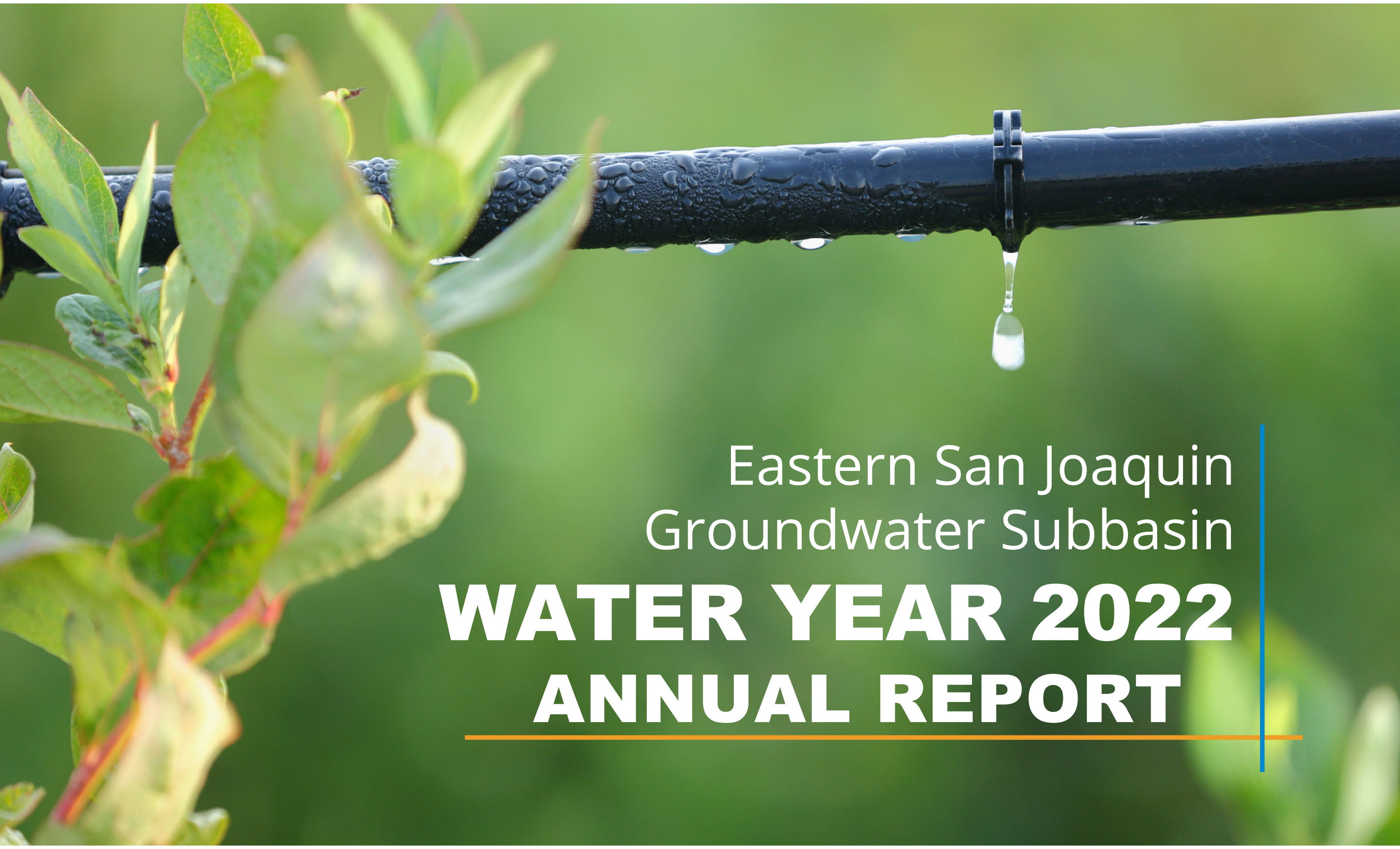
EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY



Eastern San Joaquin
Groundwater Subbasin

WATER YEAR 2022 ANNUAL REPORT

March
2023

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List of Abbreviations and Acronyms

AC	Advisory Committee
AF	acre-feet
AFY	acre-feet per year
bgs	below ground surface
CALSIMETAW	California Simulation of Evapotranspiration of Applied Water
CASGEM	California Statewide Groundwater Elevation Monitoring
CCWD	Calaveras County Water District
CDWA	Central Delta Water Agency
CIP	Capital Improvement Program
CSJWCD	Central San Joaquin Water Conservation District
Delta	Sacramento-San Joaquin River Delta
DMS	Data Management System
DWR	California Department of Water Resources
EBMUD	East Bay Municipal Utility District
EC	electrical conductivity
ESJ	Eastern San Joaquin
ESJGWA	Eastern San Joaquin Groundwater Authority
ESJWRM	Eastern San Joaquin Water Resources Model
ft/mi	feet per mile
GMP	Groundwater Management Plan
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
IDW	Inverse Distance Weighting
IWFM	Integrated Water Flow Model
LCSD	Lockeford Community Services District
LCWD	Linden County Water District
MAF	Million acre-feet
MAR	Managed Aquifer Recharge
MCL	Maximum Contaminant Level
mg/L	milligrams per liter
msl	mean sea level

MUD	Municipal Utilities Department
NAVD	North American Vertical Datum
NSJWCD	North San Joaquin Water Conservation District
OID	Oakdale Irrigation District
PRISM	Precipitation-Elevation Regressions on Independent Slopes Model
SDWA	South Delta Water Agency
SEWD	Stockton East Water District
SGMA	Sustainable Groundwater Management Act
SMCL	Secondary Maximum Contaminant Level
SSJ GSA	South San Joaquin GSA
SSJID	South San Joaquin Irrigation District
TDS	total dissolved solids
USGS	United States Geological Survey
VFD	variable frequency drive
WID	Woodbridge Irrigation District
Workgroup	Groundwater Sustainability Workgroup
WY	Water Year

EXECUTIVE SUMMARY

INTRODUCTION

The Eastern San Joaquin Groundwater Subbasin (Eastern San Joaquin Subbasin, or Subbasin) has a long history of proactively and collaboratively managing water resources, with strong participation from local water management agencies, other local agencies, stakeholders, and state and federal agencies. Collaborative efforts that have guided sustainable groundwater resources management in the Eastern San Joaquin Subbasin include the *Eastern San Joaquin Groundwater Subbasin Groundwater Sustainability Plan* (GSP) (2019) and its forerunner, the *Eastern San Joaquin Groundwater Basin Groundwater Management Plan* (GMP) (2004).

The GSP was developed jointly with the Eastern San Joaquin Groundwater Authority (ESJGWA), which is a joint powers authority formed by the 16 groundwater sustainability agencies (GSAs) within the Eastern San Joaquin Subbasin (ESJGWA, 2022). The ESJGWA includes the Central Delta Water Agency (CDWA), Central San Joaquin Water Conservation District (CSJWCD), City of Lodi, City of Manteca, City of Stockton, Eastside San Joaquin GSA (Eastside GSA) (composed of Calaveras County, Calaveras County Water District [CCWD], Stanislaus County, and Rock Creek Water District), Linden County Water District (LCWD), Lockeford Community Services District (LCSD), North San Joaquin Water Conservation District (NSJWCD), Oakdale Irrigation District (OID), County of San Joaquin GSAs (-Eastern San Joaquin 1 and -Eastern San Joaquin 2), South Delta Water Agency (SDWA), South San Joaquin GSA (composed of South San Joaquin Irrigation District [SSJID] including all conveyance works, Woodward Reservoir, City of Ripon, and City of Escalon), Stockton East Water District (SEWD), and Woodbridge Irrigation District (WID). Collectively, these 16 GSAs will be referred to as "GSAs."

Between November 2019 and January 2020, the GSAs individually adopted the GSP, which meets all relevant requirements contained within the Sustainable Groundwater Management Act (SGMA) of 2014 and the GSP Emergency Regulations. The GSP was developed in a stakeholder-driven environment with cooperation between the GSAs and their member agencies. A stakeholder engagement strategy was developed to enable the interests of beneficial users of groundwater in the Subbasin to be considered. The strategy incorporated monthly Groundwater Sustainability Workgroup meetings, monthly Advisory Committee meetings, monthly ESJGWA Board meetings, coordination with neighboring Subbasins, approximately quarterly informational open house events, outreach presentations to community groups, and information distribution to property owners and residents in the Subbasin. The GSP describes groundwater conditions in the Eastern San Joaquin Subbasin and sets up a system of management based on sustainable management criteria supported by monitoring networks, projects and management actions, adaptive management, and reporting.

This water year (WY) 2022 Annual Report for the Eastern San Joaquin Subbasin has been prepared in compliance with Article 7 *Annual Reports and Periodic Evaluations by the Agency*, § 356.2 *Annual Reports* of the GSP Emergency Regulations, as included in the California Code of Regulations. WY 2022 covers the period from October 2021 through September 2022.

GROUNDWATER MANAGEMENT ACTIVITIES AND MILESTONES

While enactment of SGMA in 2015 prohibited the development or renewal of any GMPs within medium- and high-priority groundwater basins (such as the Eastern San Joaquin Subbasin), the GSAs continued to implement the management activities identified in the 2004 GMP throughout the GSP development process (ending January 31, 2020). Such activities included continuing to work with the California Department of Water Resources (DWR) to improve sharing and exchange of data and development of the Eastern San Joaquin Water Resources Model (ESJWRM). This Annual Report uses the information contained within the GSP, data collected since the GSP was adopted and submitted to DWR, and data collected during this year of implementation to evaluate continued sustainable conditions throughout the planning and implementation horizon.

The GSP sets sustainable management criteria for applicable sustainability indicators and identifies projects and management actions to aid in maintaining sustainable conditions throughout the Eastern San Joaquin Subbasin. Under SGMA, sustainable management criteria can be defined as the following:

- **Minimum Threshold** – Quantitative threshold for each sustainability indicator used to define the point at which undesirable results may begin to occur.
- **Measurable Objective** – Quantitative target that establishes a point above the minimum threshold that allows for a range of active management in order to prevent undesirable results.
- **Interim Milestones** – Targets set in increments of five (5) years over the implementation period of the GSP to put the basin on a path to achieving sustainability by 2040.
- **Margin of Operational Flexibility** – The range of active management between the measurable objective and the minimum threshold.

During WY 2022, monitoring relative to all sustainability indicators indicated the Eastern San Joaquin Subbasin was continuing to operate under sustainable conditions relative to their respective sustainability indicators and established sustainable management criteria. As projects are implemented, the ESJGWA will continue to assess conditions relative to established criteria and definitions of undesirable results.

GROUNDWATER MONITORING AND CONDITIONS ASSESSMENT

Hydrologic Conditions

WY 2022 was drier than average and classified as a critical water year according to the San Joaquin River Valley Water Year Hydrologic Index. Estimated precipitation during WY 2022 was approximately 90% of the long-term (1969-2018) Subbasin average. Measured stream flows in the San Joaquin River were approximately 17 percent of long-term averages, whereas those in the Calaveras River were 62 percent of long-term averages and those in the Cosumnes River were 56 percent of long-term averages.

Groundwater Levels

Groundwater elevations generally decreased throughout WY 2022 for almost all wells in the representative monitoring network with groundwater level data available. No wells reported groundwater levels below the minimum thresholds established in the GSP. Twelve (12) wells reported Fall 2021 measurements and 15 wells reported Spring 2022 measurements that met or exceeded their measurable objective. All recent data show typical patterns of annual highs in the Spring and lows in the late Summer or Fall that match historical trends.

Groundwater Storage

The groundwater storage sustainability indicator for the Eastern San Joaquin Subbasin uses the groundwater level sustainable management criteria (i.e., Minimum Threshold, Measurable Objective, Interim Milestones, and Margin of Operational Flexibility) as a proxy. Therefore, the minimum thresholds for groundwater levels are designed to be protective of significant and unreasonable impacts to changes in groundwater storage. For WY 2022, groundwater storage was estimated using the ESJWRM (the Subbasin's integrated groundwater-surface water model). Based on these estimates, from the beginning to the end of WY 2022, storage in the Eastern San Joaquin Subbasin decreased by approximately 122,000 AF. This volume represents about 0.2% of the total fresh groundwater storage, which was estimated to be more than 50 million acre-feet (MAF) in 2015. This value is less than the WY2021 change in storage of -157,000 AF.

Groundwater Quality

Salinity is the only water quality constituent for which minimum thresholds were established in the Eastern San Joaquin Subbasin. In WY 2022, five of the representative monitoring wells reported measurements for total dissolved solids (TDS). TDS was not reported at the remaining five wells due to a variety of reasons, including inactive wells due to water quality concerns. All measurements reported are above the minimum thresholds for water quality set in the GSP.

Saltwater Migration

The Eastern San Joaquin Subbasin is not in a coastal area, and seawater intrusion via the aquifer formations is unlikely. Seawater could migrate into the Sacramento-San Joaquin River Delta (Delta) via the tides or as result of sea level rise and climate change. This could create the potential for seawater to percolate into the aquifers. This condition would be observable and widely noted with current monitoring of surface water conditions in the Delta.

There is saline water underlying the Delta in deeper aquifers, and saline conditions have been observed in shallower zones. This potential impairment to beneficial uses of groundwater would be related to the migration of the saline waters from west to east into the Eastern San Joaquin Groundwater Subbasin due to hydraulic conditions and the lowering of groundwater levels. The GSP established monitoring protocols for the early detection of saltwater migration from the west, under the Delta, to the east into the Eastern San Joaquin Groundwater Subbasin. The monitoring program is intended to identify the issue associated with saltwater migrations so that the ESJGWA can take early action to address undesirable results. In WY 2022, chloride was measured at two of the ten representative monitoring wells. Those not monitored reported a variety of reasons, including inactive wells due to water quality concerns and field work disruptions as a result of the COVID-19 pandemic. All measurements reported were above the minimum threshold for chloride concentrations set in the GSP.

Land Subsidence

The land subsidence sustainability indicator in the Eastern San Joaquin Subbasin uses the groundwater level sustainable management criteria as a proxy. The minimum thresholds for groundwater levels are designed to be protective of significant and unreasonable impacts to land subsidence. There were no minimum threshold exceedances for groundwater levels; therefore, there were no land subsidence sustainability threshold exceedances. Land subsidence has not historically been an area of concern in the Subbasin and there are no records of significant land subsidence caused by groundwater pumping in the Subbasin. Section 2.1.5 of the GSP details the extent of clay deposits in the Subbasin, and Section 2.2.5 of the GSP includes a description of the minimal subsidence that has historically occurred in the Subbasin. Additionally, Continuous GPS subsidence monitoring stations in the Subbasin and InSAR data released by DWR show no greater than 0.1 feet of land subsidence occurred in the Eastern San Joaquin Subbasin.

Groundwater-Surface Water Interaction

The depletions of interconnected surface water sustainability indicator in the Eastern San Joaquin Subbasin uses the groundwater level sustainable management criteria as a proxy. The minimum thresholds for groundwater levels are designed to be protective of significant and unreasonable impacts to depletions of interconnected surface waters. There were no minimum threshold exceedances for groundwater levels; therefore, there were no interconnected surface water sustainability threshold exceedances.

Total Water Use

The primary water use sectors in the Eastern San Joaquin Subbasin include urban and agriculture uses, with groundwater supplying the majority of the total water use. During WY 2022, groundwater extraction and use is estimated to be 818,507 AF for the Eastern San Joaquin Subbasin.

Surface water deliveries during WY 2022 are estimated to be 552,372 AF with the majority of surface water used between May and September. In WY 2022, south-of-Delta contractors for irrigation water services were allocated 0% of their Central Valley Project (CVP) contract total with the United States Bureau of Reclamation (USBR). Municipal and industrial water service contractors were initially allocated 25% of their contracts; in April 2022, due to the critically dry conditions, water supplies were reduced to Public Health and Safety allocations. SEWD and CSJWCD are the only CVP contractors in the Eastern San Joaquin Subbasin.

Total water use is the sum of the groundwater use and surface water use; therefore, total water use during WY 2022 is estimated to be 1,370,879 AF.

ANNUAL REPORT ELEMENTS

The following table presents the sections and page numbers where requirements for Annual Report elements can be found, subject to Article 7 §356.2 of the GSP Regulation Sections in the California Code of Regulations.

California Code of Regulations - GSP Regulation Sections	Annual Report Elements	Section(s) and page numbers(s) where requirements for Annual Report elements are included
Article 7	**Annual Reports and Periodic Evaluations by Agency**	
§ 356.2	**Annual Reports**	
	Each Agency shall submit an annual report to the Department by April 1 of each year following the adoption of the Plan. The annual report shall include the following components for the preceding water year:	
	(a) General information, including an executive summary and a location map depicting the basin covered by the report.	Executive Summary, Figure 1 pg. 6:10, 15
	(b) A detailed description and graphical representation of the following conditions of the basin managed in the Plan:	--
	(1) Groundwater elevation data from monitoring wells identified in the monitoring network shall be analyzed and displayed as follows:	--
	(A) Groundwater elevation contour maps for each principal aquifer in the basin illustrating, at a minimum, the seasonal high and seasonal low groundwater conditions.	Section 3.2, Figure 3, Figure 4 pg. 35:39
	(B) Hydrographs of groundwater elevations and water year type using historical data to the greatest extent available, including from January 1, 2015, to current reporting year.	Section 3.2, Figure 2, Appendix B, Appendix C pg. 35:39, 74:124
	(2) Groundwater extraction for the preceding water year. Data shall be collected using the best available measurement methods and shall be presented in a table that summarizes groundwater extractions by water use sector, and identifies the method of measurement (direct or estimate) and accuracy of measurements, and a map that illustrates the general location and volume of groundwater extractions.	Section 3.8.1, Figure 12, Table 6 pg. 49, 52, 58
	(3) Surface water supply used or available for use, for groundwater recharge or in-lieu use shall be reported based on quantitative data that describes the annual volume and sources for the preceding water year.	Section 3.8.2, Table 7 pg. 49:50, 53
	(4) Total water use shall be collected using the best available measurement methods and shall be reported in a table that summarizes total water use by water use sector, water source type, and identifies the method of measurement (direct or estimate) and accuracy of measurements. Existing water use data from the most recent Urban Water Management Plans or Agricultural Water Management Plans within the basin may be used, as long as the data are reported by water year.	Section 3.8, Table 8 pg. 49:58
	(5) Change in groundwater in storage shall include the following:	--
	(A) Change in groundwater in storage maps for each principal aquifer in the basin.	Section 3.3, Figure 8 pg. 40:44

California Code of Regulations - GSP Regulation Sections	Annual Report Elements	Section(s) and page numbers(s) where requirements for Annual Report elements are included
	(B) A graph depicting water year type, groundwater use, the annual change in groundwater in storage, and the cumulative change in groundwater in storage for the basin based on historical data to the greatest extent available, including from January 1, 2015, to the current reporting year.	Section 3.3, Figure 5, Figure 6, Figure 7 pg. 40:44
	(c) A description of progress towards implementing the Plan, including achieving interim milestones, and implementation of projects or management actions since the previous annual report.	Section 2.3, Appendix A pg. 26:34, 61:73

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1. INTRODUCTION

The Eastern San Joaquin Groundwater Subbasin (Eastern San Joaquin Subbasin or Subbasin) (**Figure 1**) has been identified by the California Department of Water Resources (DWR) as critically overdrafted. The Eastern San Joaquin Groundwater Sustainability Plan (Eastern San Joaquin GSP, GSP, or the Plan) was developed and submitted to DWR to meet SGMA regulatory requirements by the January 31, 2020, deadline for critically-overdrafted basins while reflecting local needs and preserving local control over water resources. While the Eastern San Joaquin GSP offers a new and significant approach to groundwater resource protection, it was developed within an existing framework of comprehensive planning efforts. Throughout the region, several separate yet related planning efforts have occurred previously or are concurrently proceeding, including integrated regional water management, urban water management, agricultural water management, watershed management, habitat conservation, and general planning and most closely, the *Eastern San Joaquin Groundwater Basin Groundwater Management Plan* (GMP) (2004). The Eastern San Joaquin GSP fits in with these prior planning efforts, building on existing local management and basin characterization.

The Eastern San Joaquin GSP provides a path to achieve and document sustainable groundwater management within 20 years following Plan adoption, promoting the long-term sustainability of locally-managed groundwater resources now and into the future.

The GSP was developed jointly by the Eastern San Joaquin Groundwater Authority (ESJGWA), which is a joint powers authority formed by the following 16 groundwater sustainability agencies (GSAs) within the Eastern San Joaquin Subbasin. Collectively, these 16 GSAs will be referred to as "GSAs".

- Central Delta Water Agency (CDWA)
- Central San Joaquin Water Conservation District (CSJWCD)
- City of Lodi
- City of Manteca
- City of Stockton
- Eastside San Joaquin GSA (Eastside GSA) (composed of Calaveras County, Calaveras County Water District [CCWD], Stanislaus County, and Rock Creek Water District)
- Linden County Water District (LCWD)
- Lockeford Community Services District (LCSD)
- North San Joaquin Water Conservation District (NSJWCD)
- Oakdale Irrigation District (OID)
- County of San Joaquin GSA – Eastern San Joaquin 1
- County of San Joaquin GSA – Eastern San Joaquin 2
- South Delta Water Agency (SDWA)
- South San Joaquin GSA (composed of South San Joaquin Irrigation District [SSJID] including all conveyance works, Woodward Reservoir, City of Ripon, and City of Escalon)
- Stockton East Water District (SEWD)

- Woodbridge Irrigation District (WID)

During water year (WY) 2022 (October 1, 2021, through September 30, 2022), groundwater management within the Eastern San Joaquin Subbasin evolved through the implementation of the GSP, which was ultimately adopted by the GSAs between November 2019 and January 2020. The GSP was developed in a stakeholder-driven environment, including 69 open meetings and numerous other outreach activities. The result is a GSP that describes groundwater conditions in the Eastern San Joaquin Subbasin and sets up a system of management based on quantitative thresholds, termed sustainable management criteria (SMC), for six sustainability indicators: chronic lowering of groundwater levels, degraded water quality, saltwater migration, inelastic land subsidence, change in groundwater storage, and depletions of interconnected surface water.

This Annual Report provides information on conditions in the Eastern San Joaquin Subbasin and progress towards implementing the GSP for WY 2022. The report has been prepared in accordance with Article 7 *Annual Reports and Periodic Evaluations by the Agency*, § 356.2 *Annual Reports* of the GSP Emergency Regulations as contained within the California Code of Regulations.

