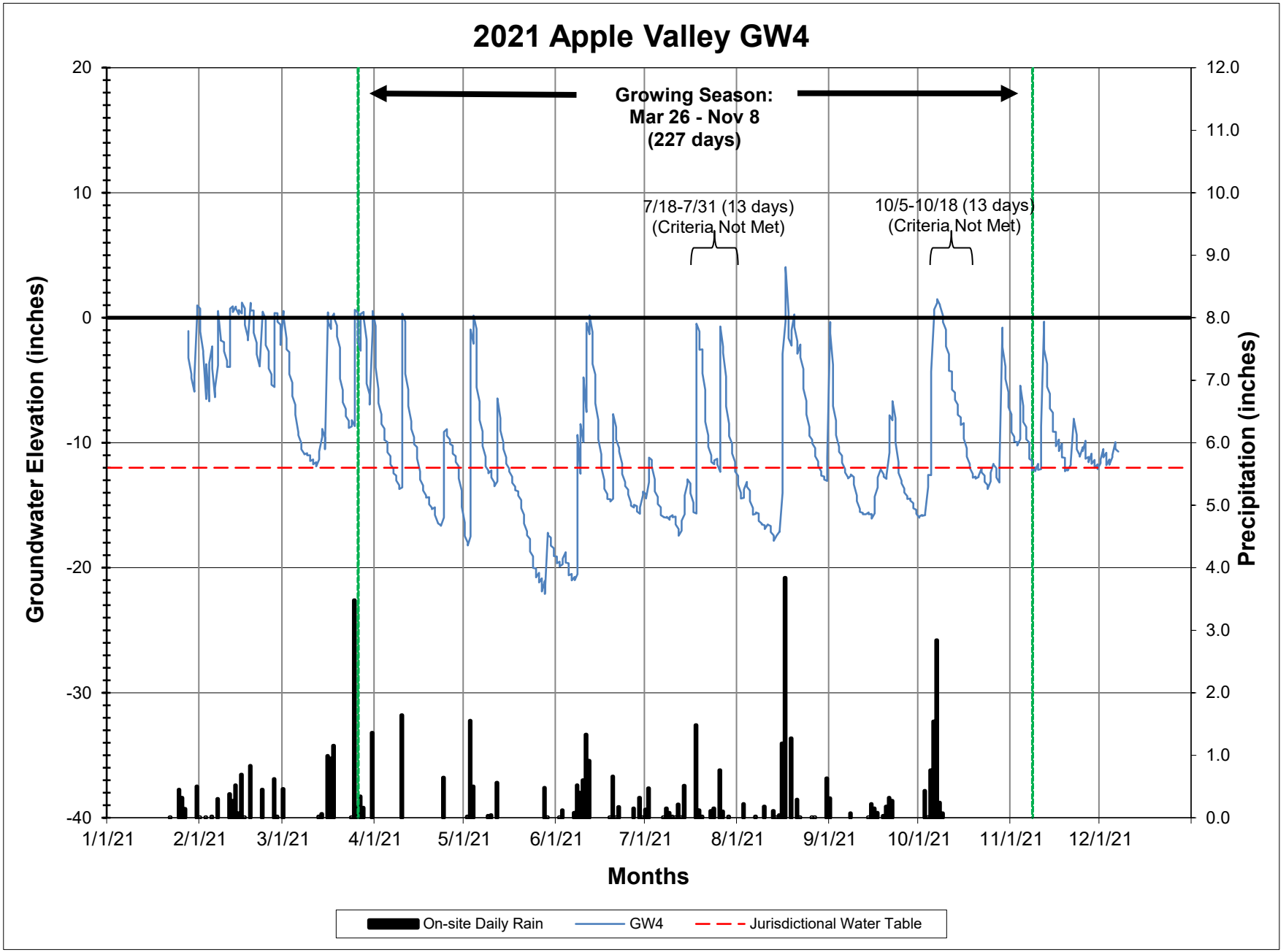
Summary of Groundwater Monitoring Results Apple Valley								
Well ID	Wetland ID	Hydroperiod (%)						
		Year 1 (2021)	Year 2 (2022)	Year 3 (2023)	Year 4 (2024)	Year 5 (2025)	Year 6 (2026)	Year 7 (2027)
GW1	W1	100						
GW2	W3	27						
GW3	W3	100						
GW4	W3	6						
GW5	W3	100						
GW6	W3	45						
GW7	W3	27						
GW8	W3	6						