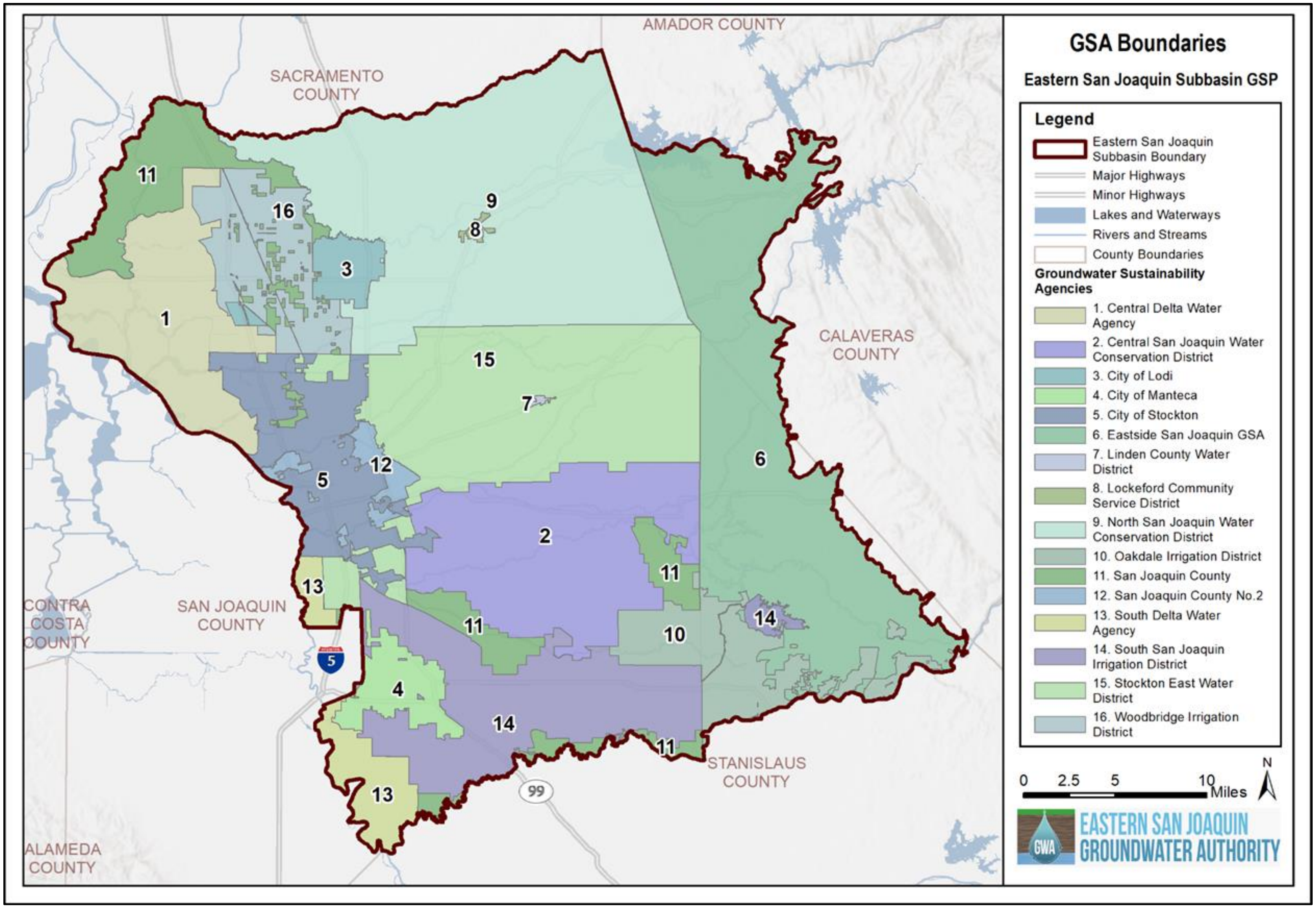

Figure 1. Eastern San Joaquin Groundwater Subbasin

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2. GROUNDWATER MANAGEMENT ACTIVITIES AND MILESTONES

This section documents the activities and milestones from the passing of the Sustainable Groundwater Management Act (SGMA) throughout GSP development, summarizes the contents of the GSP for the Eastern San Joaquin Subbasin, and documents GSP implementation progress during WY 2022.

Implementation of the GSP is underway, which includes this Annual Report as well as monitoring and associated assessment of sustainable management criteria and identified projects, management actions, and adaptive management (as needed).

2.1 GROUNDWATER SUSTAINABILITY PLAN DEVELOPMENT

Preliminary development of the Eastern San Joaquin GSP began with formation of the member GSAs and agreement to form the ESJGWA for the purpose of GSP development and implementation. The ESJGWA Board of Directors (ESJGWA Board) developed an Advisory Committee (AC) that included staff members from the GSAs. The AC provides technical review and recommendations to the ESJGWA Board for ongoing sustainable groundwater management and development of the Eastern San Joaquin GSP. The ESJGWA also developed a Groundwater Sustainability Workgroup (Workgroup) to promote stakeholder input and relied upon the Workgroup when developing the GSP. The Workgroup began with an application process to ensure a diverse cross-section of populations were represented to serve on the Workgroup. Workgroup members participated and provided valuable input throughout the GSP development process.

On March 3, 2018, the GSAs filed a notice of intent to prepare a GSP with DWR. A public draft of the GSP was posted for public comment in July 2019, and a notice of intent to adopt a GSP was sent by the ESJGWA to all cities and counties in the Eastern San Joaquin Subbasin on August 16, 2019. The Final GSP, published November 5, 2019, was adopted by the individual GSAs between November 2019 and January 2020. On January 8, 2020, the ESJGWA Board passed a resolution agreeing to submit the Plan to DWR on behalf of the 16 GSAs.

The ESJGWA received comments on the submitted GSP from DWR in April 2022. A Revised GSP was again adopted by the individual GSAs and re-published in June 2022 with revisions to address DWR's comments incorporated.

2.2 GROUNDWATER SUSTAINABILITY PLAN CONTENTS SUMMARY

The GSP was prepared in compliance with all relevant elements of the SGMA Regulations and GSP Emergency Regulations, Article 5 *Plan Contents*. The subsections below summarize the contents of the GSP relevant to assessing changing conditions in the Eastern San Joaquin Subbasin for the purposes of evaluating GSP implementation progress in this Annual Report.

2.2.1 Plan Area

The GSP's plan area encompasses the Eastern San Joaquin Subbasin (5-22.01), as defined by DWR's Final 2018 Basin Boundary Modifications (released February 11, 2019). The Eastern Subbasin is located at the north end of the larger San Joaquin Valley Groundwater Basin, to the east of the Sacramento-San Joaquin River Delta (Delta), and is generally bounded by the Sierra Nevada foothills to the east, the San Joaquin River to the west, Dry Creek to the north, and Stanislaus River to the south. The major river systems traversing the Subbasin include the Calaveras, Mokelumne, and Stanislaus Rivers. Multiple smaller streams also flow through the Subbasin to the San Joaquin River.

The plan area covers areas of San Joaquin County east of the San Joaquin River, including the cities of Stockton, Lodi, Manteca, Escalon, and Ripon, and portions of Calaveras and Stanislaus Counties. The Subbasin is bordered by Sacramento, Amador, and Contra Costa Counties. Land use patterns in the Eastern San Joaquin Subbasin are dominated by agricultural uses, including nut and fruit trees, vineyards, row crops, grazing, and forage. Irrigated crop acreage in the Subbasin is 44% fruit and nut trees, 23% vineyards, and 8% alfalfa and irrigated pasture, according to 2018 DWR statewide crop mapping (LandIQ, 2022).

2.2.2 Hydrogeologic Conceptual Model

One principal aquifer exists across the Eastern San Joaquin Subbasin that is composed of three water production zones. The zones are:

- **Shallow Zone** that consists of the alluvial sands and gravels of the Modesto, Riverbank, and Upper Turlock Lake Formations
- **Intermediate Zone** that consists of the Lower Turlock Lake and Laguna Formations
- **Deep Zone** that consists of the consolidated sands and gravels of the Mehrten Formation

The Stockton Fault is the largest fault in the Eastern San Joaquin Subbasin. It is a large reverse fault with displacements of up to 3,600 feet. The Vernalis Fault is a reverse fault with a northwest-southeast trend that bounds the Tracy-Vernalis anticlinal trend that is mapped outside of the west boundary of the Eastern San Joaquin Subbasin. Additionally, the Stockton Arch is a broad transverse structure that underlies the southern half of the Eastern San Joaquin Subbasin. The base of fresh water (encountered saline) has been observed as shallow as 650 feet below ground surface (bgs) in the eastern part of the Subbasin to over 2,000 feet bgs in the northern part of the Subbasin.

2.2.3 Existing Groundwater Conditions

Groundwater levels in some portions of the Subbasin have been declining for many years, while groundwater levels in other areas of the Subbasin have remained stable or increased in recent years. The change in groundwater levels varies across the Subbasin, with the greatest declines occurring in the central portion of the Subbasin. The western and southern portions of the Subbasin have experienced less change in groundwater levels, in part due to the minimal groundwater pumping in the Delta area to the west and the import of surface water for agricultural and urban uses.

In many areas of the Subbasin, groundwater levels reached their lowest in Fall 1992. In numerous cases, areas that experienced undesirable results in 1992 put mitigation measures in place thereafter, often deepening wells, meaning that 1992 groundwater levels would no longer trigger undesirable effects. Groundwater levels in some areas of the Subbasin have recovered since 1992; however, groundwater levels in other portions of the Subbasin declined further below 1992 levels.

A central pumping depression exists east of the City of Stockton. Groundwater generally flows from the outer edges of the Subbasin towards the depression in the middle of the Subbasin. Along the eastern side of the Subbasin, the lateral gradient of groundwater levels ranges from approximately 21 feet per mile (ft/mi) during the seasonal high to 16 ft/mi during the seasonal low. Along the western side of the Subbasin, the lateral gradient ranges from approximately 7 ft/mi during the seasonal high to 6 ft/mi during the seasonal low. The steeper gradients on the east side of the Subbasin compared to the west side is primarily due to the steeper aquifer units in that area, combined with a lack of head influence from the Delta.

Groundwater quality in the Subbasin varies by location. Areas along the western margin have historically had higher levels of salinity. Salinity may be naturally occurring or the result of human activity. Sources of salinity in the Subbasin include Delta sediments, deep saline groundwater, and irrigation return water. Elevated concentrations of other constituents, such as nitrate, arsenic, and point-source contaminants, are generally localized and not widespread and are generally related to natural sources or land use activities.

While the total volume of groundwater in storage in the Subbasin has declined over time, groundwater storage reduction has not historically been an area of concern in the Subbasin as there are large volumes of fresh water stored in the aquifer. As estimated in the GSP, the total volume of fresh groundwater in storage was estimated at over 53 million acre-feet (MAF) in 2015 (Woodard & Curran, 2019, page 2-80). Significant impacts to groundwater beneficial uses were estimated (via modeling) to occur if there was a depletion of 23 MAF (e.g., only 30 MAF of fresh groundwater remained in the aquifer). As such, it is highly unlikely the Subbasin will experience conditions under which the volume of stored groundwater poses a concern, although the depth to access that groundwater does pose a concern.

Land subsidence has not historically been an area of concern in the Subbasin, and there are no records of land subsidence caused by groundwater pumping in the Subbasin. The three Continuous GPS subsidence monitoring stations in the Subbasin and DWR's InSAR data all indicated less than 0.1 feet in subsidence during WY 2022, further supporting the conclusion that inelastic land subsidence is not currently an area of concern in the Subbasin.

Seawater intrusion is not present in the Subbasin. While the Delta ecosystem evolved with a natural salinity cycle that brought brackish tidal water in from the San Francisco Bay, current management practices endeavor to maintain freshwater flows through a combination of hydraulic and physical barriers and alterations to existing channels.

Major river systems in the Subbasin are highly managed to meet instream flow requirements for fisheries, water quality standards, and the water rights of users downstream. Many smaller streams run through the Subbasin that provide contributions to both groundwater, riparian habitat, and the major river systems. The interconnection between reaches of these streams and the groundwater system will be better understood through monitoring as the GSP is implemented.

2.2.4 Water Budgets

Water budgets provide a quantitative accounting of precipitation, surface water and groundwater entering and leaving the Eastern San Joaquin Subbasin under historical, current, projected, and projected with climate change conditions. The budgets were estimated using the ESJWRM. The primary components of the groundwater budget are:

- Inflows:
    - Deep percolation from precipitation, applied water (surface water and groundwater) for agricultural lands, and applied water (surface water and groundwater) for outdoor use in the urban areas or industrial purposes
    - Stream seepage (i.e., losses to the groundwater system)
    - Other recharge (including unlined canals/reservoir seepage, local tributaries seepage, and Managed Aquifer Recharge [MAR] projects)
    - Subsurface inflow
- Outflows:
    - Groundwater outflow to streams (i.e., stream gain from the groundwater system)
    - Groundwater pumping

   - Subsurface outflow
- Change in Groundwater Storage (Inflows Minus Outflows)

The average annual groundwater storage is shown as decreasing under historical, current, projected, and projected with climate change conditions, suggesting conditions of overdraft without the implementation of projects and/or management actions to address this situation.

The sustainable conditions scenario results in groundwater outflows almost equal to groundwater inflows, bringing the long-term (50-year) average change in groundwater storage to close to zero. Based on this analysis, the sustainable yield of the Subbasin is about 715,000 acre-feet per year (AFY) ± 10 percent. Groundwater pumping and sustainable yield is discussed further in Section 3.8.1.

2.2.5 Sustainable Management Criteria

SGMA allows several pathways to meet the distinct local needs of each groundwater basin, including development of sustainable management criteria, usage of other sustainability indicators as a proxy, and identification of indicators as not being applicable to the basin. Sustainable management criteria were developed based on information about the Subbasin in the hydrogeologic conceptual model, the descriptions of current and historical groundwater conditions, the water budgets (historical and projected), and input from stakeholders during the GSP development process.

The sustainability goal for the Eastern San Joaquin Subbasins is:

> *…to maintain an economically viable groundwater resource for the beneficial use of the people of the Eastern San Joaquin Subbasin by operating the Subbasin within its sustainable yield or by modification of existing management to address future conditions. This goal will be achieved through the implementation of a mix of supply and demand type projects consistent with the GSP implementation plan*.

The method prescribed by SGMA to measure undesirable results and achieve the sustainability goal involves setting minimum thresholds and measurable objectives for a series of representative monitoring sites. These representative sites are a subset of the monitoring network developed as part of the GSP. The sustainable management criteria for the Subbasin are summarized in **Table 2**.

Of the six sustainability indicators addressed in the Eastern San Joaquin Subbasin, chronic lowering of groundwater levels is the driver for sustainable groundwater management as several other indicators all correlated with groundwater levels. Measurable objectives, minimum thresholds, and interim milestones were developed for each of the identified representative wells.

Minimum thresholds for groundwater levels were developed with reference to historical drought low conditions and domestic well depths. Specifically, minimum thresholds were established based on the deeper of the historical drought low plus a buffer of the historical fluctuation or the 10th percentile domestic well depth, whichever is shallower – establishing levels that are protective of 90 percent of domestic wells. In municipalities with ordinances requiring the use of municipal water (water provided by a city’s municipal wells) for domestic users, the 10th percentile municipal well depth is used in place of the 10th percentile domestic well depth criteria. Measurable objectives were established based on the historical drought low and provide a buffer above the minimum threshold. A table summarizing minimum thresholds and measurable objectives is included in the GSP. Graphs showing the minimum threshold and measurable objective for each of the representative wells are contained in an appendix to the GSP and included herein as **Appendix B**.

Minimum thresholds for water quality were defined by considering two primary beneficial uses at risk of undesirable results related to salinity: drinking water and agriculture uses. Minimum thresholds are 1,000 milligrams per liter (mg/L) for each representative monitoring well, consistent with the upper limit secondary maximum contaminant level (SMCL) for total dissolved solids (TDS). Crop tolerances in the Subbasin range by crop type from 900 mg/L TDS for almonds up to 4,000 mg/L TDS for wheat, assuming a 90 percent yield.

The Eastern San Joaquin Subbasin is not in a coastal area, and seawater intrusion is not currently present. Undesirable results related to seawater intrusion are not currently occurring and are not reasonably expected to occur. However, this GSP recognizes that saltwater currently found in some of the aquifers under the Delta could migrate and impair groundwater quality. As such, the GSP establishes monitoring protocols for the early detection of saltwater migration from under the Delta or deep aquifer zones, were it ever to occur, so that the ESJGWA can take early actions to address any associated undesirable results.

The GSP develops minimum thresholds and measurable objectives that include monitoring for chloride and an analysis of isotopic ratios to identify the source of high salinity. The minimum threshold for saltwater migration is a 2,000 mg/L chloride isocontour line established near the western edge of the Subbasin between sentinel monitoring locations. A 2,000 mg/L chloride concentration is approximately 10 percent of seawater chloride concentrations (19,500 mg/L).

For depletions of interconnected surface water, the minimum thresholds and measurable objectives for groundwater levels are used. There is significant correlation between groundwater levels and interconnected stream depletions, and the groundwater levels minimum thresholds are found to be protective of depletions. Similarly, the minimum thresholds and measurable objectives for groundwater levels are used for the land subsidence and groundwater storage sustainability indicators as both are also strongly linked to groundwater levels. The groundwater levels minimum thresholds are found to be protective of land subsidence and groundwater storage.

2.2.6 Monitoring Networks:

Monitoring networks were developed for the sustainability indicators that apply to the Eastern San Joaquin Subbasin, leveraging existing monitoring that has been developed locally and in cooperation with DWR. The objective of these monitoring networks is to monitor conditions across the Subbasin so that the GSAs can continue to manage groundwater sustainably. Specifically, the monitoring network was developed to do the following:

- Monitor impacts to the beneficial uses or users of groundwater.
- Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds.
- Demonstrate progress toward achieving measurable objectives described in the GSP.
- Support estimation of annual changes in water budget components.

To achieve these objectives, the monitoring well networks incorporate sites and frequencies that can detect seasonal and long-term trends for each applicable sustainability indicator. This includes selection of an appropriate temporal frequency and spatial density to evaluate groundwater conditions related to the effectiveness of the GSP.

There are four monitoring well networks established within the Eastern San Joaquin Subbasin GSP: a representative network for water levels, a broad network for water levels, a representative network for water quality, and a broad network for water quality. Monitoring well data from the representative networks are used to determine compliance with the minimum thresholds, while data from the broad networks are used for informational purposes to identify trends and fill data gaps. The two monitoring well networks for water quality are also used to develop a chloride isocontour to evaluate potential for saltwater migration. Water level data inform depletions of interconnected surface water.

Wells in the monitoring networks are measured on a semi-annual schedule (spring and fall) for both groundwater levels and water quality. Historical measurements have been entered into the Subbasin Data Management System (DMS), and future data will also be stored in the DMS.

A summary of the wells in the monitoring networks is shown in **Table 1** below.

Table 1. Summary of Monitoring Network Wells

Representative Networks	**Well Count**
Groundwater Level	21[1]
Groundwater Quality*	10
Broad Networks	
CASGEM (Groundwater Levels)	76
Nested or Clustered Wells (Groundwater Levels & Quality)**	16
Agency Wells (Groundwater Levels & Quality)**	5

*The 10 groundwater quality wells in the Representative Network are also part of the Broad Network for groundwater levels. The well count presented in this table for the Broad Network does not include the 10 wells that are included in the Representative Network for water quality.

**Wells are in both the groundwater level and water quality Broad Monitoring Network.

2.2.7 Projects and Management Actions

Achieving sustainability in the Subbasin requires implementation of projects and management actions. The Subbasin will achieve sustainability by implementing water supply projects that either replace groundwater use or supplement groundwater supplies to attain the current estimated pumping offset and/or recharge targets identified in the GSP. In addition, three projects have been identified that support demand-side reduction activities through conservation measures, including water use efficiency upgrades. Currently, no pumping restrictions have been proposed for the Subbasin; however, GSAs maintain the flexibility to implement such demand-side management actions in the future if need is determined. Additional management activities are:

- Monitoring and recording of groundwater levels and groundwater quality data
- Maintaining and updating the DMS with newly collected data
- Annual monitoring of progress toward sustainability
- Annual reporting of Subbasin conditions to DWR as required by SGMA

[1] 20 wells were included in the representative monitoring network for groundwater levels in the GSP. An additional well (01S10E04C001M) was added during WY 2020 in an effort to fill identified data gaps in the Subbasin.

As part of the effort to respond to DWR's comments on the GSP in June 2022, projects and management actions were incorporated into a version of the ESJWRM Projected Conditions Baseline (PCBL) and ESJWRM Projected Conditions Baseline with Climate Change (PCBL-CC) to evaluate the impacts of such projects on the overall water budget of the Subbasin. Initially, all the projects from the GSP and 2022 Sustainable Groundwater Management (SGM) Grant Program's SGMA Implementation Round 1 application were considered. Based on updates in previous annual reports and information from representatives of the GSAs, these projects were categorized as Category A or B based on how likely they were to be online by 2040, how likely they were to advance in the next five years, and if they already had the necessary water rights and/or agreements to proceed with the project. Category A included 11 projects (indicated in the table in **Appendix A)** that were simulated in ESJWRM and tested against varying hydrologic, water supply, and demand conditions in the PCBL and PCBL-CC scenarios. Model results indicated that with the 11 Category A projects in place, the Subbasin is not projected to experience groundwater level undesirable results (defined as at least 25 percent of representative monitoring network wells exceeding groundwater level minimum thresholds for two consecutive years) even under climate change conditions.

Table 2. Summary of Sustainable Management Criteria

Sustainability Indicator	Undesirable Results	Identification of Undesirable Results	Measurable Objective	Minimum Threshold
Chronic lowering of groundwater levels	An undesirable result is experienced if sustained groundwater levels are too low to satisfy beneficial uses within the Subbasin over the planning and implementation horizon of the GSP.	Undesirable results occur when more than 25% of representative monitoring wells (5 of 20[1] wells in the Subbasin) fall below their minimum elevation thresholds for two consecutive years that are categorized as non-dry years (below-normal, above-normal, or wet), according to the San Joaquin Valley Water Year Hydrologic Classification.	At each of 20[1] representative wells, the measurable objective was defined based on the deeper of 1992 or 2015-2016 groundwater level values.	The deeper of 1992 and 2015-2016 groundwater levels with a buffer of 100 percent of historical range applied, or the 10th percentile domestic well depth within a 3-mile radius of the monitoring well,[2] whichever is shallower. In municipalities with ordinances requiring the use of municipal water, the 10th percentile municipal well depth is used in place of the 10th percentile domestic well depth criteria.