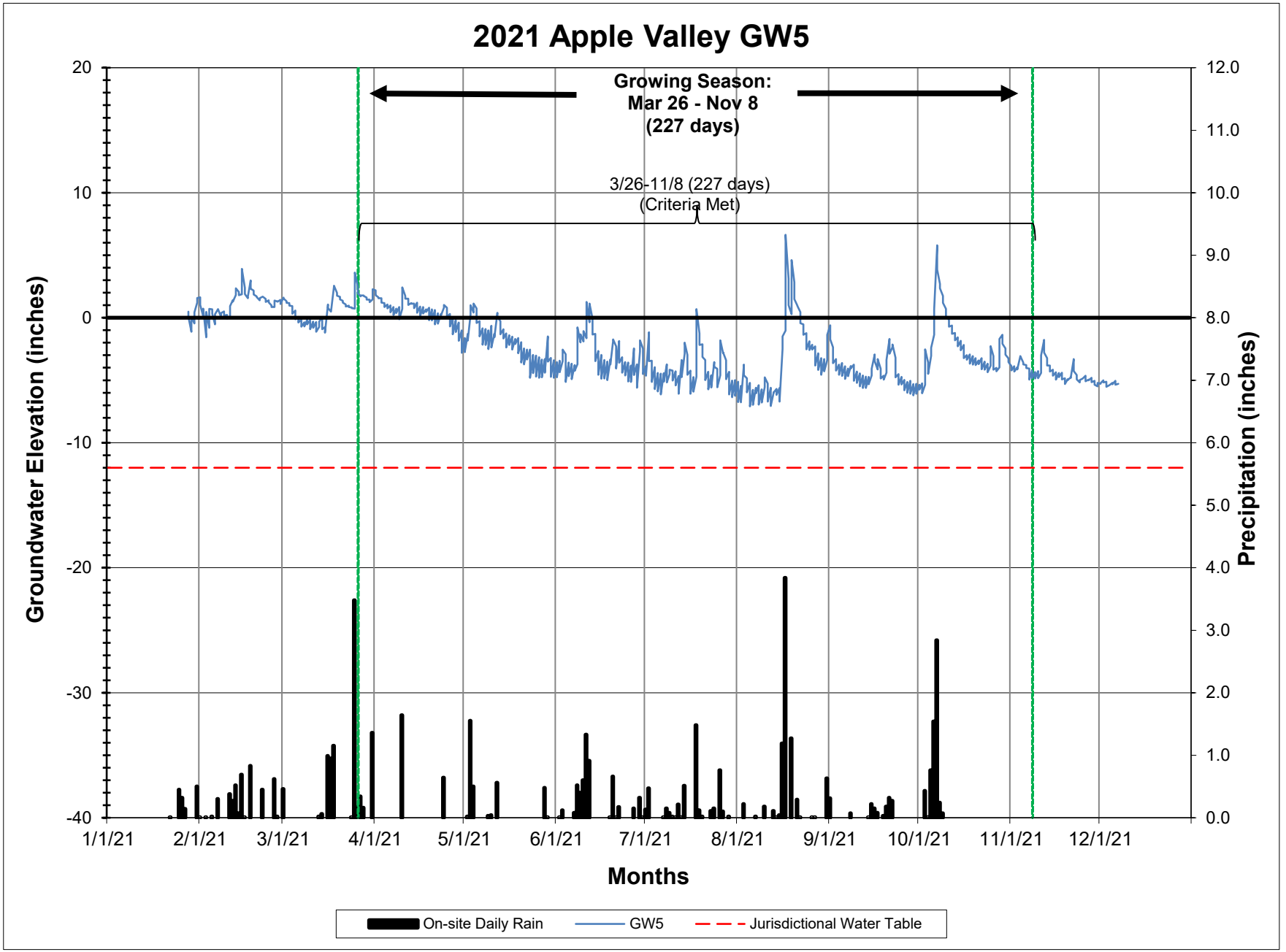

MY1 2021 Apple Valley Stage Recorder AV1 Stream Overbank Hydrograph
Bankfull Event
3/25/21
Water Depth (ft)
Rainfall (in)
Months
1/28/21
2/28/21
3/31/21
4/30/21
5/31/21
6/30/21
7/31/21
8/31/21
9/30/21
10/31/21
11/30/21
Rain
AV1 Depth
AV1 TOB