Sustainability Indicator	Undesirable Results	Identification of Undesirable Results	Measurable Objective	Minimum Threshold
Reduction in groundwater storage	An undesirable result is experienced if sustained groundwater storage volumes are insufficient to satisfy beneficial uses within the Subbasin over the planning and implementation horizon of the GSP. Undesirable results related to groundwater storage are not present and are not likely to occur in the Subbasin.	Undesirable results would occur if groundwater storage volumes were depleted by 23 MAF (e.g., 30 MAF of freshwater remain in storage).	Management of reduction in groundwater storage is performed using groundwater levels as a proxy.	Management of reduction in groundwater storage is performed using groundwater levels as a proxy.
Degraded water quality	An undesirable result is experienced if SGMA-related groundwater management activities cause significant and unreasonable impacts to the long-term viability of domestic, agricultural, municipal, environmental, or other beneficial uses over the planning and implementation horizon of the GSP.	Undesirable results occur when more than 25% of representative monitoring wells (3 of 10 wells in the Subbasin) exceed the minimum thresholds for water quality for two consecutive years and where these concentrations are the result of groundwater management activities.	At each of 10 representative wells, 600 mg/L TDS. The measurable objective is close to the recommended SMCL of 500 mg/L and significantly below the upper limit SMCL of 1,000 mg/L.	At each of 10 representative wells, 1,000 mg/L TDS, consistent with the upper SMCL and developed based on the crop tolerances for fruit and nut trees and vineyards.
Saltwater migration	An undesirable result is experienced if sustained groundwater salinity levels caused by saltwater migration and due to groundwater management practices are too high to satisfy beneficial uses within the basin over the planning and implementation horizon of the GSP. Saltwater migration is not present and is not likely to occur in the Eastern San Joaquin Subbasin.	Undesirable results are considered to occur during GSP implementation when 2,000 mg/L chloride reaches an established isocontour line and where these concentrations are caused by intrusion of a seawater source as a result of groundwater management activity.	500 mg/L chloride concentrations at an established isocontour line along the western portion of the Subbasin.	2,000 mg/L chloride concentrations at the established isocontour line along the western portion of the Subbasin. An action plan is in place to trigger additional monitoring and analysis at detections of 1,000 mg/L chloride in the monitoring network to confirm seawater source.

Sustainability Indicator	Undesirable Results	Identification of Undesirable Results	Measurable Objective	Minimum Threshold
Land subsidence	An undesirable result is experienced if the occurrence of land subsidence substantially interferes with beneficial uses of groundwater and infrastructure within the Subbasin over the planning and implementation horizon of the GSP. There are no historical records of significant and unreasonable impacts from subsidence in the Subbasin.	An undesirable result occurs when subsidence substantially interferes with beneficial uses of groundwater and surface land uses. Undesirable results would occur when substantial interference with land use occurs, including significant damage to canals, pipes, or other water conveyance facilities.	Management of land subsidence is performed using groundwater levels as a proxy.	Management of land subsidence is performed using groundwater levels as a proxy.
Depletions of interconnected surface water	An undesirable result is experienced if the depletions of interconnected surface water causes significant and unreasonable adverse effects on beneficial uses of surface water within the Subbasin over the planning and implementation horizon of the GSP.	An undesirable result occurs when depletions result in reductions in flow or levels of major rivers and streams that are hydrologically connected to the basin such that the reduced surface water flow or levels have a significant and unreasonable adverse impact on beneficial uses and users of the surface water.	Management of depletions of interconnected surface water is performed using groundwater levels as a proxy.	Management of depletions of interconnected surface water is performed using groundwater levels as a proxy.

Notes:

1 20 wells were included in the representative monitoring network for groundwater levels in the GSP. An additional well (01S10E04C001M) was added during WY 2020 in an effort to fill identified data gaps in the Subbasin.

2 A radius of 2 miles was used for well 03N07E21L003 to reflect domestic well depths in close proximity to the Mokelumne River.

2.2.8 Implementation

Implementation of the GSP includes monitoring of conditions, comparing against sustainable management criteria, reporting of those conditions, evaluating the GSP, implementing adaptive management strategies, implementing projects and management actions, and funding of these activities. Data are collected through monitoring on a prescribed schedule for each monitoring network. The data collected are used to improve the understanding of the Subbasin, as well as for comparison with the sustainable management criteria. Each representative monitoring well site included in each monitoring well network has defined quantitative measurable objectives and minimum thresholds for each applicable sustainability indicator. Comparison of monitoring well data and measurable objectives allow for assessment and tracking of desired conditions. Comparisons with minimum thresholds allow for assessment and tracking of undesirable results.

While undesirable results are not anticipated, should groundwater levels at representative monitoring sites begin to approach minimum thresholds, the ESJGWA will convene a working group to evaluate adaptive management strategies, such as the implementation of groundwater pumping curtailments, land fallowing, etc. Further, the total percentage of representative sites exceeding minimum thresholds will be calculated and compared against the percentage which has been identified as reflective of undesirable results.

Implementation activities are reported in annual reports due April 1st of each year and include conditions and activities from the previous water year. This WY 2022 report is the fourth annual report to be prepared follow GSP submittal on January 31, 2020. Evaluation reports will also be developed every five years to document progress on implementation and to reconsider elements of the GSP.

The Eastern San Joaquin Subbasin applied for funding under the Proposition 68 Sustainable Groundwater Planning Grant Program, Round 3. The ESJGWA was awarded $500,000 on January 24, 2020 and will be used to install additional monitoring wells adjacent to the Delta to assess cross-boundary flows in the area, improve the existing DMS, and design a Rate Study to develop a cost allocation framework that will help the Subbasin identify how costs for implementation activities will be distributed between GSAs. Additionally, the ESJGWA recently received funding under the Proposition 68 Sustainable Groundwater Management Grant Program – Critically Overdrafted Basin SGMA Implementation Round 1 to implement projects that enhance direct recharge in the Subbasin. Projects in the Subbasin are being implemented at the GSA level and include monitoring and reporting, model verification efforts, and public engagement and outreach. Finally, the ESJGWA submitted a grant application under the Proposition 68 Sustainable Groundwater Management Grant Program Round 2 for additional funding to further implementation of the identified projects.

2.3 GSP IMPLEMENTATION PROGRESS

Throughout the GSP development process, measurable objectives, interim milestones, and minimum thresholds for applicable sustainability indicators, as well as projects and management actions, were identified to aid in maintaining sustainable conditions throughout the Subbasin. Implementation progress of projects, management actions, and adaptive management activities are detailed in **Appendix A**. The following sections describe progress made in achieving the interim milestones identified in the GSP for groundwater levels and groundwater quality.

Groundwater levels are used as a proxy for reduction in groundwater storage, land subsidence, and depletion of interconnected surface water. Monitoring for saltwater migration is done in conjunction with measuring chloride concentrations through the groundwater quality representative monitoring network wells. The ESJWRM was used to quantify recent changes in groundwater storage to reflect WY 2016 to 2022 for this Annual Report, described in Section 3.3. During WY 2022, conditions relative to all thresholds for all applicable sustainability indicators were considered sustainable.

It should be noted that since early 2020, GSP implementation has been affected by the coronavirus pandemic (COVID-19) as GSA employees were encouraged to work from home and avoid public gatherings to prevent the spread of the virus. Monitoring activities that required traveling and in-person contact may have been temporarily suspended or delayed in accordance with State and public health guidelines, resulting in monitoring data gaps during WY 2022. Pandemic restrictions may have also delayed implementation progress of projects, management actions, and adaptive management activities described in **Appendix A**.

2.3.1 Groundwater Levels

An analysis was performed to determine conditions relative to established thresholds (including interim milestones for 2025, measurable objectives, and minimum thresholds) during WY 2022 for the chronic lowering of groundwater levels sustainability indicator (**Table 3**). All representative monitoring network wells were monitored in WY 2022 at least once. Attempts were made to monitor seven wells, but they were deemed temporarily inaccessible. Two of those wells became accessible by Spring 2022. Groundwater levels at these wells will be reported on in future annual reports. Hydrographs with historical data at each of the 20 representative monitoring network wells are included in **Appendix B**.

As defined in the GSP, interim milestones are established as the current condition for the first 10 years and then follow a linear trend between the current condition and the measurable objective.

Table 3. Chronic Lowering of Groundwater Levels Threshold Analysis:

Well ID	CASGEM ID	Interim Milestone (2025) (IM)	Measurable Objective (MO)	Minimum Threshold (MT)	Fall 2021 (Seasonal Low)	Difference between Fall 2021 (ft msl)			Spring 2022 (Seasonal High)	Difference between Spring 2022 (ft msl)		
		(ft msl)	(ft msl)	(ft msl)	(ft msl)	IM	MO	MT	(ft msl)	IM	MO	MT
01S09E05H002	378824N1210000W001	-8.7	-19.6	-49.8	-17.1	-8.4	2.5	32.7	-18.6	-9.9	1.0	31.2
01N07E14J002	379316N1211665W001	-49.9	-70.4	-114.4	-61.4	-11.5	9	53	-60.4	-10.5	10.0	54.0
Lodi City Well #2	Not Part of CASGEM Program	0.6	-3.5	-38.5	-0.06	-0.66	3.44	38.44	-0.06	-0.7	3.4	38.4
Manteca 18	Not Part of CASGEM Program	9.1	5.8	-16	0.8	-8.3	-5	16.8	1.8	-7.3	-4.0	17.8
Swenson-3	380067N1213458W003	-19.3	-19.3	-26.6	**	**	**	**	**	**	**	**
01S10E26J001M	378163N1208321W001	81.7	81.7	43.7	79	-2.7	-2.7	35.3	79.1	-2.6	-2.6	35.4
02N08E15M002	380206N1210943W001	-63.2	-69.7	-124.1	**	**	**	**	**	**	**	**
#3 Bear Creek	Not Part of CASGEM Program	-49.3	-50.3	-72.3	-58.7	-9.4	-8.4	13.6	-54.6	-5.3	-4.3	17.8
04N07E20H003M	381843N1212261W001	-35.5	-36.7	-81.7	-34.7	0.8	2	47	-33.4	2.1	3.3	48.3
03N07E21L003	380909N1212153W001	-51.5	-57.5	-100	*	*	*	*	-55.5	-4.0	2.0	44.5
Hirschfeld (OID-8)	Not Part of CASGEM Program	36	31.5	8	30.7	-5.3	-0.8	22.7	31.0	-5.0	-0.5	23.0
Burnett (OID-4)	377909N1208675W001	79.7	79.7	60.7	78.7	-1	-1	18	76.2	-3.5	-3.5	15.5
02S07E31N001	377136N1212508W001	13.8	13	1.5	16.4	2.6	3.4	14.9	17.9	4.1	4.9	16.4
02S08E08A001	377810N1211142W001	22.2	24	0.6	14.36	-7.84	-9.64	13.76	17.4	-4.8	-6.6	16.8
02N07E03D001	380578N1212017W001	-61.7	-79.7	-122.8	**	**	**	**	-57.7	4.0	22.0	65.1
01N09E05J001	379661N1210011W001	-20.2	-51.1	-86.8	**	**	**	**	**	**	**	**
02N07E29B001	379976N1212308W001	-49.8	-80.4	-130.1	**	**	**	**	**	**	**	**
04N05E36H003	381559N1213727W001	-5.1	-5.1	-31.1	-4.37	0.73	0.73	26.73	-4.1	1.0	1.0	27.0
03N06E05N003	381317N1213524W001	-14.1	-14.1	-35.1	**	**	**	**	-9.1	5.0	5.0	26.0
04N05E24J004	381816N1213723W001	-6.2	-6.2	-31.2	**	**	**	**	**	**	**	**
01S10E04C001M[1]	378846N1208816W001		70	50	*	*	*	*	60.5		-9.5	10.5

* Groundwater level data for WY 2022 unavailable.

** Well temporarily inaccessible. No measurement was taken.

[1] This well is a new representative monitoring network well. Interim Milestones for 2025 have not yet been established.

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2.3.2 Groundwater Storage

The GSP uses groundwater level minimum thresholds, measurable objectives, and interim milestones as a proxy for the reduction in groundwater storage sustainability indicator. An analysis to determine conditions relative to established thresholds (including interim milestones for 2025, measurable objectives, and minimum thresholds) during WY 2022 for the chronic lowering of groundwater levels sustainability indicator is described in Section 3.2. The ESJWRM was updated to estimate the changes in groundwater storage during WY 2022, as described in Section 3.3.

2.3.3 Groundwater Quality

An analysis was performed to determine conditions relative to established sustainable management criteria (including interim milestones for 2025, measurable objectives, and minimum thresholds) during WY 2022 for the degraded water quality sustainability indicator (**Table 2)**. During WY 2022, TDS was sampled at 119-075-01 and specific conductance was sampled at Well 1, 2, and 3 and converted to TDS. TDS was not sampled at Stockton 10R, 26, and SSS8. Stockton 26 was decommissioned during the reporting period and will be replaced by a neighboring well in City of Stockton in the representative monitoring network. Stockton SSS8 was inactive in WY 2022 due to impacts of PFOA, but City of Stockton is expected to be able to conduct water quality monitoring in WY 2023.

As defined in the GSP, interim milestones are established following a linear trend between the current condition and measurable objective. In many cases, the most recent available data are what was presented in the GSP. Additional groundwater quality data will be collected and reported moving forward as part of GSP implementation.

Table 4. Degraded Water Quality Threshold Analysis

Well ID	Interim Milestone (2025)	Measurable Objective	Minimum Threshold	Current Conditions from GSP	WY 2022, if available**	
	(Total Dissolved Solids, mg/L)	(Total Dissolved Solids, mg/L)	(Total Dissolved Solids, mg/L)	(Total Dissolved Solids, mg/L)	Date of Measurement	(Total Dissolved Solids, mg/L)
Well 1	525	600	1,000	500	10/06/2021	406[2]
Well 2	532.5	600	1,000	510	10/06/2021	545[3]
Well 3	532.5	600	1,000	510	10/06/2021	470[4]
Stockton 10R	391.5	600	1,000	322	-	No Data[5]
Stockton 26	412.5	600	1,000	350	-	No Data[6]
Stockton SSS8	427.5	600	1,000	370	-	No Data[7]
Well 15	375	600	1,000	300	-	No Data[8]
Well 16	360	600	1,000	280*	8/23/2022	260
Well 17	375	600	1,000	300*	-	No Data[9]
119-075-01	375	600	1,000	300	11/9/2022	340

*Calculated by averaging 2012-2018 data due to limitations on data availability.
**For wells where Water Year 2022 data are unavailable, the current conditions presented in the GSP represent the most recent available information, unless noted otherwise.

[2] Measurement was reported as specific conductance (micromhos per centimeter [umho/cm]) and converted to TDS.
[3] Measurement was reported as specific conductance (micromhos per centimeter [umho/cm]) and converted to TDS.
[4] Measurement was reported as specific conductance (micromhos per centimeter [umho/cm]) and converted to TDS.
[5] No data available for WY 2022. The most recent measurement for Stockton 10R was 350 mg/L on 2/17/2021. Data from this well will be reported in WY 2023.
[6] City of Stockton Well 26 has been decommissioned and was inactive at the time this report was developed. This well will be replaced in the representative monitoring network for water quality by a neighboring City of Stockton well.
[7] City of Stockton Well SSS8 was inactive due to PFOA impacts during WY 2022. Well SSS8 was active in early WY 2023 and therefore will be reported in the WY 2023 annual report.
[8] No data available for WY 2022 because City of Manteca monitors these wells for TDS every 3 years. The most recent measurement for Well 15 was 310 mg/L on 8/12/2021.
[9] No data available for WY 2022 because City of Manteca monitors these wells for TDS every 3 years. The most recent measurement for Well 17 was 320 mg/L on 5/11/2021.

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2.3.4 Saltwater Migration

An analysis was performed to determine conditions relative to established sustainable management criteria (including measurable objectives and minimum thresholds) during WY 2022 for the saltwater migration indicator (**Table 5**). Chloride concentrations were monitored at 119-075-01. Chloride concentrations were not monitored at Well 1, Well 2, Well 3, Stockton 10R, Stockton 26, Stockton SSS8, or at Manteca Wells 15, 16, and 17. Stockton 26 was decommissioned during the reporting period and will be replaced by a neighboring well in City of Stockton in the representative monitoring network. Stockton SSS 8 was inactive in WY 2022 due to impacts of PFOA, but City of Stockton is expected to be able to conduct water quality monitoring in WY 2023.

Interim milestones, which are based on the measurable objective, are not included in **Table 5** as these will be further developed through ongoing water quality monitoring.

Table 5. Saltwater Migration Threshold Analysis

Well ID	Measurable Objective	Minimum Threshold	WY 2022, if available**	
	(Chloride, mg/L)	(Chloride, mg/L)	Date of Measurement	(Chloride, mg/L)
Well 1	500	2,000	-	No Data
Well 2	500	2,000	-	No Data
Well 3	500	2,000	-	No Data
Stockton 10R	500	2,000	-	No Data[10]
Stockton 26	500	2,000	-	No Data[11]
Stockton SSS8	500	2,000	-	No Data[12]
Well 15	500	2,000	-	No Data[13]
Well 16	500	2,000	8/23/2022	16
Well 17	500	2,000	-	No Data[14]
119-075-01	500	2,000	11/9/2022	27

**For wells where Water Year 2022 data are unavailable, the current conditions presented in the GSP represent the most recent available information, unless noted otherwise.

2.3.5 Land Subsidence

The GSP uses groundwater level minimum thresholds, measurable objectives, and interim milestones as a proxy for the land subsidence sustainability indicator. An analysis to determine conditions relative to established thresholds (including interim milestones for 2025, measurable objectives, and minimum thresholds) during WY 2022 for the chronic lowering of groundwater levels sustainability indicator is

[10] No data available for WY 2022. The most recent measurement for Stockton 10R was 20 mg/L on 2/17/2021. Data from this well will be reported in WY 2023.

[11] City of Stockton Well 26 has been decommissioned and was inactive at the time this report was developed. This well will be replaced in the representative monitoring network for water quality by a neighboring City of Stockton well.

[12] City of Stockton Well SSS8 was inactive due to PFOA impacts during WY 2022. Well SSS8 was active in early WY 2023 and therefore will be reported in the WY 2023 annual report.

[13] No data available for WY 2022 because City of Manteca monitors these wells for Chloride every 3 years. The most recent measurement for Well 15 was 15 mg/L on 8/12/2021.

[14] No data available for WY 2022 because City of Manteca monitors these wells for Chloride every 3 years. The most recent measurement for Well 17 was 17 mg/L on 5/11/2021.

described in Section 3.2. Additionally, per publicly available datasets, there are three Continuous GPS subsidence monitoring stations in the Subbasin, P273, CNDR and P309 that were measured during WY 2022 along with InSAR data released by DWR. P273 showed no land subsidence over WY 2022. P309 showed <0.01 feet of land subsidence over WY 2022 and CNDR showed 0.01 feet of land subsidence (both within the realm of error) over the last water year. These results are reflected in the recently released InSAR data which show that no land subsidence occurred in the Eastern San Joaquin Subbasin greater than 0.1 feet.

2.3.6 Groundwater-Surface Water Interaction

The GSP uses groundwater level minimum thresholds, measurable objectives, and interim milestones as a proxy for the depletions of interconnected surface water sustainability indicator. An analysis to determine conditions relative to established thresholds (including interim milestones for 2025, measurable objectives, and minimum thresholds) during WY 2022 for the chronic lowering of groundwater levels sustainability indicator is described in Section 3.2.

3. GROUNDWATER MONITORING AND CONDITIONS ASSESSMENT

This section discusses hydrologic conditions, groundwater elevation trends, groundwater quality, and groundwater-surface water interaction in the Eastern San Joaquin Subbasin.

3.1 HYDROLOGIC CONDITIONS:

Rainfall data derived from the PRISM (Precipitation-Elevation Regressions on Independent Slopes Model) dataset of the DWR's California Simulation of Evapotranspiration of Applied Water (CALSIMETAW) model indicate a Subbasin average of 14 inches of rainfall during WY 2022. This represents approximately 90% of the long-term (WY 1969-2018) Subbasin average precipitation of 15.4 inches. San Joaquin River flow at Vernalis for the same period had an average monthly discharge of approximately 110 thousand acre-feet, representing about 17% of the long-term (WY 1930-2020) average flow at that location (USGS, 2023). The Cosumnes River at Michigan Bar for this period had an average monthly discharge of approximately 18 thousand acre-feet, representing about 56% of the long-term (WY 1965-2020) average flow at that location (USGS, 2023); and the Calaveras River flow below New Hogan Dam had an average monthly discharge of approximately 7.9 thousand acre-feet, representing about 62% of the long-term (WY 1965-2020) average flow at that location (US Army Corps of Engineers, 2023).

3.2 GROUNDWATER LEVELS:

Figure 2 shows the location of the representative wells identified in the GSP monitoring network for the chronic lowering of groundwater levels. Individual hydrographs[15], charts of groundwater levels over time, for these wells are included in **Appendix B**. The hydrographs display historical trends of groundwater levels in the Subbasin through WY 2022, contingent upon data availability. All available data are shown (DWR, 2023b). Hydrographs for representative monitoring wells also display the quantitative minimum threshold and measurable objective that were developed in Chapter 3 (Sustainable Management Criteria) of the GSP.

All hydrographs show yearly cycles of groundwater level declines in summer due to typical patterns in groundwater pumping and recharge during winter recovery. Of the 21 representative monitoring wells, 12 wells reported groundwater levels for Fall 2021 and 16 wells in Spring 2022 as shown in **Table 3**. Water levels fluctuated around the measurable objective for multiple representative wells, remaining an average of 0.5 feet below the measurable objectives in Fall 2021 and 1.1 feet above the measurable objectives in Spring 2022. Seven representative wells (Manteca 18, 01S10E26J001M, #3 Bear Creek, Hirschfeld (OID-8), Burnett (OID-4), 02S08E08A001, and 01S10E04C001M1) reported Spring 2022 levels that did not meet the measurable objective. Water levels remained an average of 30.8 feet above the minimum threshold for all representative wells with reported data in Spring 2022. No wells reported groundwater levels below the minimum threshold, and as a result, no undesirable results were triggered as specified by the sustainable management criteria set in the GSP.