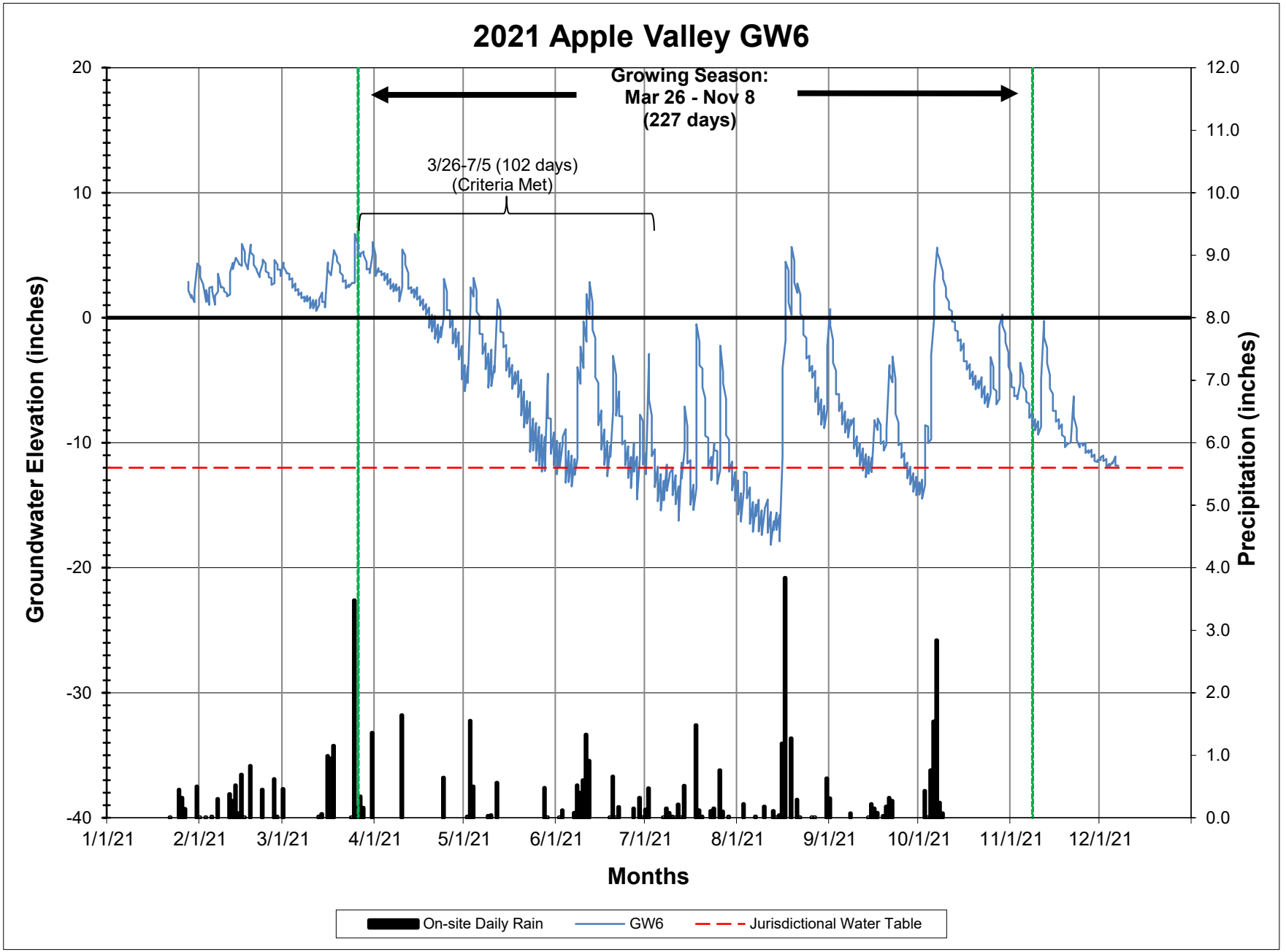

2021 Apple Valley GW1
Growing Season:
Mar 26 - Nov 8
(227 days)
3/26-11/8 (227 days)
(Criteria Met)
Groundwater Elevation (inches)
Precipitation (inches)
20
10
0
-10
-20
-30
-40
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1/1/21
2/1/21
3/1/21
4/1/21
5/1/21
6/1/21
7/1/21
8/1/21
9/1/21
10/1/21
11/1/21
12/1/21
Months
On-site Daily Rain
GW1
Jurisdictional Water Table

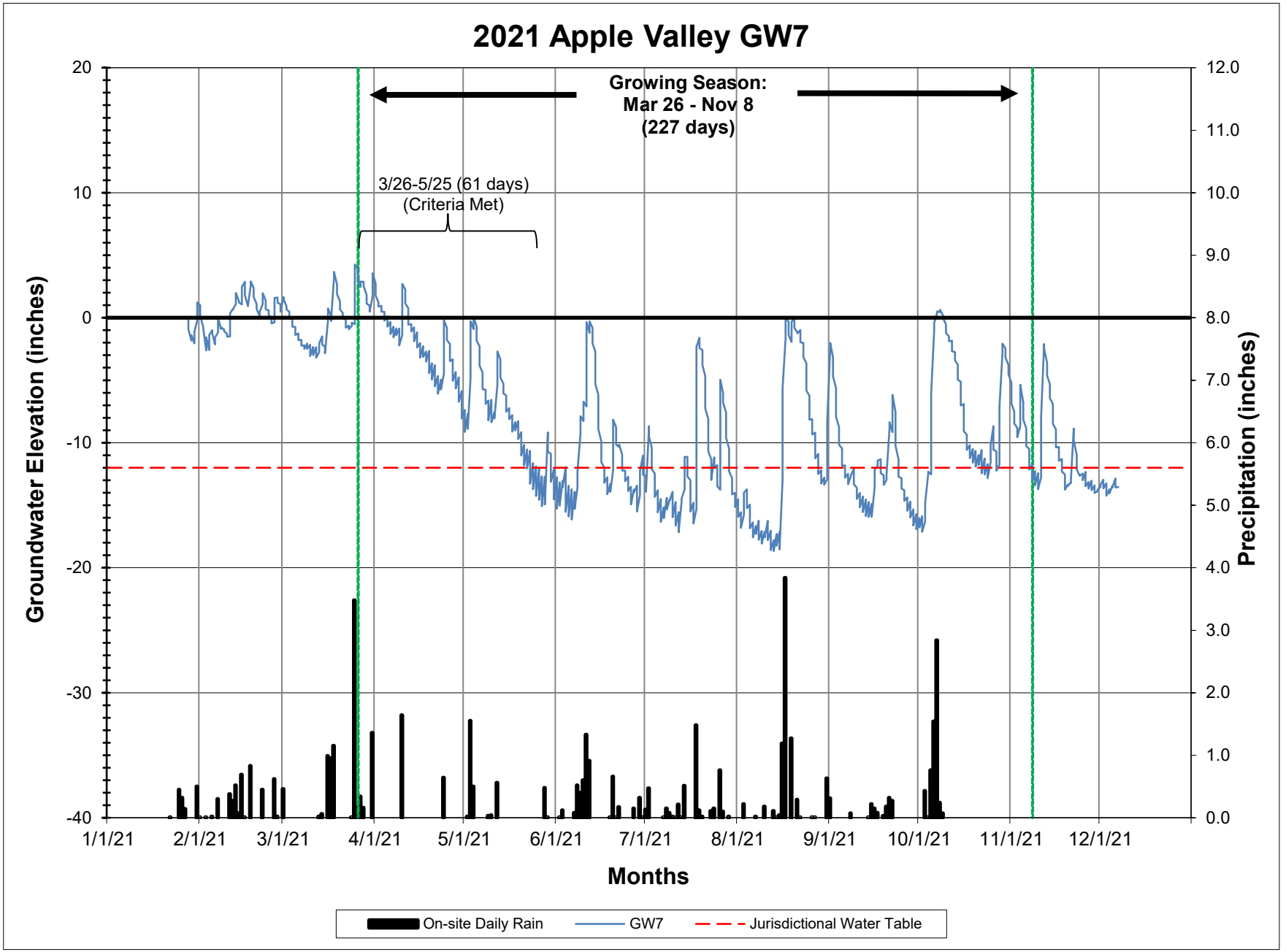

2021 Apple Valley GW2
Growing Season:
Mar 26 - Nov 8
(227 days)
3/26-5/25 (61 days)
(Criteria Met)
Groundwater Elevation (inches)
Precipitation (inches)
Months
20
10
0
-10
-20
-30
-40
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1/1/21
2/1/21
3/1/21
4/1/21
5/1/21
6/1/21
7/1/21
8/1/21
9/1/21
10/1/21
11/1/21
12/1/21
On-site Daily Rain
GW2
Jurisdictional Water Table