According to DWR's Dry Well Reporting System, Eastern San Joaquin Subbasin had 54 reported water shortages from dry wells in the 365 days prior to the preparation of this report (DWR, 2023a).

Hydrographs showing WY 2022 for wells in the broad monitoring network are included in **Appendix C**.

[15] Except where noted, groundwater levels in hydrographs were converted to the North American Vertical Datum of 1988 (NAVD88), consistent with CASGEM groundwater data reporting.

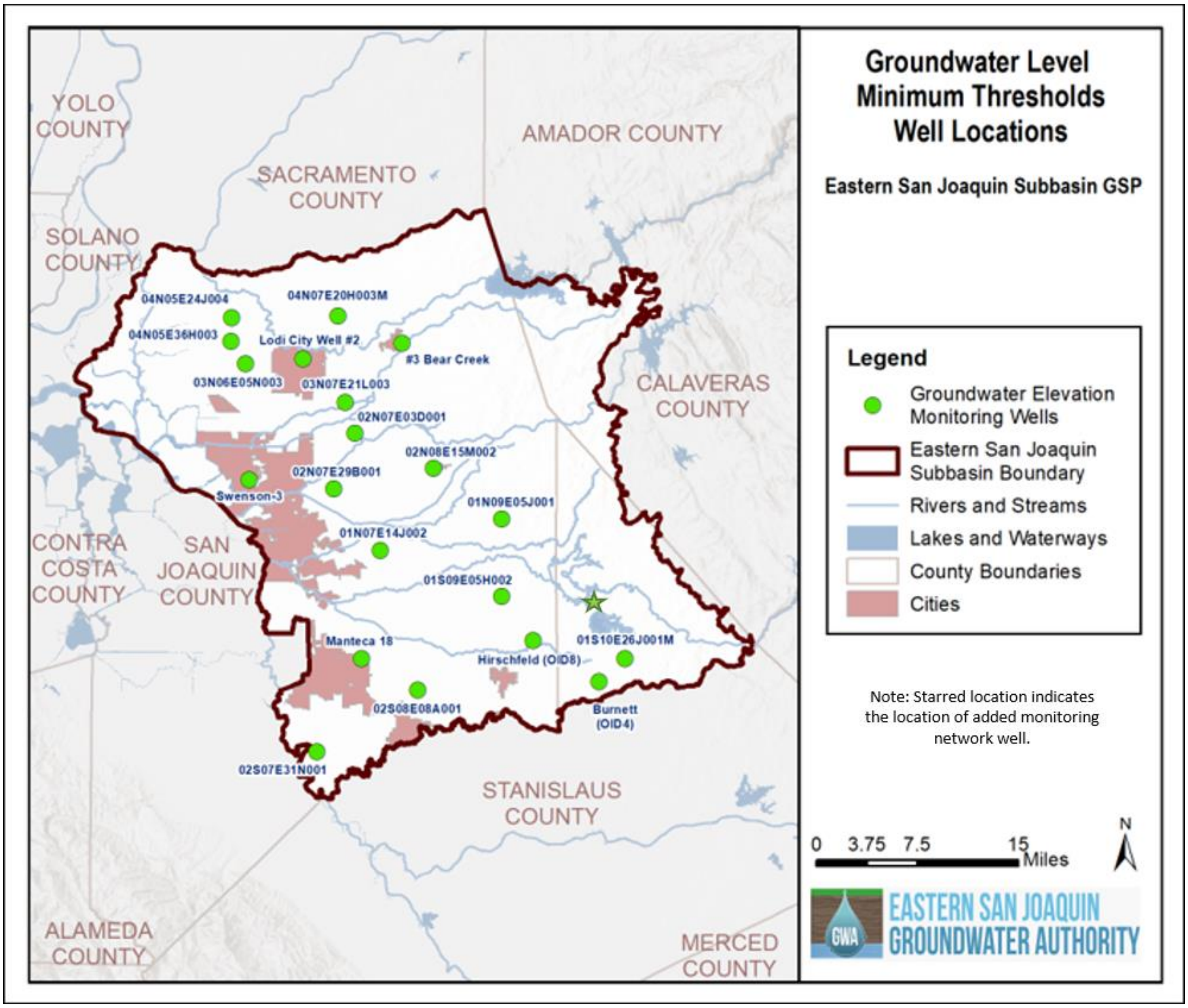


Figure 2. Groundwater Level Representative Monitoring Well Locations

3.2.1 Comparison of Current and Historical Spring Groundwater Levels

A comparison of Spring 2022 groundwater levels with the range of historical spring levels for representative wells in the Subbasin shows a general trend of decreasing groundwater levels. Groundwater levels decreased an average of 3.3 feet between Spring 2021 and Spring 2022 for representative wells with WY 2021 and WY 2022 data. This trend correlates with increased groundwater use during dry years, which is not surprising given WY 2022 was a critical (C) water year under the San Joaquin Valley Water Year Hydrologic Index following critical and dry water years before that (WY 2021 and WY 2020, respectively).

3.2.2 Groundwater Level Contour Maps:

Groundwater level contour maps were developed as part of this annual report to represent seasonal high and seasonal low conditions. Fall 2021 (September, October, November 2021) and Spring 2022 (March, April, May 2022) groundwater elevation maps are included in **Figure 3** and **Figure 4**.

Previous work expanded the groundwater level period to include September and November 2021 and May 2022 for seasonal low and seasonal high readings, respectively. This definition was used again in this year's annual report for consistency. This approach reduces the impact of disruptions, whether for unanticipated COVID-19 reasons or for well accessibility issues, to the monitoring data quality used to develop the groundwater contour map. This also allowed the analysis to capture a larger dataset and better represent current conditions.

Groundwater levels in the center of the Subbasin fell slightly between Spring of WY 2021 and the beginning of WY 2022 (Fall 2021). Between Fall WY 2022 (Fall 2021) and Spring WY 2022 (Spring 2022), groundwater levels stayed relatively constant, likely reflecting the dry conditions of the winter season during WY 2022 that did not cause the typical seasonal high rise.

Groundwater elevation contours shown in **Figure 3** and **Figure 4** used the Inverse Distance Weighting (IDW) interpolation method (as opposed to the spline interpolation used in the GSP) as the IDW method better represented the updated data set. Areas where there were limited WY 2022 data available are indicated with hash marking on both figures. There is a notable data gap on the eastern side of the Subbasin. Installation of new monitoring wells in these regions as part of GSP implementation, as well as corresponding changes to groundwater level monitoring, will be critical in filling these data gaps.

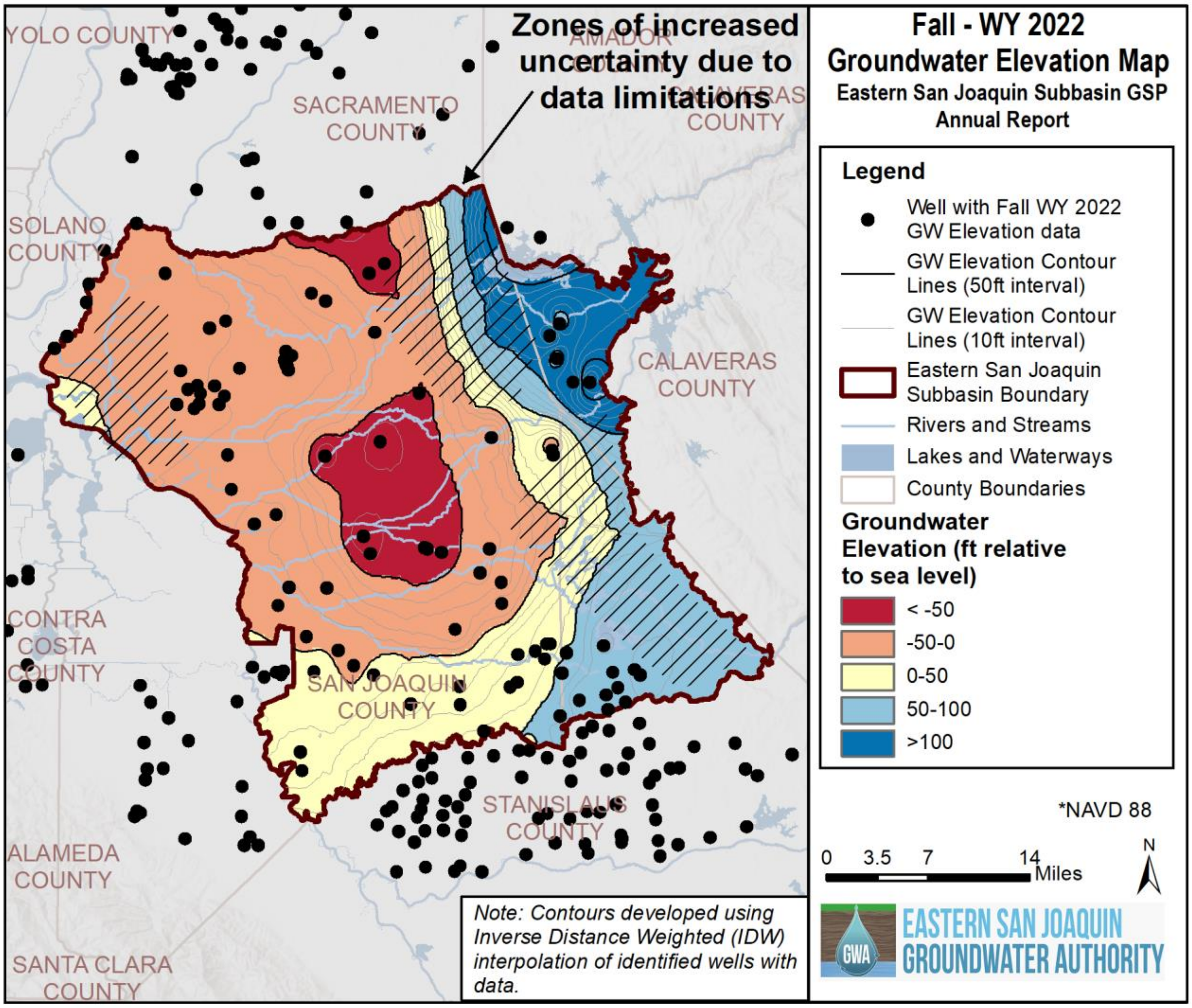


Figure 3. Seasonal Low Groundwater Levels in the Eastern San Joaquin Subbasin, based on data from September 2021 (WY 2021), October and November 2021 (WY 2022)

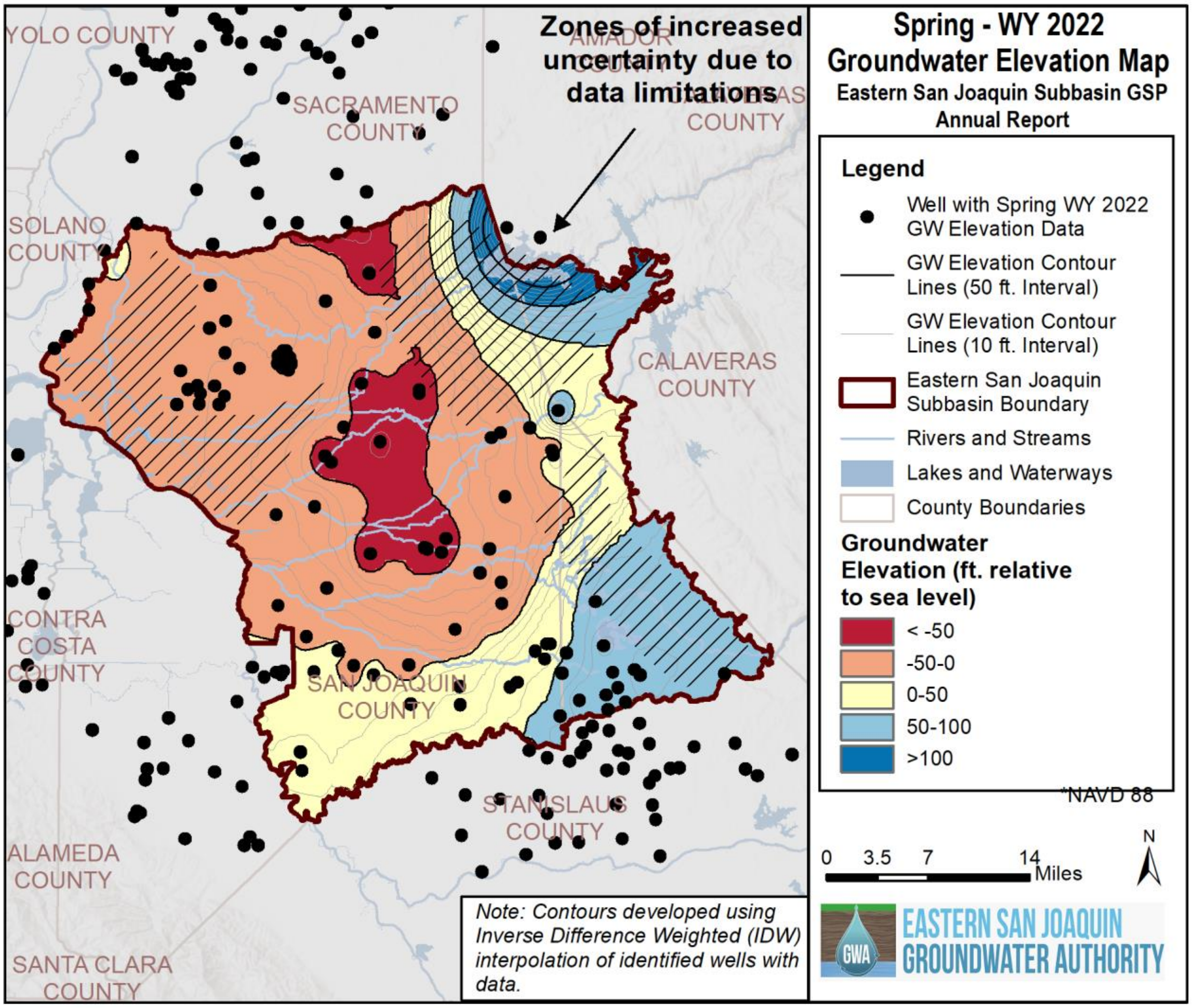


Figure 4. Seasonal High Groundwater Levels in the Eastern San Joaquin Subbasin, based on data from March, April, and May 2022 (WY 2022)

3.3 GROUNDWATER STORAGE

Change in groundwater storage is estimated using the ESJWRM. **Figure 5** shows the annual and cumulative change in storage from WY 1996 to 2022 for the Eastern San Joaquin Subbasin. In WY 2022 (October 1, 2021 to September 30, 2022), the Eastern San Joaquin Subbasin saw a decrease of groundwater in storage of approximately 122,000 AF, reflecting the dry conditions of the year. **Figure 5** indicates positive "Change in Storage", meaning that inflows (consisting of deep percolation, recharge, flow from streams, and boundary inflows) were less than outflows in WY 2022. **Figure 6** adds all inflows together to highlight the annual change in storage. **Figure 7** shows this inverse "Change in Storage" plotted with "Groundwater Pumping" and "Cumulative Change in Storage."

Figure 8 shows the change in groundwater storage for the Eastern San Joaquin Subbasin by ESJWRM element between October 1, 2021 and September 30, 2022. On an ESJWRM element basis, groundwater storage was estimated to increase or decrease by 0.25 feet over much of the Subbasin, with an area of decrease of up to 2 feet in the center of the Subbasin due to decreased surface water availability and subsequent increased agricultural groundwater pumping compared to WY 2021. The north-central portion of the Subbasin experienced the largest increase in storage in comparison to WY 2021, with a 2-foot increase through WY 2022. Though change in storage varied on an ESJWRM element basis, there was an overall net decrease in groundwater storage in the Eastern San Joaquin Subbasin during WY 2022, as previously stated and reflected in **Figure 5** to **Figure 7,** and mapped in **Figure 8.**

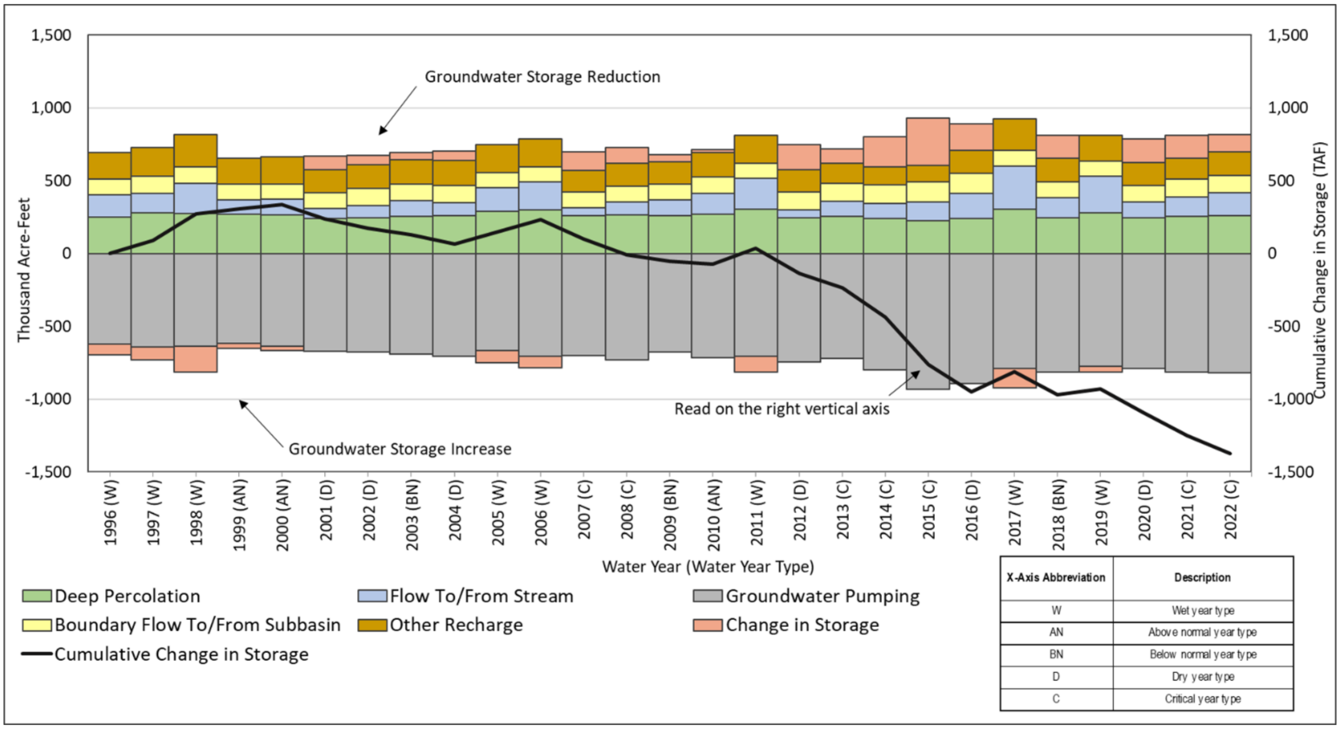


Figure 5. Modeled Change in Annual Storage with Water Use and Year Type

Notes:

1. Water Year Types based on San Joaquin Valley Water Year Index (CA DWR, 2022). Water Year 2022 classification is critical (C) based on the hydrologic conditions for that year.
2. “Other Recharge” includes managed aquifer recharge, recharge from unlined canals and/or reservoirs, and recharge from ungauged watersheds.
3. “Change in Storage” balances the water budget. For instance, if annual outflows (-) are greater than inflows (+), there is a decrease in storage, but this would be shown as storage depletion on the positive side of the bar chart to balance out the increased outflows on the negative side of the bar chart.
4. The uncertainty associated with estimating change in storage using ESJWRM was evaluated using sensitivity analysis. This analysis indicates that the average difference in change in storage estimates varies approximately 47% across all sensitivity runs.

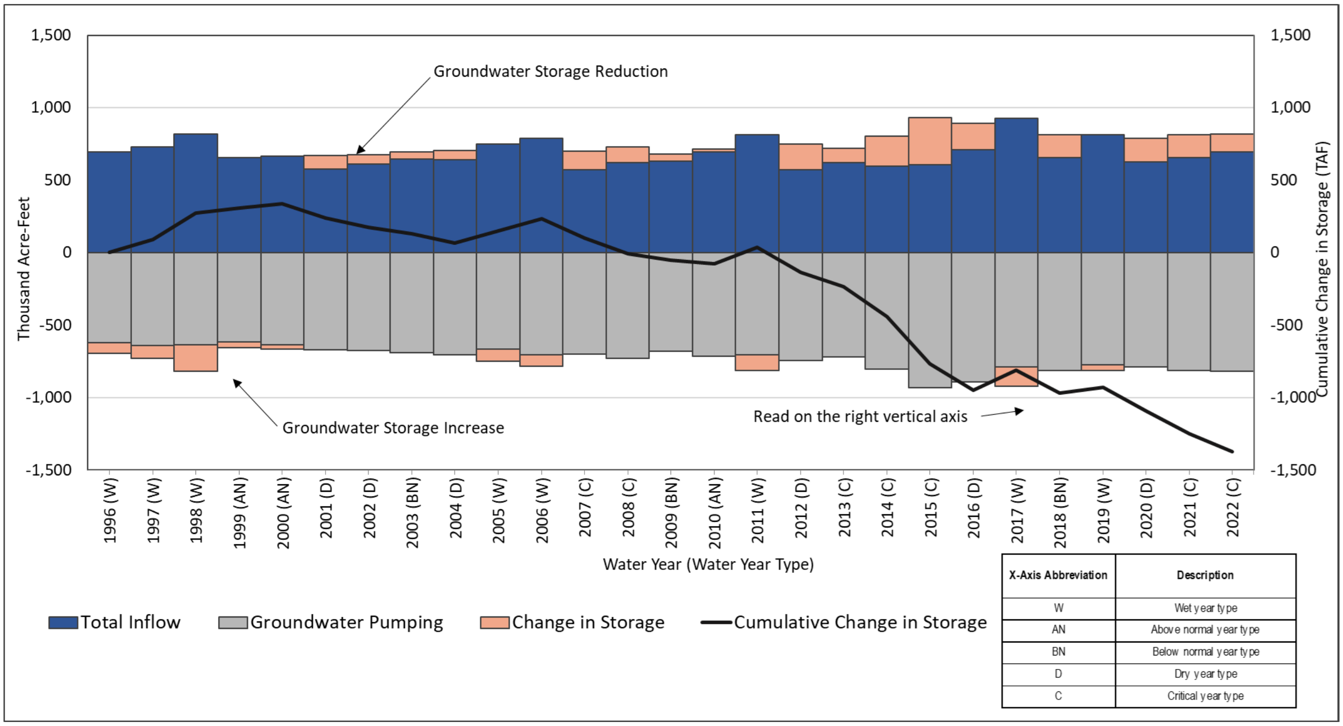


Figure 6. Modeled Change in Annual Storage with Inflows and Year Type

Notes:

1. Water Year Types based on San Joaquin Valley Water Year Index (CA DWR, 2018). Water Year 2022 classification is critical (C) based on the hydrologic conditions that year.
2. "Total Inflow" includes "Deep Percolation", "Flow To/From Stream", "Other Recharge", and "Boundary Flow To/From Subbasin" from **Figure 5**.
3. "Change in Storage" balances the water budget. For instance, if annual outflows (-) are greater than inflows (+), there is a decrease in storage, but this would be shown as storage depletion on the positive side of the bar chart to balance out the increased outflows on the negative side of the bar chart.