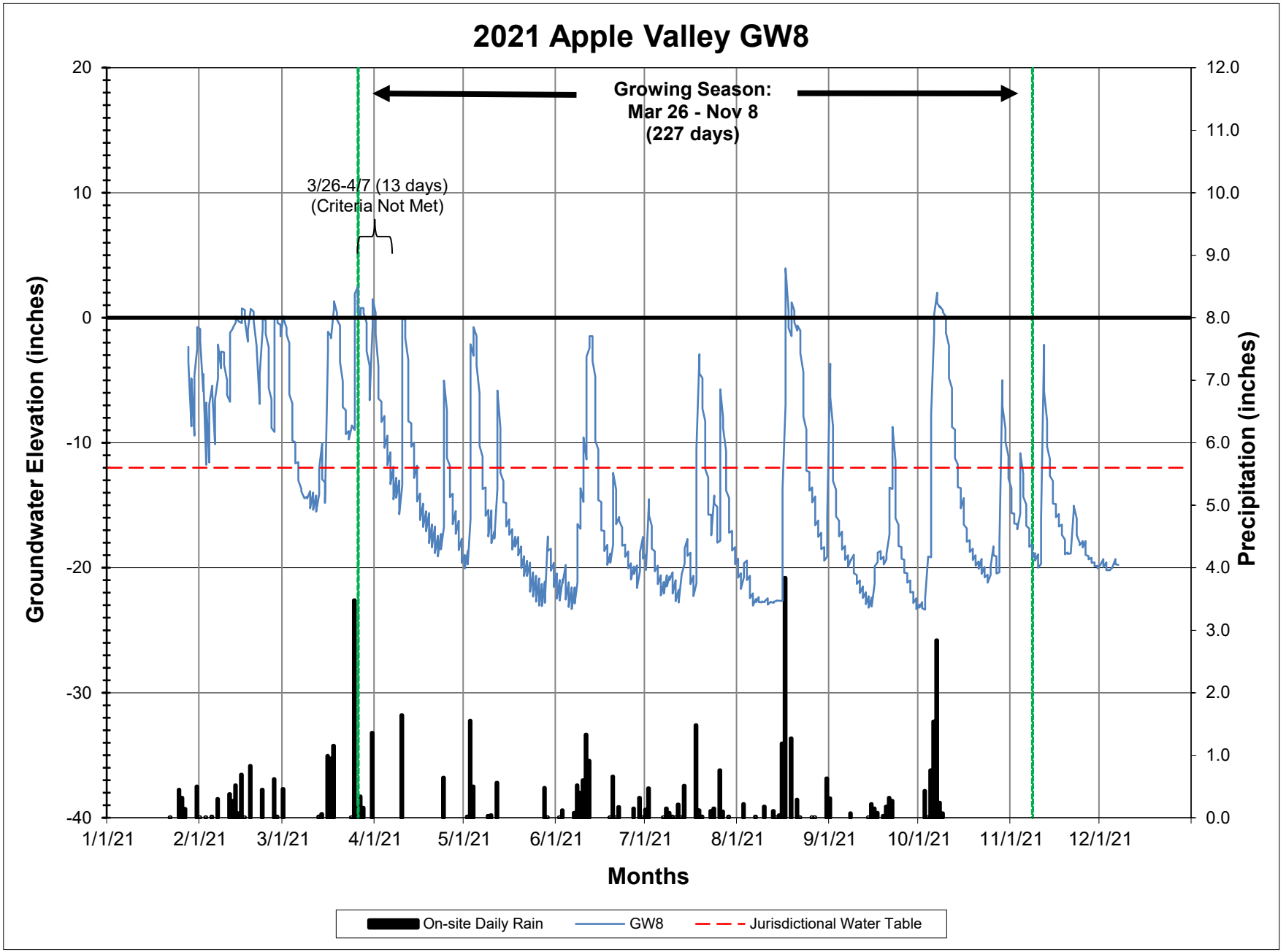

2021 Apple Valley GW3
Growing Season:
Mar 26 - Nov 8
(227 days)
3/6-11/8 (227 days)
(Criteria Met)
Groundwater Elevation (inches)
Precipitation (inches)
Months
20
10
0
-10
-20
-30
-40
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1/1/21
2/1/21
3/1/21
4/1/21
5/1/21
6/1/21
7/1/21
8/1/21
9/1/21
10/1/21
11/1/21
12/1/21
On-site Daily Rain
GW3
Jurisdictional Water Table


2021 Apple Valley GW4
Growing Season:
Mar 26 - Nov 8
(227 days)
7/18-7/31 (13 days)
(Criteria Not Met)
10/5-10/18 (13 days)
(Criteria Not Met)
Groundwater Elevation (inches)
Precipitation (inches)
Months
20
10
0
-10
-20
-30
-40
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1/1/21
2/1/21
3/1/21
4/1/21
5/1/21
6/1/21
7/1/21
8/1/21
9/1/21
10/1/21
11/1/21
12/1/21
On-site Daily Rain
GW4
Jurisdictional Water Table


2021 Apple Valley GW5
Growing Season:
Mar 26 - Nov 8
(227 days)
3/26-11/8 (227 days)
(Criteria Met)
Groundwater Elevation (inches)
Precipitation (inches)
Months
20
10
0
-10
-20
-30
-40
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1/1/21
2/1/21
3/1/21
4/1/21
5/1/21
6/1/21
7/1/21
8/1/21
9/1/21
10/1/21
11/1/21
12/1/21