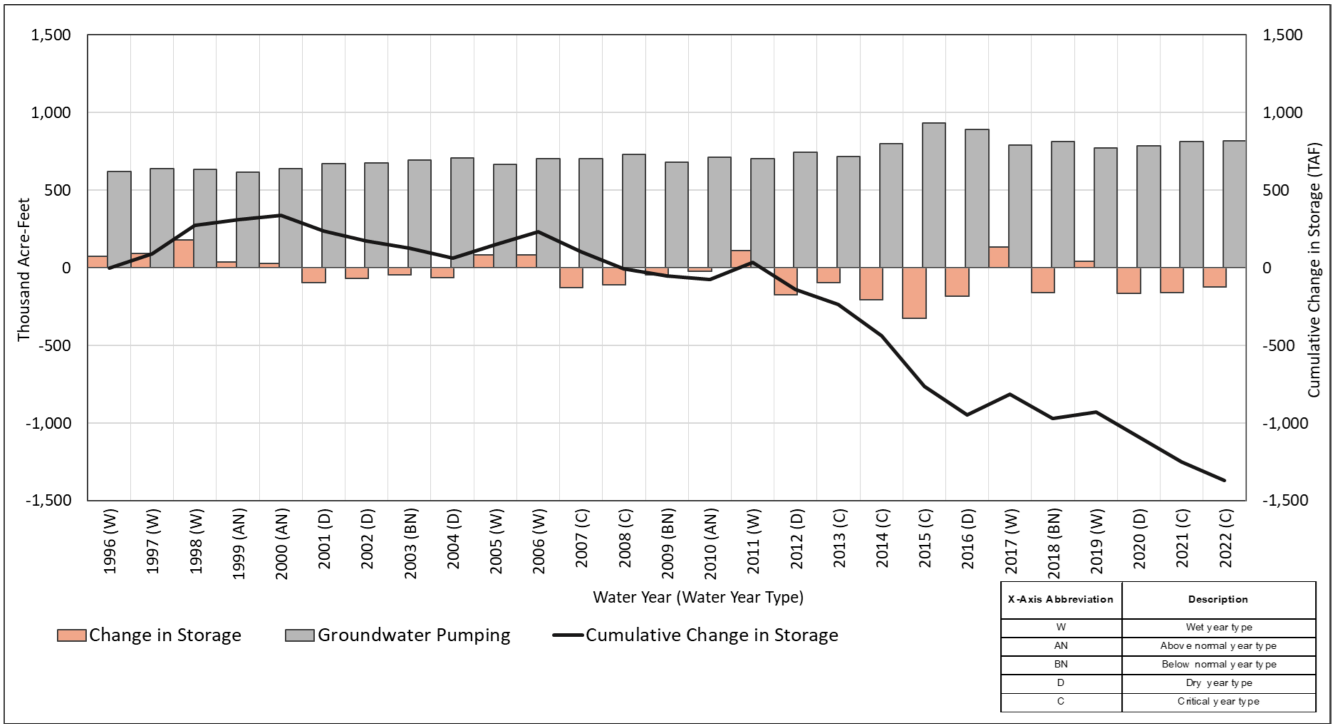


Figure 7. Modeled Change in Annual Storage with Groundwater Pumping and Year Type

Notes:

1. Water Year Types based on San Joaquin Valley Water Year Index (CA DWR, 2018). Water Year 2022 classification is critical (C) based on the hydrologic conditions for this analysis, however, the San Joaquin Valley Water Year Index has not yet published the WY 2022 designation.
2. "Groundwater Pumping" and "Change in Storage" are the inverse of what is shown in **Figure 5** and **Figure 6**. In this figure, a positive "Change in Storage" indicates an increase in groundwater storage, while a negative "Change in Storage" indicates a decrease in groundwater storage. These changes are directly reflected in the "Cumulative Change in Storage" line. The annual "Groundwater Pumping" is shown adjacent to the "Change in Storage" for the same year.

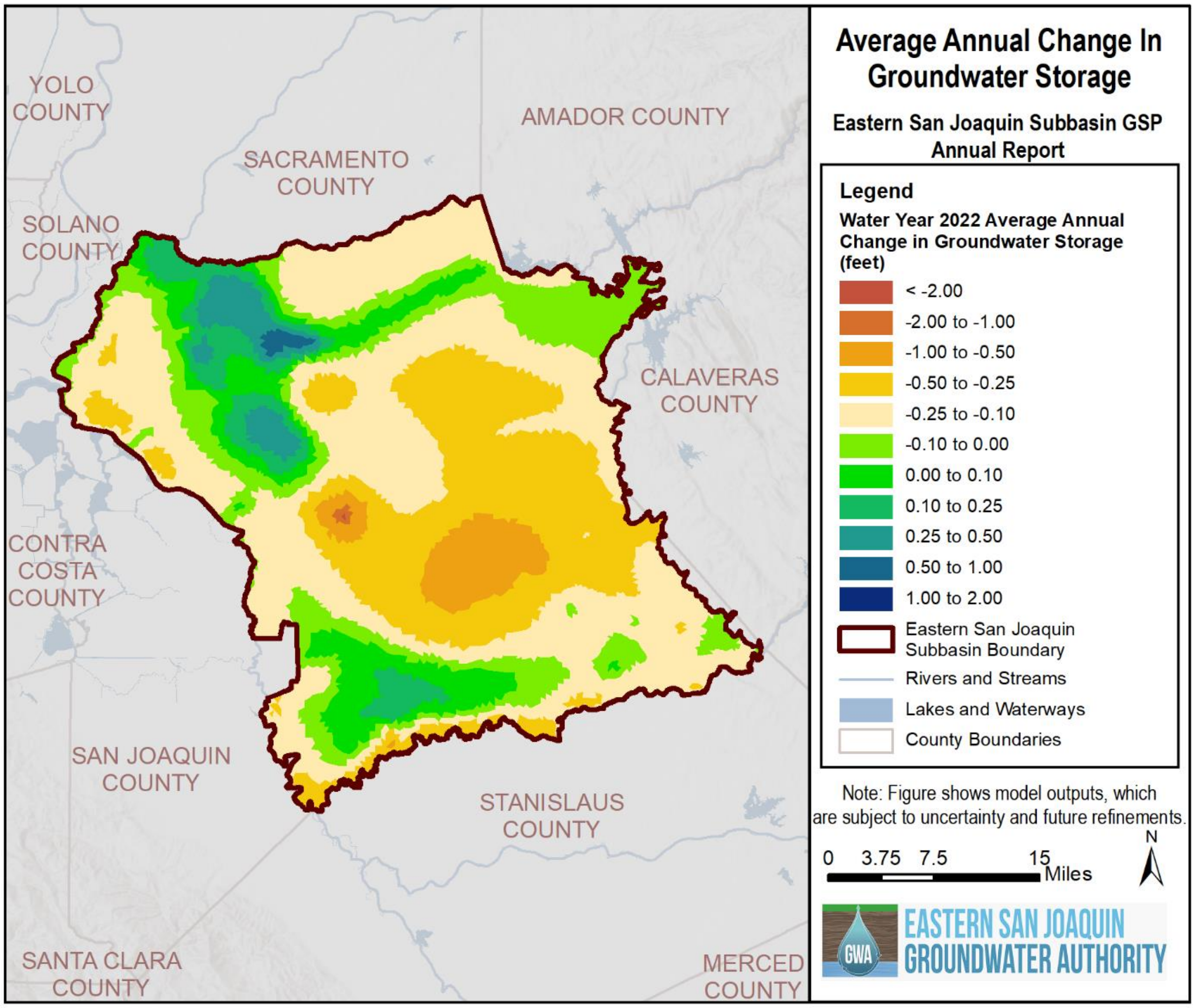


Figure 8. Eastern San Joaquin Subbasin WY 2022 Change in Storage

3.4 GROUNDWATER QUALITY

While groundwater quality in the Eastern San Joaquin Subbasin is generally sufficient to meet beneficial uses and is on track to surpass measurable objectives, there are a few constituents of concern that are either currently impacting groundwater use or could impact groundwater in the future. Each water quality parameter may be naturally occurring or anthropogenic in source, as well as localized or widespread. The primary naturally occurring water quality constituents of concern in the Eastern San Joaquin Subbasin are salts and arsenic. The primary water quality constituents related to human activity include nitrates, salts, and various point-source contaminants such as petroleum hydrocarbons, solvents, and emerging contaminants. Historical groundwater quality conditions for these constituents are described in Section 2.2.4 in the GSP.

A primary maximum contaminant level (MCL) or secondary maximum contaminant level (SMCL) is defined for a variety of parameters. For the purposes of this GSP, comparing parameter concentrations to their MCL or SMCL is used as the basis for describing groundwater quality concerns in the Eastern San Joaquin Subbasin. Water quality has generally not significantly affected beneficial uses of groundwater in the Eastern San Joaquin Subbasin.

Through GSP implementation, monitoring networks for water quality are tested for TDS, cations and anions (including chloride and nitrate), arsenic, and field parameters including pH, electrical conductivity (EC), and temperature. Arsenic and nitrate are monitored for informational purposes only and to track trends in arsenic concentrations, especially as projects are implemented; the GSP does not include sustainability goals, measurable objectives, or minimum thresholds for arsenic or nitrate. Through new monitoring efforts, the GSP will document trends in monitored constituents and identify opportunities for coordination with existing programs. Through coordination with existing agencies and through additional monitoring, the ESJGWA will know if existing regulations are being met or if groundwater management activities in the Subbasin are contributing to significant and unreasonable undesirable effects related to degraded water quality. (It should be noted that arsenic and nitrate are currently regulated in the Subbasin through existing water resources monitoring and management programs such as the Irrigated Lands Regulatory Program. If groundwater quality conditions violate those regulations, or if monitoring efforts indicate concerning trends, the ESJGWA will take steps to coordinate with regulatory agencies implementing those programs and will evaluate establishing minimum thresholds and measurable objectives for these constituents at that time.)

Ten representative monitoring wells were selected to be monitored for water quality. These wells are currently monitored and managed by City of Manteca, Cal Water, City of Stockton, and San Joaquin County. These measurements are logged in **Table 4** in Section 2.3.3, GSP Implementation Progress of this Annual Report. Details regarding the status of wells that were not sampled during WY 2022 are also included. There were no minimum threshold exceedances to report for WY 2022.

The broad monitoring network for water quality includes sampling from five identified local water quality wells and 16 nested and/or clustered well sites that are also monitored for groundwater levels in the broad monitoring network for groundwater levels.

3.4.1 Total Dissolved Solids Measurements in Representative Monitoring Network Wells

During WY 2022, TDS measurements were reported from five of the ten representative monitoring wells for water quality. The five wells without data were not sampled for a variety of reasons, including due to inactive wells as a result of PFOA impacts. The most recent figures available are included in footnotes beneath **Table 4,** and the locations of the ten representative monitoring wells are shown in **Figure 9**. There were no minimum threshold exceedances to report for WY 2022.

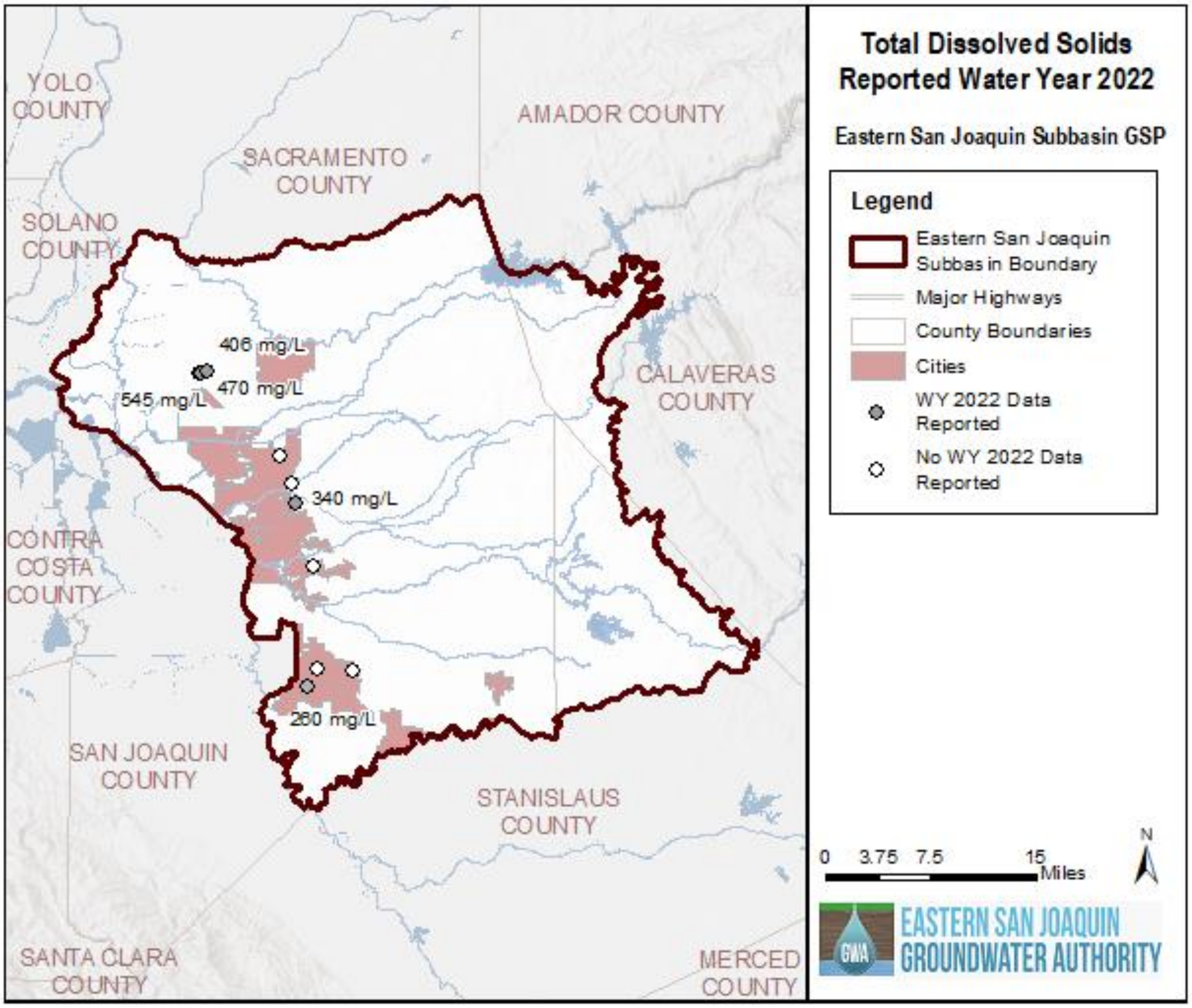


Figure 9. Water Year 2022 Total Dissolved Solids Measurements at Representative Monitoring Well Sites

3.4.2 Contaminated Sites

At the time of preparation of this annual report, there were 175 open or active point source contamination sites identified by GeoTracker in the Eastern San Joaquin Subbasin. Of these, there are 125 sites that have ongoing cleanup programs in progress and 58 of these sites are identified as locations of leaking underground storage tanks (LUSTs) that are being remediated. There is one Superfund site within the Subbasin boundary, in the City of Stockton (SWRCB, GeoTracker, 2023a). Real-time data are on contaminated sites added during a single water year are limited. However, updates regarding the status of contaminated sites within the Eastern San Joaquin Subbasins will be provided in subsequent Annual Reports where information is available.

3.4.3 Regional Groundwater Quality

The primary naturally occurring water quality constituents of concern are salinity and arsenic, while primary water quality constituents related to human activity include nitrates, salinity, and various point-source contaminants. According to the Combined Water Quality and Exposure Risk map, which shows aquifer risk based on groundwater that may not be meeting primary drinking water standards, water quality across the Subbasin is most degraded along the western side of the Subbasin, particularly in the southwest corner of the Subbasin and around the cities of Stockton and Lodi. Nitrate is designated as High Risk in these areas. High Risk areas for arsenic are mostly concentrated in the southwest corner of the Subbasin (SWRCB, 2023b).

3.5 SALTWATER MIGRATION

As described in the GSP, the ESJGWA monitors chloride concentrations to support information collection and early detection of saltwater intrusion and will report chloride concentrations to DWR in each annual report. While saltwater migration is not expected to occur, the GSP established monitoring protocols for the early detection of saltwater migration were it ever to occur. Chloride measurements were reported at two of the ten representative monitoring wells for water quality. The remaining eight representative monitoring wells were not sampled for a variety of reasons, including inactive wells due to PFOA impacts. These figures are included in **Table 5** and are shown visually in **Figure 10**. There were no minimum threshold exceedances for saltwater migration to report for WY 2022.

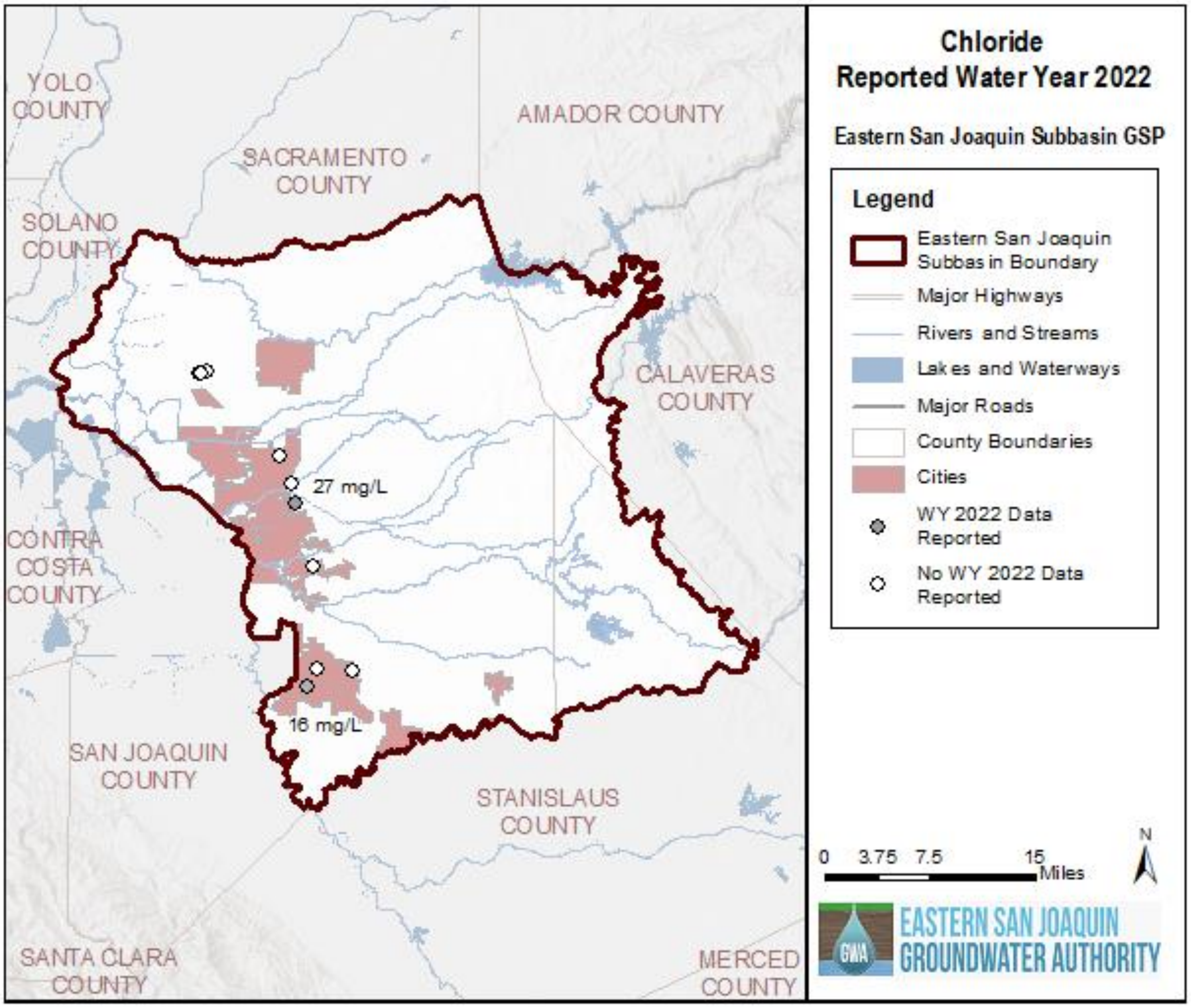


Figure 10. Water Year 2022 Chloride Measurements at Representative Monitoring Well Sites

3.6 LAND SUBSIDENCE

SGMA considers the impact of groundwater management actions on land subsidence through the land subsidence sustainability indicator. In the Eastern San Joaquin Subbasin, the land subsidence sustainability indicator uses the groundwater level sustainability indicator as a proxy. Minimum thresholds for groundwater levels are protective of significant and unreasonable impacts to land subsidence, as described in the GSP. There were no minimum threshold exceedances for groundwater levels; therefore, there are no land subsidence impacts to report for WY 2022.

Additionally, per publicly available datasets, there are three Continuous GPS subsidence monitoring stations in the Subbasin (P273, CNDR and P309) that were measured during WY 2022 along with InSAR data released by DWR. Data from these other sources support the Subbasin results that there were no land subsidence impacts in WY 2022.

3.7 GROUNDWATER-SURFACE WATER INTERACTION

SGMA considers the impact of groundwater management actions on groundwater-surface water interactions through the depletions of interconnected surface water sustainability indicator. In the Eastern San Joaquin Subbasin, the depletions of interconnected surface water sustainability indicator use the groundwater level sustainability indicator as a proxy. Minimum thresholds for groundwater levels are protective of significant and unreasonable impacts to interconnected surface waters, as described in the GSP. There were no minimum threshold exceedances for groundwater levels; therefore, there are no groundwater-surface water interaction impacts to report for WY 2022.

3.8 TOTAL WATER USE

3.8.1 Groundwater Use

Groundwater pumping data are available only from a limited number of metered wells within the Eastern San Joaquin Subbasin, with the remainder of extraction information estimated using ESJWRM[16]. Metered data are available from municipal water purveyors (Cal Water, City of Escalon, City of Lodi, City of Manteca, City of Ripon, City of Stockton, LCSD, and SEWD). Agricultural, private domestic, and other groundwater production in the Subbasin is largely unmetered and were estimated using the ESJWRM, which bases water use on crop type, hydrologic data (precipitation and evapotranspiration), irrigation efficiency, and population information. WY 2022 metered groundwater production was not available from LCWD and therefore was also estimated using the ESJWRM using the same approach.

Figure 11 shows the general location and volume of groundwater pumping within the Subbasin by ESJWRM element for WY 2022. Large portions of the Subbasin elements experience very little pumping between 0.0 to 0.5 AF/acre or feet, while areas with agriculture or municipal pumping wells have pumping ranging from 0.5 to approximately 10 AF/acre.

In WY 2022, total groundwater use in the Eastern San Joaquin Subbasin was estimated at 818,507 AF across water use sectors, as shown in **Table 6**. As the estimated sustainable yield of the Eastern San Joaquin Subbasin is 715,000 AFY ± 10 percent over the long-term, pumping may exceed the sustainable yield during certain years, balanced by other years with reduced pumping so that the long-term average remains at or below the sustainable yield. The groundwater use simulated in ESJWRM over the last 13 years (WY 2010-2022) ranged from a low of about 705,000 AF in WY 2011 (wet year) to a high of about 932,000 AF in WY 2015 (critical year), with 5 of the 13 simulated years staying within the range of the sustainable yield due to two droughts occurring during the simulation period. It is important to note that the ESJWRM was recently updated and recalibrated with more recent data; however, the Subbasin sustainable yield has not been recalculated following model's updated calibration.

3.8.2 Surface Water Use

Surface water delivery data are available from purveyors in the Subbasin and include deliveries for urban and industrial use (City of Lodi; City of Manteca; and City of Stockton, including Cal Water and unincorporated portions of San Joaquin County) and deliveries for agricultural use (CCWD, CSJWCD, NSJWCD, OID, SSJID, SEWD, and WID). The remaining surface water use is estimated in the ESJWRM

[16] A pilot project was undertaken in SEWD to test use of satellite technology to measure and quantify crop evapotranspiration. These measurements, in combination with known data on surface water deliveries, could provide a more direct measure of groundwater pumping for agricultural irrigation. The approach will be further evaluated and may be used along with modeling to quantify agricultural groundwater extractions in the future.

and includes riparian diversions occurring in the CDWA, SDWA, and along major Subbasin rivers. Sources of surface water in the Subbasin include Calaveras River, Mokelumne River, San Joaquin River, and Stanislaus River. Surface water deliveries during WY 2022 are estimated to be 552,372 AF for the Eastern San Joaquin Subbasin (**Table 7**), with most of the surface water used between May and September.

Conjunctive use is the use of surface water in coordination with groundwater to allow the Subbasin to recharge and store additional water supply, either through in-lieu use or direct recharge. In-lieu recharge occurs for both agricultural and municipal purveyors wherever surface water is being delivered to offset groundwater that would have otherwise been used. Agencies conducting in-lieu recharge include Cal Water, CCWD, City of Escalon, City of Lodi, City of Manteca, City of Ripon, City of Stockton, CSJWCD, LCWD, LCSD, NSJWCD, OID, SSJID, SEWD, and WID. While in-lieu recharge was not quantified separately in this report, estimates may be made in future annual reports.

Direct recharge projects exist in NSJWCD and SEWD and recharged over 8,700 AF in WY 2022. These projects use water from the Calaveras River, Mokelumne River, and Stanislaus River and include NSJWCD's Tracy Lake Groundwater Recharge Project, NSJWCD's Cal-Fed/Costa Recharge project, and SEWD's Farmington Groundwater Recharge Program.

3.8.3 Total Water Use

Total water use is the sum of the groundwater use and surface water use. Total water use during WY 2022 is estimated to be 1,370,879 AF for the Eastern San Joaquin Subbasin **(Table 8).** Groundwater pumping accounts for almost 60% of total water use in the Subbasin, while surface water deliveries are a little more than 40% of total water use.

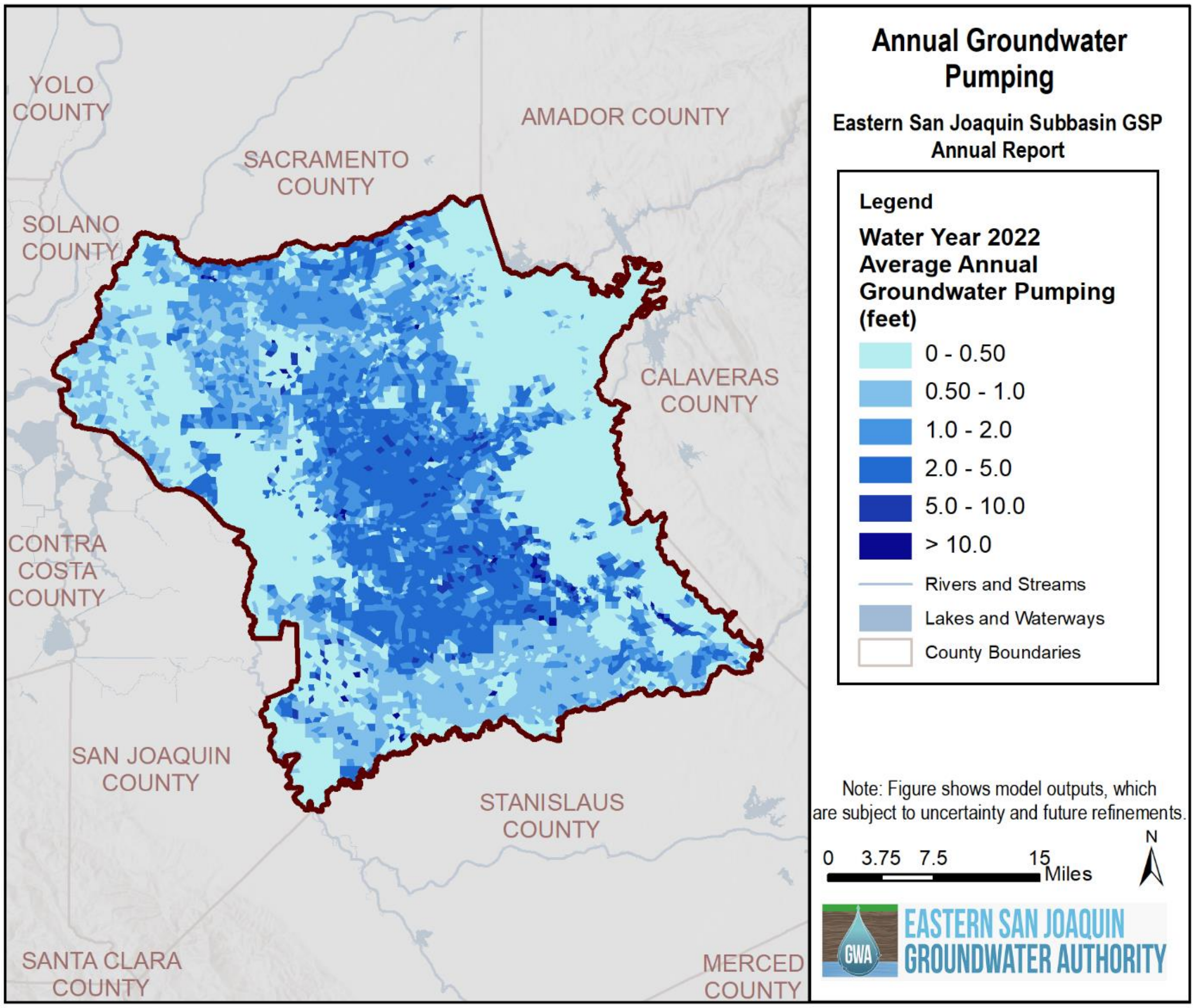


Figure 11. Eastern San Joaquin Subbasin WY 2022 Groundwater Extraction

Table 6. Water Year 2022 Monthly Groundwater Extraction (in acre-feet)[17]

Month	Agricultural		Urban and Industrial		Total
	*Agency Reported Values**	*Estimated Agricultural***	*Agency Reported Values**	*Private Domestic***	
Oct-21	109	76,900	2,453	1,400	80,862
Nov-21	62	4,000	1,700	1,000	6,761
Dec-21	84	3,800	1,231	900	6,015
Jan-22	57	5,600	1,070	900	7,627
Feb-22	342	19,400	1,687	800	22,229
Mar-22	159	12,100	2,371	1,100	15,730
Apr-22	153	75,700	2,038	1,200	79,091
May-22	601	136,000	2,581	1,800	140,983
Jun-22	555	127,300	3,178	1,600	132,634
Jul-22	516	104,300	3,641	1,700	110,156
Aug-22	439	124,600	3,702	1,300	130,042
Sep-22	276	81,600	3,301	1,200	86,377
Total	3,353	771,300	28,954	14,900	818,507
Measurement Accuracy	***High***	***Medium***	***High***	***Medium***	-

* Agency reported values for agriculture were collected for some of the agencies (Manteca and OID) that report pumping for either agricultural or landscape use.

** Additional groundwater pumping is estimated by the ESJWRM based on crop type, hydrologic data (precipitation and evapotranspiration), irrigation efficiency, and population information.

[17] Groundwater pumping estimated using ESJWRM assumes an uncertainty of +/- 20%. This uncertainty has been applied only to unmetered data, which have been rounded to indicate uncertainty. Metered data have been directly reported by the Subbasin GSAs.

Table 7. Water Year 2022 Monthly Surface Water Delivered for Use (in acre-feet)

Month	Agricultural		Urban and Industrial		Total
	*Agency Reported Values**	*Estimated Riparian***	*Agency Reported Values*	*Estimated in ESJWRM*	
Oct-21	22,865	12,300	5,061	0	40,227
Nov-21	2,182	700	3,339	0	6,221
Dec-21	1,923	400	3,634	0	5,957
Jan-22	2,292	500	3,710	0	6,502
Feb-22	9,536	1,300	3,625	0	14,461
Mar-22	11,583	2,300	4,577	0	18,459
Apr-22	26,431	11,200	5,204	0	42,835
May-22	40,219	44,200	6,463	0	90,882
Jun-22	44,765	26,500	7,146	0	78,411
Jul-22	50,006	31,800	7,239	0	89,045
Aug-22	50,082	25,800	7,343	0	83,225
Sep-22	40,761	28,800	6,586	0	76,147
Total	302,646	185,800	63,927	0	552,372
Measurement Accuracy	***High***	***Medium***	***High***	***Medium***	-

* Agency reported values reflect deliveries to meet demand, which was based on evapotranspiration and land use.

** Estimated agricultural surface water deliveries include deliveries to Central Delta Water Authority, South Delta Water Authority, and riparian users along major streams.

Table 8. Water Year 2022 Monthly Total Water Use (in acre-feet)

Month	Agricultural						Urban and Industrial						Total
	Direct Measurement			*Estimated in ESJWRM***			*Direct Measurement*			*Estimated in ESJWRM***			
	*Groundwater**	*Surface Water*	*Total*	*Ground water*	*Surface Water*	*Total*	*Groundwater*	*Surface Water*	*Total*	*Groundwater*	*Surface Water*	*Total*	
Oct-21	109	22865	22,974	76,900	12,300	89,200	2,453	5,061	7,514	1,400	0	1,400	121,088
Nov-21	62	2182	2,244	4,000	700	4,700	1,700	3,339	5,039	1,000	0	1,000	12,982
Dec-21	84	1923	2,007	3,800	400	4,200	1,231	3,634	4,866	900	0	900	11,972
Jan-22	57	2292	2,349	5,600	500	6,100	1,070	3,710	4,780	900	0	900	14,130
Feb-22	342	9536	9,878	19,400	1,300	20,700	1,687	3,625	5,312	800	0	800	36,690
Mar-22	159	11583	11,741	12,100	2,300	14,400	2,371	4,577	6,948	1,100	0	1,100	34,189
Apr-22	153	26431	26,584	75,700	11,200	86,900	2,038	5,204	7,242	1,200	0	1,200	121,926
May-22	601	40219	40,820	136,000	44,200	180,200	2,581	6,463	9,044	1,800	0	1,800	231,864
Jun-22	555	44765	45,320	127,300	26,500	153,800	3,178	7,146	10,324	1,600	0	1,600	211,045
Jul-22	516	50006	50,521	104,300	31,800	136,100	3,641	7,239	10,880	1,700	0	1,700	199,201
Aug-22	439	50082	50,522	124,600	25,800	150,400	3,702	7,343	11,045	1,300	0	1,300	213,267
Sep-22	276	40761	41,037	81,600	28,800	110,400	3,301	6,586	9,887	1,200	0	1,200	162,524
Total	3,353	302,646	305,998	771,300	185,800	957,100	28,954	63,927	92,881	14,900	0	14,900	1,370,879
Measurement Accuracy	***High***	***High***	***High***	***Medium***	***Medium***	***Medium***	***High***	***High***	***High***	***Medium***	***Medium***	***Medium***	-

* Agency reported values for agriculture was collected for some of the agencies (Manteca and OID) that report pumping for either agricultural or landscape use.

** Includes estimated agricultural groundwater use, estimated private domestic groundwater use, and estimated riparian surface water use. See previous tables for further details.

3.8.4 Eastern San Joaquin Water Resources Model Update

The ESJWRM was originally developed and calibrated to model historical groundwater storage from water years 1996-2015. The *Eastern San Joaquin Water Resources Model Final Report* provides detailed documentation on the original development of the ESJWRM model (Woodard & Curran, 2018). The model has been updated annually to include the recent Water Year data as part of the annual report preparation to reflect more recent data. In 2021, the ESJWRM was updated and calibrated for the entire period of record from 1996-2020. Updates to the model are described in *Eastern San Joaquin Water Resources Model Version 2.0 Update* (Woodard & Curran, 2022). In late 2022, the monthly agricultural demand distribution for ESJWRM was updated in select areas of the groundwater subbasin, causing slight changes to water budget numbers, but minimal differences to overall model calibration. The version of ESJWRM used for this report was ESJWRM Version 2.2. Data for WY 2022 were collected from the same public and private sources that had provided the historical data through 2020 used in the most recent model update. As a result of the model extension, a new historical water budget was generated including updated estimates of change in groundwater storage. The full annual groundwater budget for water years 1996-2022 is shown earlier in **Figure 5**.

Data Sources

Data were requested and received from the following entities in the Subbasin to complete the ESJWRM update through WY 2022:

Agricultural Water Purveyors

- Calaveras County Water District
- Central San Joaquin Water Conservation District
- North San Joaquin Water Conservation District
- Oakdale Irrigation District
- South San Joaquin Irrigation District
- Stockton East Water District
- Woodbridge Irrigation District

Municipal Water Purveyors

- California Water Service Company Stockton District
- City of Escalon
- City of Lodi
- City of Manteca
- City of Ripon
- City of Stockton
- Linden County Water District
- Lockeford Community Services District
- Stockton East Water District

Additional publicly available data were downloaded to complete the ESJWRM update:

State

- California Department of Finance population estimates

Federal

- United States Geological Survey (USGS) stream flows[18]
- United States Army Corps of Engineers reservoir releases[19]

Other

- Precipitation-Elevation Regressions on Independent Slopes Model (PRISM) Climate Group, Oregon State University

Updated Components

The above data sources provided the necessary data to allow the historical model to reflect recent conditions. The following components of the model were updated:

Surface Water Diversions and Deliveries: Monthly surface water diversions and deliveries were provided for October 2021 through September 2022 for urban and industrial use and agricultural use as described in Section 3.8.2. Remaining riparian diversion occurring in CDWA, SDWA, and along major rivers were estimated based off agricultural demands estimated in ESJWRM.

Groundwater Pumping: Groundwater extractions from October 2021 to September 2022 were provided by most municipal water purveyors as described in Section 3.8.1. Pumping estimates were made in ESJWRM based on land use type and population, for private agriculture wells, domestic wells, and municipal wells from water purveyors that did not have metered extraction.

Population: California Department of Finance estimates (E-4 Population Estimates for Cities, Counties, and the State, 2021-2022, with 2020 Census Benchmark) were downloaded to update annual population for 2022 (State of California, 2023). Rural populations were estimated from Department of Finance county totals and spatially assigned throughout the model by urban acreage.

Land Use: Each element within the ESJWRM is comprised of some fraction of 27 land uses, including 23 agricultural crop categories, native vegetation, water surface, riparian vegetation, and urban landscape. For WY 2021, the model continues to utilize data from DWR's 2016 Statewide Crop Mapping which provides data on urban and irrigated land throughout the model domain on a parcel scale (DWR, 2016).

Precipitation: Rainfall data for the model area are derived from the PRISM (Precipitation-Elevation Regressions on Independent Slopes Model) database used in the DWR's CALSIMETAW (California Simulation of Evapotranspiration of Applied Water) model. The database contains daily precipitation data from October 1, 1921, on a four-kilometer grid throughout the model area. ESJWRM has monthly rainfall data defined for every model element in order to preserve the spatial distribution of the monthly rainfall. Each of the model elements was mapped to the nearest of 364 available PRISM reference nodes, uniformly distributed across the model domain. The PRISM dataset is available online from Oregon State University through a partnership with the NRCS National Water and Climate Center (Oregon State University, 2023).

Streamflow: Monthly inflow to the Eastern San Joaquin Subbasin were updated for Dry Creek, Mokelumne River, Calaveras River, Stanislaus River, and San Joaquin River. Sources of data included USGS (USGS, 2023) and United States Army Corps of Engineers (US Army Corps of Engineers, 2023).

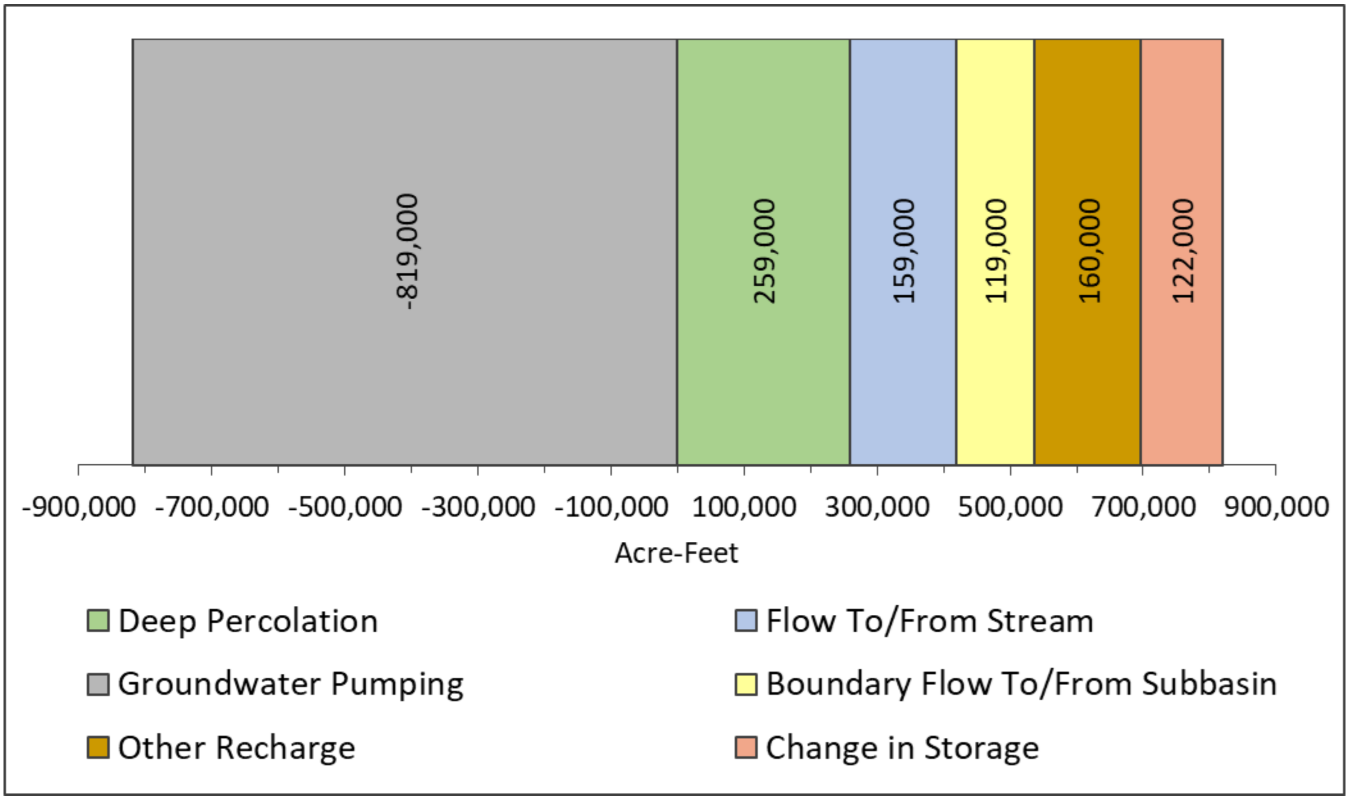
[18] New Melones Reservoir flows are monitored at a USGS gauge downstream on the Stanislaus River below Goodwin Dam near Knights Ferry, CA.
[19] Reservoir release for New Hogan Reservoir on the Calaveras River.