On-site Daily Rain
GW5
Jurisdictional Water Table


2021 Apple Valley GW6
Growing Season:
Mar 26 - Nov 8
(227 days)
3/26-7/5 (102 days)
(Criteria Met)
Groundwater Elevation (inches)
Precipitation (inches)
Months
20
10
0
-10
-20
-30
-40
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1/1/21
2/1/21
3/1/21
4/1/21
5/1/21
6/1/21
7/1/21
8/1/21
9/1/21
10/1/21
11/1/21
12/1/21
On-site Daily Rain
GW6
Jurisdictional Water Table


2021 Apple Valley GW7
Growing Season:
Mar 26 - Nov 8
(227 days)
3/26-5/25 (61 days)
(Criteria Met)
Groundwater Elevation (inches)
Precipitation (inches)
Months
20
10
0
-10
-20
-30
-40
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1/1/21
2/1/21
3/1/21
4/1/21
5/1/21
6/1/21
7/1/21
8/1/21
9/1/21
10/1/21
11/1/21
12/1/21
On-site Daily Rain
GW7
Jurisdictional Water Table


2021 Apple Valley GW8
Growing Season:
Mar 26 - Nov 8
(227 days)
3/26-4/7 (13 days)
(Criteria Not Met)
Groundwater Elevation (inches)
Precipitation (inches)
Months
20
10
0
-10
-20
-30
-40
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1/1/21
2/1/21
3/1/21
4/1/21
5/1/21
6/1/21
7/1/21
8/1/21
9/1/21
10/1/21
11/1/21
12/1/21
On-site Daily Rain
GW8
Jurisdictional Water Table