Non-gauged tributaries into the Subbasin were estimated internally by the model using the Integrated Water Flow Model (IWFM) small-watershed package.

Boundary Conditions: Averages of historical model data by water year type were used to update the assumed groundwater elevation boundary conditions in the model.

Results:

Evaluation of WY 2022 (**Figure 12**) shows that the Eastern San Joaquin Subbasin experienced, on an average and net basis, 697,000 AF of inflows and 819,000 AF of outflow, leading to an annual decrease of groundwater in storage of 122,000 AF. Deep percolation from the root zone is the largest contributor of groundwater inflow (259,000 AFY), followed by recharge from managed aquifer projects, unlined canals or reservoirs, and ungauged watersheds (160,000 AFY); recharge from streams (159,000 AFY); and boundary flows from surrounding groundwater subbasins (119,000 AFY). Groundwater production (819,000 AFY) accounts for the greatest outflow from the Eastern San Joaquin Subbasin. **Table 9** compares these values against those from WY 2021.



Notes:

1. "Other Recharge" includes managed aquifer recharge, recharge from unlined canals and/or reservoirs, and recharge from ungauged watersheds.
2. "Change in Storage" is placed to balance the water budget. For instance, if annual outflows (-) are greater than inflows (+), there is a decrease in storage, but this would be shown on the positive side of the bar chart to balance out the increased outflows on the negative side of the bar chart.

Figure 12. WY 2022 Average Annual Estimated Groundwater Budget, Eastern San Joaquin Subbasin

Table 9. Comparison of WY 2021 and WY 2022 Water Budget (in acre-feet)

Water Budget Element	WY 2021	WY 2022
Water Year Type	Critical	Critical
Deep Percolation	251,000	259,000
Other Recharge	154,000	160,000
Flow to/from Stream	125,000	159,000
Boundary Flow to/from Subbasin	122,000	119,000
Groundwater Pumping	-809,000	-819,000
Change in Storage	157,000	122,000

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Appendix A – GSP Implementation Progress

Table A-1. Summary of Implementation Progress of GSP Projects and Management Actions

Activity	Category A Project	Project Type	Project Proponent	Current Status	Schedule (initiation and completion)	Status
Project 1: Lake Grupe In-lieu Recharge	x	In-lieu Recharge	SEWD	Complete	2020-2023	Project is substantially complete. Meter installation and some finishing work pending.
Project 2: SEWD Surface Water Implementation Expansion	x	In-lieu Recharge	SEWD	Implementation phase	2019-2029	The Project is being implemented in stages. SEWD has completed the conversion of 1820 acres to surface water, is in the construction phase to convert an additional 942 acres, and in the planning phase to convert an additional 1,048 acres. During WY 2023, the SEWD plans to continue constituent outreach efforts and address the necessary improvements to facilitate the conversions of an additional 3,000 acres to surface water.
Project 3: City of Manteca Advanced Metering Infrastructure		Conservation	City of Manteca	Experiencing delays due to other higher priority projects needed	TBD	The Project status information presented in the GSP is up to date. Project implementation did not occur during WY 2021 due to delays as a result of COVID-19, staff shortages, and lack of funding. Updates regarding activity progress will be included in future Annual Reports.
Project 4: City of Lodi Surface Water Facility Expansion & Delivery Pipeline		In-lieu Recharge	City of Lodi	Planning phase	2030-2033	The Project status information presented in the GSP is up to date. Project implementation did not occur during WY 2021 since implementation is not planned until 2030. Updates regarding activity progress will be included in future Annual Reports.

Activity	Category A Project	Project Type	Project Proponent	Current Status	Schedule (initiation and completion)	Status
Project 5: White Slough Water Pollution Control Facility Expansion	x	Recycling/ In-lieu Recharge	City of Lodi	Construction complete	2019-2020	The Project status information presented in the GSP is up to date. The Project is complete.
Project 6: CSJWCD Capital Improvement Program	x	In-lieu Recharge	CSJWCD	Can be implemented immediately	2020-2027, on-going with 7-year completion cycles	The Project status information presented in the GSP is up to date. The Project has been implemented and is on-going each year of available water delivery. Updates regarding activity progress will be included in future Annual Reports.
Project 7: NSJWCD South System Modernization	x	In-lieu Recharge	NSJWCD	Environmental review is complete, funding has been sought and a landowner improvement district formed	2018-2024	This Project is progressing. Phase 1 completed in 2019-2021 included: new pump station, variable frequency drive (VFD), meters, automation equipment, SCADA, new main junction box at Tretheway and Brandt Road. Phase 2 improvements include replacing sections of main pipeline and adding more meters and SCADA. Phase 2 will be constructed in 2023. NSJWCD is working on sub-improvement districts for lateral distribution. ID3A formed in 2021 for construction of the Pixley lateral, which was completed in 2022. Working on formation of ID3B for Handel lateral (for which NSJWCD received $1 mil federal grant). NSJWCD was just awarded a $3M IRWM grant for Phase 3 South System improvements to focus on more mainline replacement and groundwater recharge capacity.

Activity	Category A Project	Project Type	Project Proponent	Current Status	Schedule (initiation and completion)	Status
Project 8: Long-term Water Transfer to SEWD	x	Transfers/ In-lieu Recharge	SSJ GSA	Infrastructure is in place. Environmental Review may need to be implemented	2019-2021	OID and SJJID completed a one-year water transfer to SEWD in the amount of 13,823 AF from March to July 2022. The water was delivered through the existing Goodwin Tunnel and the Upper Farmington Canal for final delivery to SEWD's municipal and agricultural customers. The parties have also recently agreed to terms on a 10-year pre-1914 water transfer for up to 10,000 AF in critical years and up to 20,000 AF in non-critical years pending compliance with CEQA.
Project 9: BNSF Railway Company Intermodal Facility Recharge Pond		Direct Recharge	CSJWCD	Planning phase	2020-2023	The Project status information presented in the GSP is up to date. Project implementation did not occur during WY 2021 due to delays as a result of the COVID-19 pandemic. CSJWCD plans to move forward with the Project during WY 2022. Updates regarding activity progress will be included in future Annual Reports.
Project 10: City of Stockton Advanced Metering Infrastructure		Conservation	City of Stockton	Initial study completed in 2011. RFP for AMI ready to be issued.	2022-2028	The initial study included a data transmission study (propagation study) and full feasibility and cost-benefit analysis. The Project is included in the City of Stockton Municipal Utilities Department's (MUD's) Capital Improvement Program (CIP) 2023-2025 schedule. The draft request for proposals has been prepared for project implementation and will be issued in the spring of 2023.

Activity	Category A Project	Project Type	Project Proponent	Current Status	Schedule (initiation and completion)	Status
Project 11: South System Groundwater Banking with East Bay Municipal Utilities District (EBMUD)	x	In-lieu Recharge	NSJWCD	Agreement is in place; parties need to finalize design. Environmental review and permitting needed	2020-2025	NSJWCD and EBMUD are working to complete the pilot DREAM Project. Facilities complete and water that was banked in prior years will be returned in February through March 2023. Additional water will be banked and returned in future years. Planning efforts for a larger scale banking project are underway.
Project 12: NSJWCD North System Modernization/Lakso Recharge	x	In-Lieu Recharge/ Direct Recharge	NSJWCD	Planning phase	2021-2026	Project is advancing. NSJWCD awarded Proposition 68 Round 2 funding $3.9 mil. Work underway to prepare master plan and make Phase 1 improvements including facilities necessary to operate Lakso recharge project. NSJWCD working with North System landowners to form improvement district to use surface water for irrigation and conduct on-farm recharge in wet years.
Project 13: Manaserro Recharge Project		Direct Recharge	NSJWCD	Planning phase	2023-2025	The Project status information presented in the GSP is up to date. Project implementation did not occur during WY 2021 due to a lack of funding. NSJWCD is continuing to work on a strategic plan and funding options for the implementation of this Project. Recently adopted NSJWCD groundwater charge may provide funding to advance this project in future years.

Activity	Category A Project	Project Type	Project Proponent	Current Status	Schedule (initiation and completion)	Status
Project 14: Tecklenburg Recharge Project	x	Direct Recharge	NSJWCD	Planning phase	2022-2024	This project is proceeding. District in negotiations to purchase property and acquire necessary easements in first quarter of 2023. Will prepare design plans in 2023 and construct in 2023-2024.
Project 15: City of Escalon Wastewater Reuse		Recycling/ In-lieu Recharge/ Transfers	SSJ GSA	Planning phase	2020-2028	The Project status information presented in the GSP is up to date. The Project is in the early conceptual stages and requires additional feasibility analysis and long-term planning. The City of Escalon has hired a consultant to explore the feasibility of project alternatives and to develop engineering plans and specifications.
Project 16: City of Ripon Surface Water Supply		In-lieu Recharge	SSJ GSA	Design complete; environmental permitting underway	2020-2024	The Project status information presented in the GSP is up to date. Project implementation did not occur during WY 2022 as it requires additional feasibility analysis and long-term planning. Updates regarding activity progress will be included in future Annual Reports.

Activity	Category A Project	Project Type	Project Proponent	Current Status	Schedule (initiation and completion)	Status
Project 17: City of Escalon Connection to Nick DeGroot Water Treatment Plant		In-lieu Recharge	SSJ GSA	Conceptual design phase; environmental review complete	2020-2023	The Project status information presented in the GSP is up to date. Project implementation requires additional feasibility analysis and long-term planning. Estimated costs for the alternatives currently range between $3.5 million - $8 million. In Water Year 2022, the City of Escalon hired a consultant to develop a preferred project alternative and to develop engineering plans and specifications. Escalon is nearing the 30% design milestone.
Project 18: Farmington Dam Repurpose Project		Direct Recharge	SEWD	Preplanning phase with reconnaissance study complete	2030-2050	The Project status information presented in the GSP is up to date. Project implementation did not occur during WY 2022 as SEWD dedicated resources to bring short-term projects online first. More resources will be directed toward the implementation of this Project as Project 2 is completed. Updates regarding activity progress will be included in future Annual Reports.
Project 19: Recycled Water Transfer to Agriculture		Recycling/Transfers/ In-lieu Recharge	City of Manteca	Planning phase with evaluation completed in Draft Reclaimed Water Facilities Master Plan	Not determined	The Project status information presented in the GSP is up to date. Project implementation did not occur during WY 2022 due to delays as a result of COVID-19, staff shortages, and lack of funding. Updates regarding activity progress will be included in future Annual Reports.

Activity	Category A Project	Project Type	Project Proponent	Current Status	Schedule (initiation and completion)	Status
Project 20: Mobilizing Recharge Opportunities		Direct Recharge	San Joaquin County	Early conceptual planning phase	Not determined	The Project has been expanded into a multi-benefit project, and the ESJGWA will apply for grant funds for the expanded project under the Sustainable Groundwater Management Implementation Grant Program Round 1. Regionwide surface water availability and needs are being discussed, and future acquisition of the Mokelumne River Water and Power Authority's water rights will be explored. Updates regarding activity progress will be included in future Annual Reports.
Project 21: NSJWCD Winery Recycled Water		Recycling/ In-Lieu Recharge/ Direct Recharge	NSJWCD	Conceptual planning and discussion	2025-2027	The Project status information presented in the GSP is up to date. Project implementation did not occur during WY 2021 due to a lack of funding. NSJWCD is continuing to work on a strategic plan and funding options for the implementation of this Project.

Activity	Category A Project	Project Type	Project Proponent	Current Status	Schedule (initiation and completion)	Status
Project 22: Pressurization of SSJID Facilities		Conservation	SSJ GSA	Feasibility study complete	2019-2030	In WY 2021, SSJID evaluated the feasibility of converting its entire irrigation system to a pressurized piped system. Although the cost is currently deemed to be infeasible, there are opportunities to make strategic improvements to modernize the irrigation system to provide partial pressurization or for growers to become more efficient and receive an improved level of service through increased lateral capacity, new reservoirs, and the increased use of SCADA controls. SSJID compiled and ranked these opportunities into a comprehensive Water Master Plan which adopted by the Board in December of 2022. In order to fund the capital improvement program identified in the WMP, SSJID will be initiating a Prop 218 rate setting process to be completed in 2023.
Project 23: SSJID Storm Water Reuse		Storm Water/ In-lieu Recharge/ Direct Recharge	SSJ GSA	Planning phase	2027-2030	The Project status information presented in the GSP is up to date. Project implementation did not occur during WY 2021 since implementation is not planned until 2030. SSJID continues to fund capital improvements to make this Project part of SSJID's annual CIP and could be expanded as a result of the Water Master Plan, which was adopted by the SSJID Board of Directors in December 2022. Updates regarding activity progress will be included in future Annual Reports.

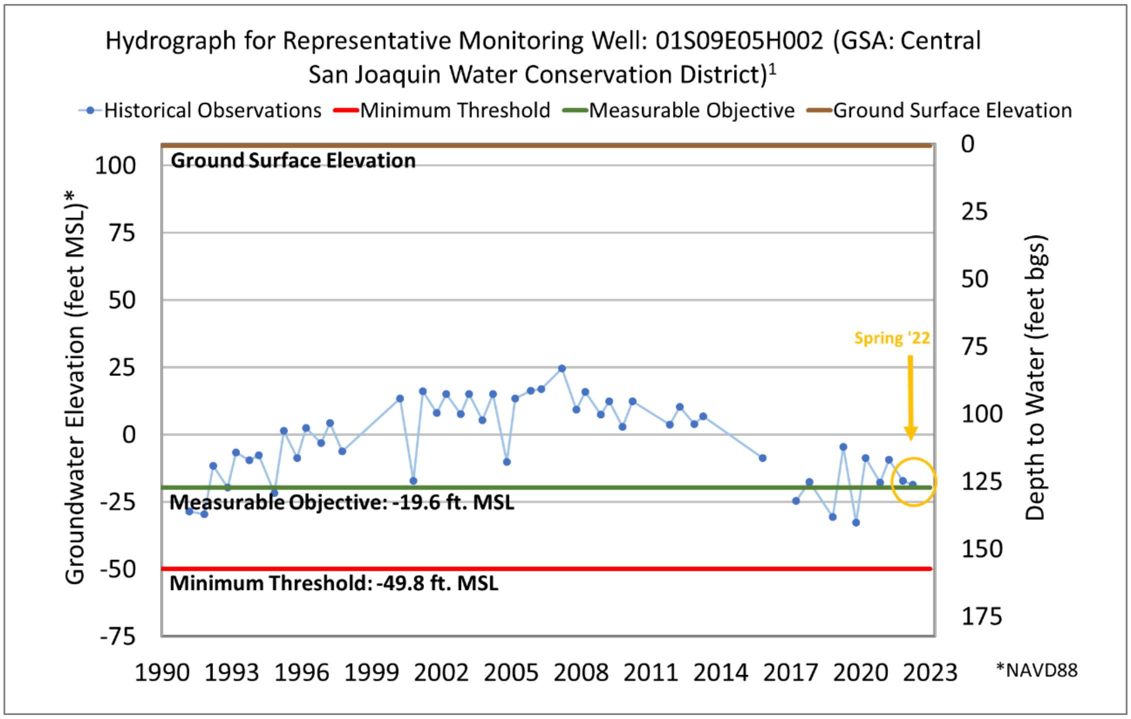
Activity	Category A Project	Project Type	Project Proponent	Current Status	Schedule (initiation and completion)	Status
Project 24: South Stockton Well Rehabilitation Program (new)		Monitoring and Reporting	City of Stockton	Rehab existing wells. Design in progress to add well head treatment to existing Well SSS8. Back-up power to be added to Well SSS3 & SSS9.	2021-2023	Design of SSS8 well head treatment is complete and construction is scheduled to start in 2023. HCS Engineering to design backup power to Well SSS3 and SSS9. The design is scheduled to start in January 2023.
Project 25: Delta Water Supply Project Phase 2: Groundwater Improvement Project	x	Direct Recharge	City of Stockton	RFP advertised in Jan 2022 for geotechnical investigation and feasibility study. If feasible a recharge basin will be designed and constructed.	2022-2026	The request for proposals was released in early spring of 2022. Geosyntec was awarded the contract and the geotechnical study began in July of 2022. The geotechnical and feasibility study are scheduled to be completed in early spring of 2023. Once the geotechnical study is complete the design and construction of the basin(s) will begin.
Mokelumne River Loss Study		Model Refinement and Validation	NSJWCD	Conceptual planning and discussion	2020-2025	The Project status information presented in the GSP is up to date. Project implementation did not occur during WY 2021 due to a lack of funding and lack of staff resources to complete the plans and move the projects forward. NSJWCD is continuing to work on strategic plan and funding options for the implementation of this Project.
Monitoring and recording of groundwater levels and groundwater quality data		Monitoring and Reporting	Implemented at Subbasin scale	Ongoing	2020-2040	The Project status information presented in the GSP is up to date. This is the fourth Annual Report that reports groundwater level and groundwater quality monitoring data. Updates regarding activity progress will be included in future Annual Reports.

Activity	Category A Project	Project Type	Project Proponent	Current Status	Schedule (initiation and completion)	Status
Maintaining and updating the Subbasin Data Management System (DMS) with newly collected data		Monitoring and Reporting	Implemented at Subbasin scale	Ongoing	2020-2040	The Project status information presented in the GSP is up to date. The DMMs was maintained and updated to include monitoring data for WY 2022. Updates regarding activity progress will be included in future Annual Reports.
Annual monitoring of progress toward sustainability		Monitoring and Reporting	Implemented at Subbasin scale	Ongoing	2020-2040	The Project status information presented in the GSP is up to date. This is the fourth Annual Report that monitors the progress toward sustainability. Updates regarding progress toward sustainability will be included in future Annual Reports.
Annual reporting of Subbasin conditions to DWR as required by SGMA		Monitoring and Reporting	Implemented at Subbasin scale	Ongoing	2020-2040	The Project status information presented in the GSP is up to date. This is the fourth Annual Report that describes the current conditions in the Subbasin and will be submitted to DWR as required by SGMA. Updates regarding Subbasin conditions will be included in future Annual Reports.
Addressing Data Gaps		Monitoring and Reporting	San Joaquin County	Ongoing	2020-2040	During WY 2021, NSJWCD contracted with DWR and San Joaquin County to install a TSS monitoring well with in the NSJWCD area.
Wallace-Burson Conjunctive Use Program		Conjunctive Use/Direct Recharge	CCWD	Conceptual planning and discussion	2030-2040	Hydrogeology and water supply studies developed; designing and developing specific program facilities (e.g., recharge basins, conveyance).

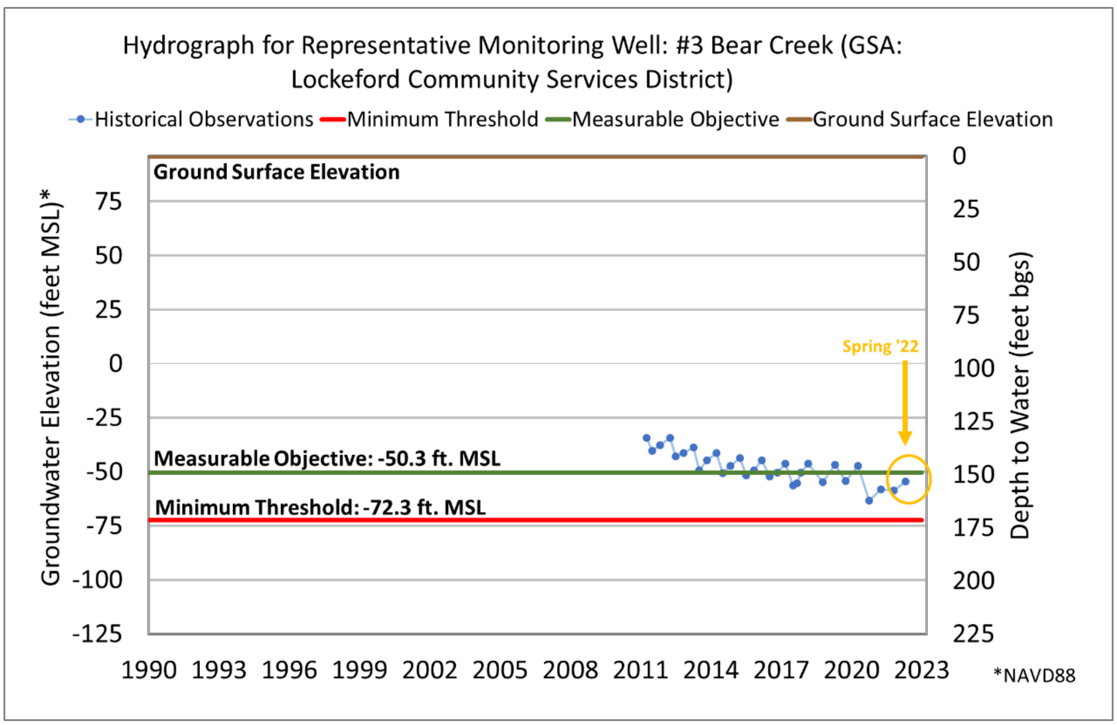
Activity	Category A Project	Project Type	Project Proponent	Current Status	Schedule (initiation and completion)	Status
Calaveras River Wholesale Water Service Expansion		In-Lieu Recharge	CCWD	Conceptual planning	2020-2040	CCWD has available surface water supply to set up agreement(s) facilitating in-lieu recharge in Calaveras County portion of subbasin. Studies needed based on specific partners, arrangements, etc.
AMI Replacement and Conversion		Monitoring and Reporting/Conservation	CCWD	Complete	2022	CCWD completed replacement and conversion of customer water meters to Automated Meter Infrastructure (AMI) by March 2022. Anticipated improved customer-level consumption data going forward.
Groundwater Monitoring Plan		Monitoring and Reporting	NSJWCD	Ongoing	2023	NSJWCD is preparing a groundwater monitoring plan to recommend monitoring well placement to better track project benefits in the district and fill data gaps related to the interaction of the Mokelumne River and the groundwater basin on both sides of the river.

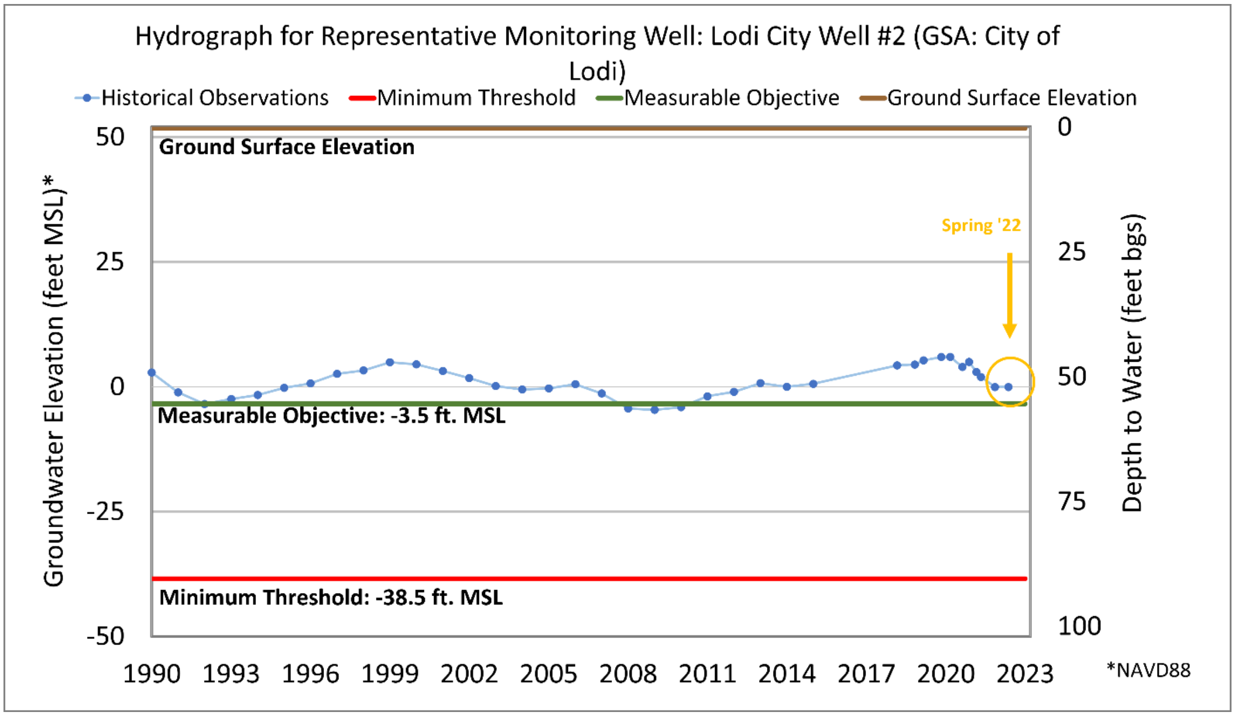
Activity	Category A Project	Project Type	Project Proponent	Current Status	Schedule (initiation and completion)	Status
Recycled Water to Manteca Golf Course		Recycling	City of Manteca	The city is currently updating its Reclaimed Water Master Plan to include RW to the Golf Course. 12-in reclaimed water pipeline has been installed to the Golf Course.	Not yet determined	The City of Manteca is currently updating its Reclaimed Water Master Plan and will be reviewing feasible reclaimed water projects as part of the update. The city is pursuing recycled water projects, one of which is sending reclaimed water to irrigate the Manteca Golf Course. 12-in reclaimed water piping from the reclaimed water source (the city's Wastewater Quality Control Facility) to the Manteca Golf Course has been installed. The city will be seeking funding, like grants, to finance the construction of a pump station, storage tank etc. to transmit water to the golf course.
West Groundwater Recharge Basin	x	Direct Recharge	SEWD	Ongoing	2032	The project is currently in the design stage with first phase construction beginning spring 2024 and is estimated to be completed in approximately 2032.
Threfall Ranch Reservoir, In-Lieu and Direct Recharge Project		In-Lieu and Direct Recharge	Stanislaus County SMWC	Ongoing	2025	Final design has been completed, and environmental review and permitting is pending receipt of project funding.

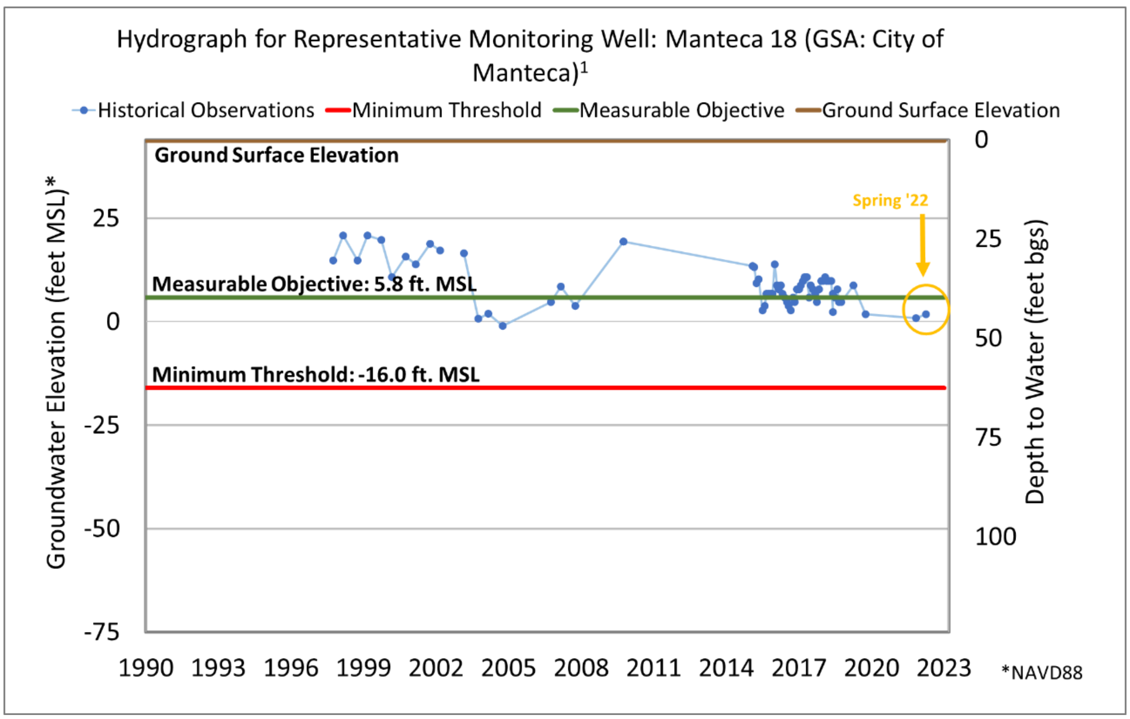
APPENDIX B – REPRESENTATIVE MONITORING NETWORK WELL HYDROGRAPHS



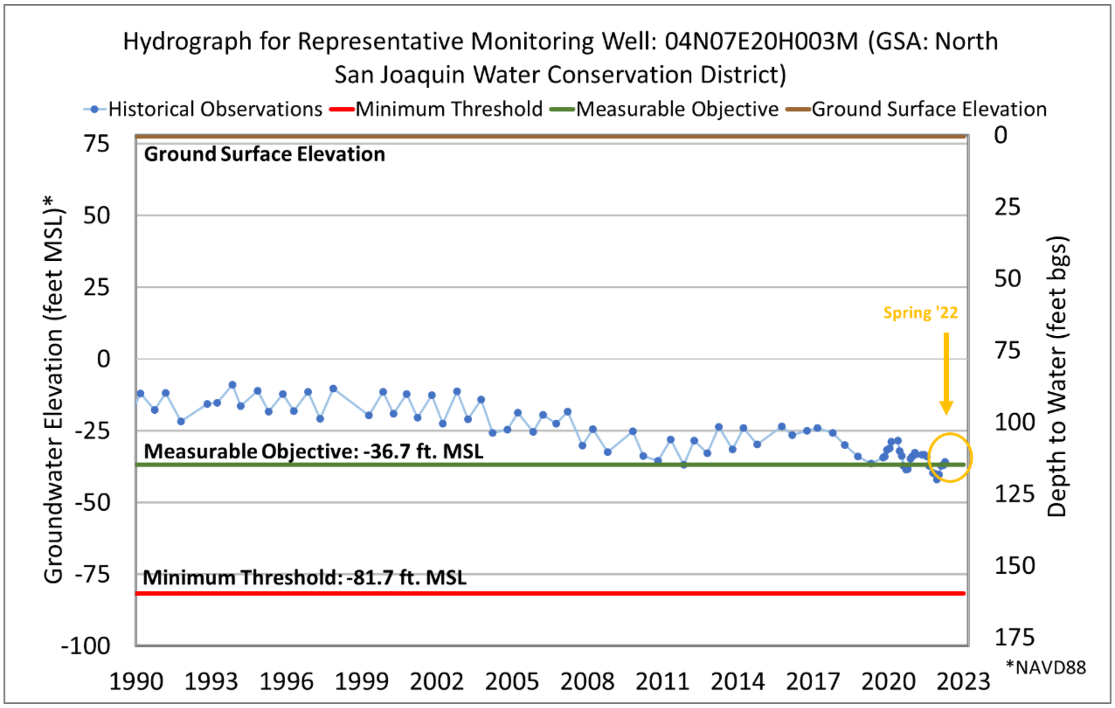
[1]The dataset shown in this hydrograph has been revised to remove the 2016 outlier.

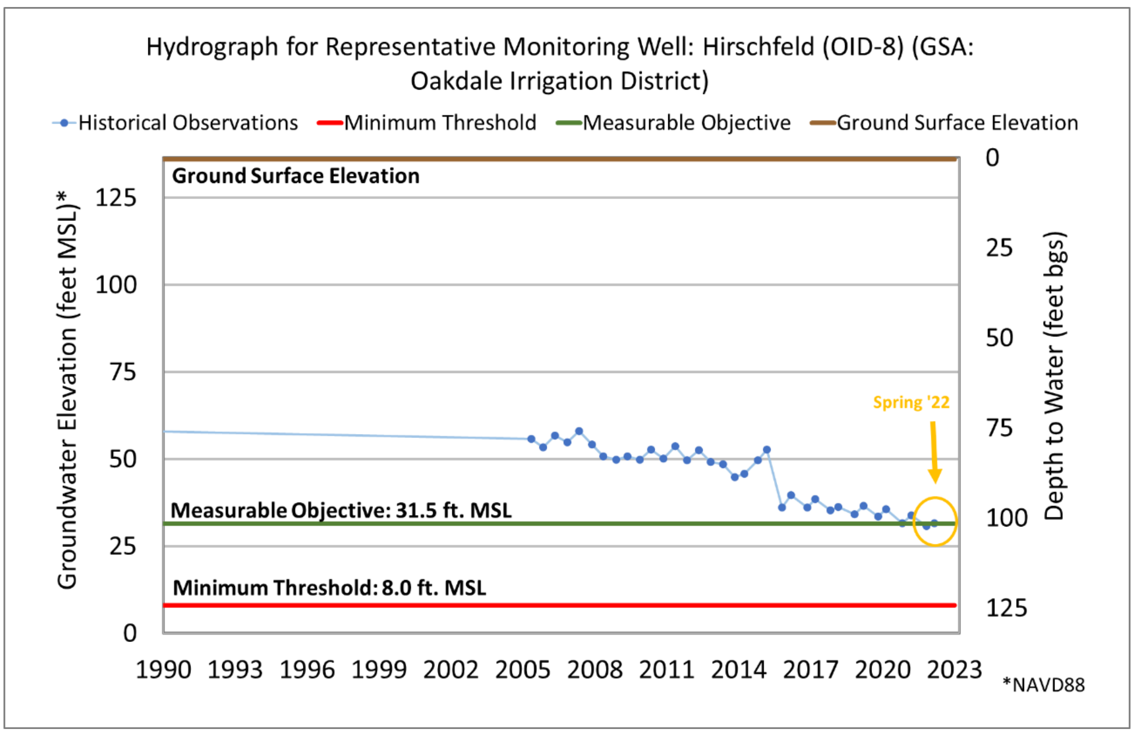


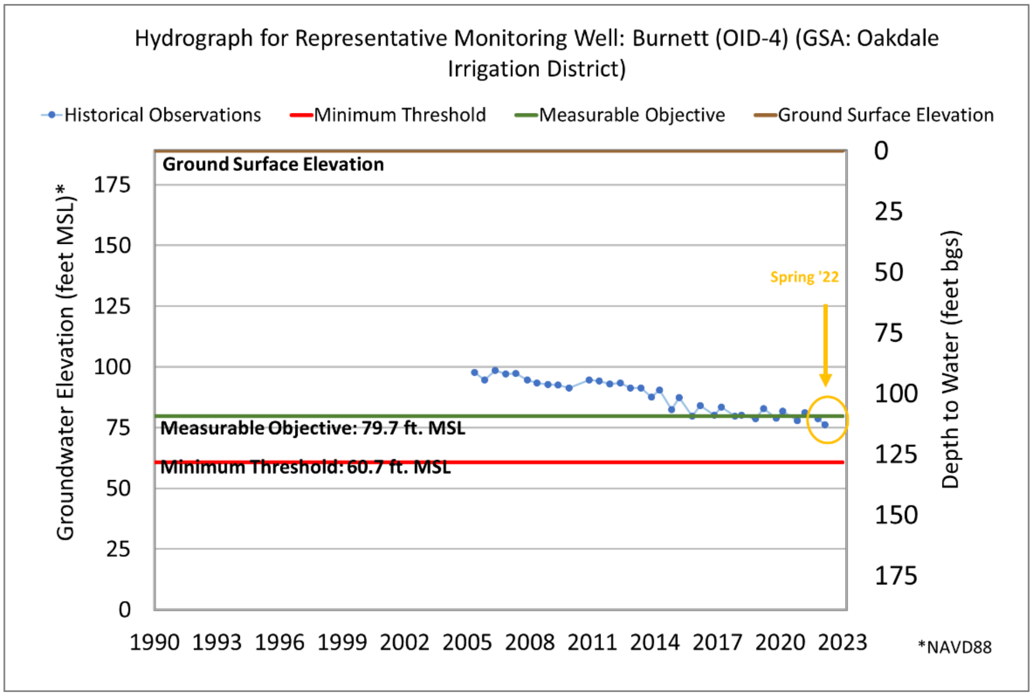


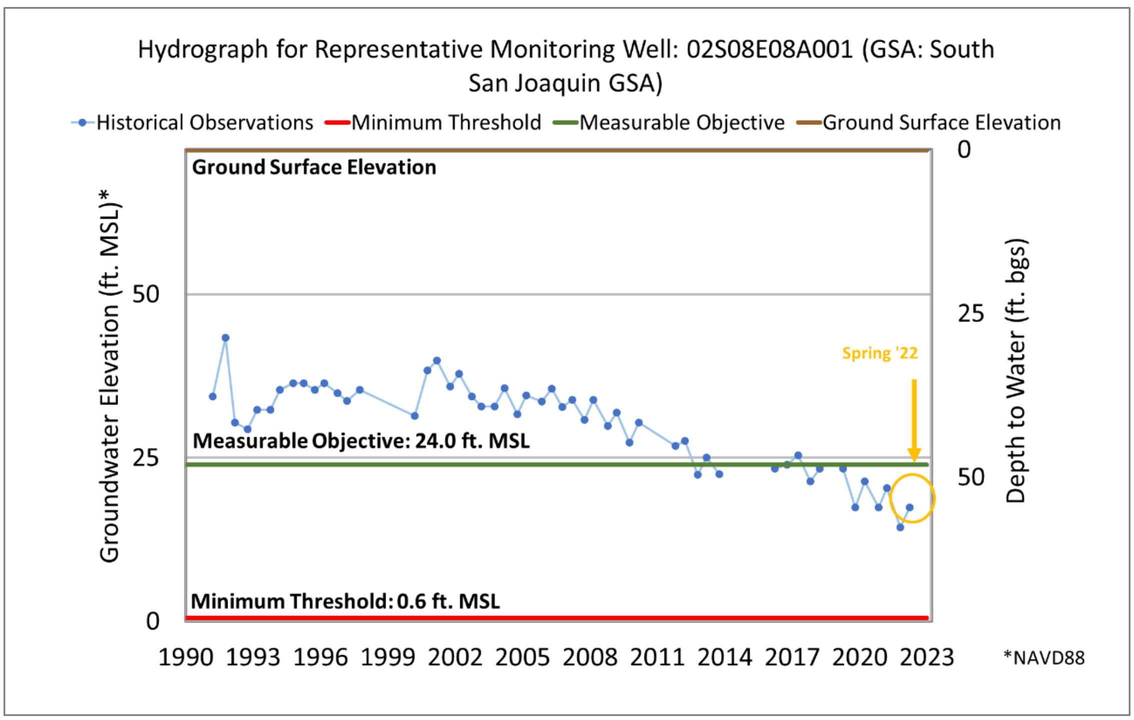


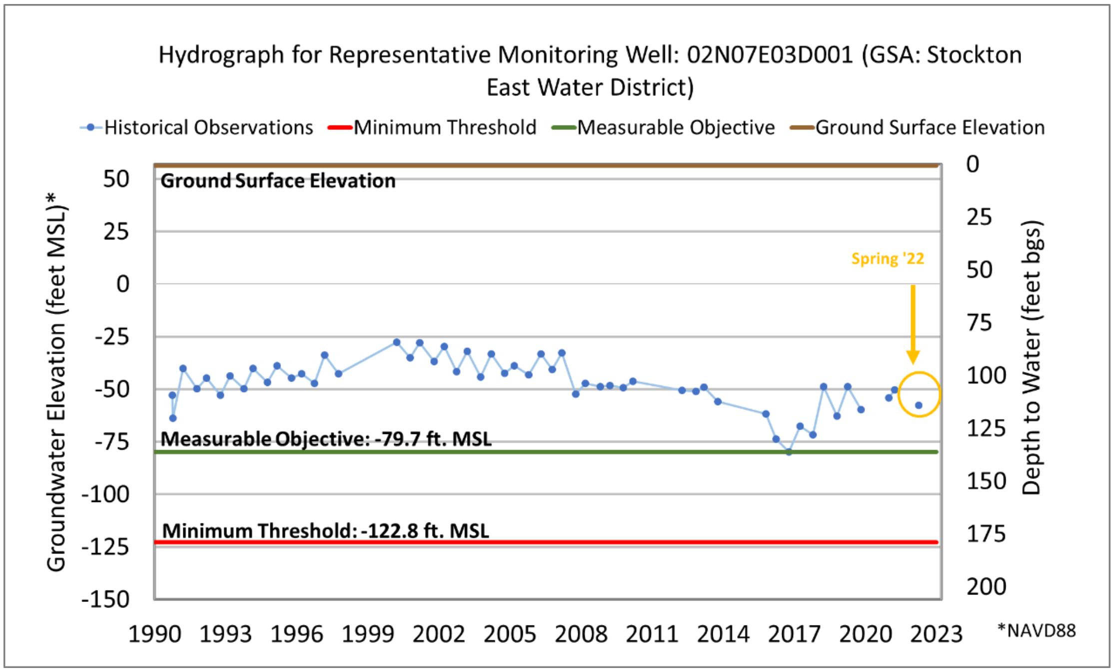
[1]The dataset shown in this hydrograph has been revised to remove the 2002 outlier.

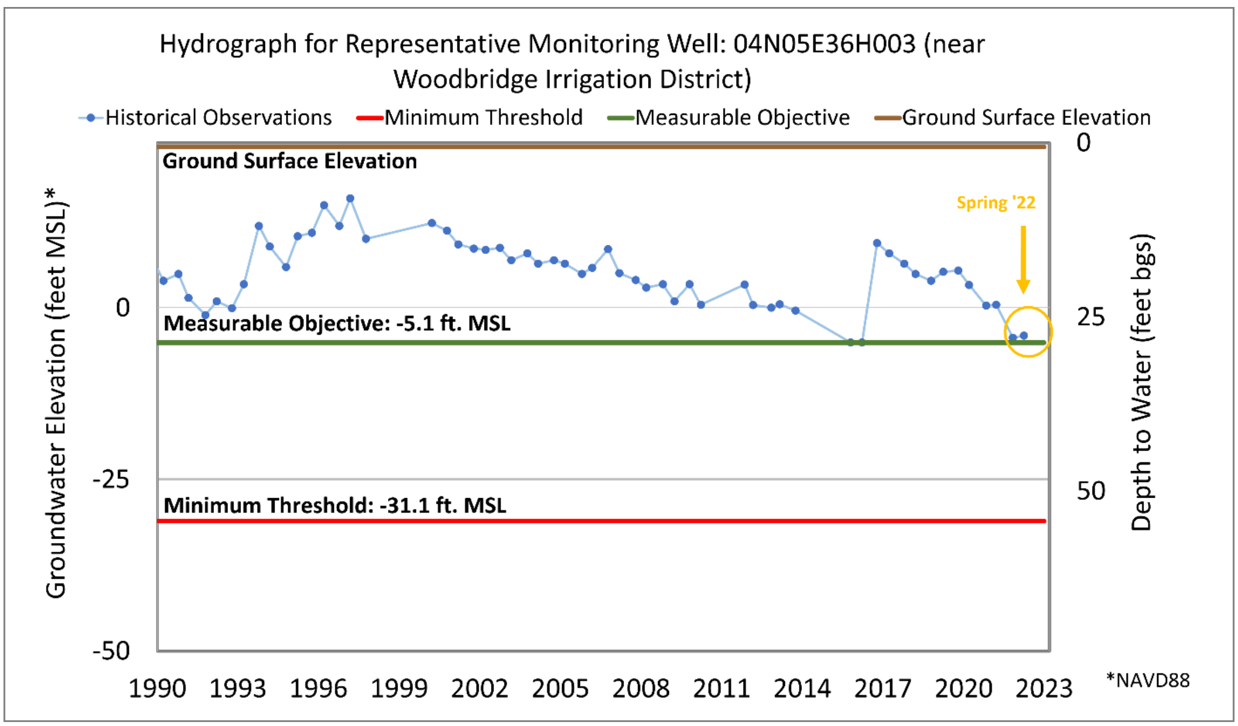

Hydrograph for Representative Monitoring Well: 04N07E20H003M (GSA: North San Joaquin Water Conservation District)
Historical Observations
Minimum Threshold
Measurable Objective
Ground Surface Elevation
Ground Surface Elevation
Spring '22
Measurable Objective: -36.7 ft. MSL
Minimum Threshold: -81.7 ft. MSL
Groundwater Elevation (feet MSL)*
Depth to Water (feet bgs)
75
50
25
0
-25
-50
-75
-100
0
25
50
75
100
125
150
175
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
2023
*NAVD88

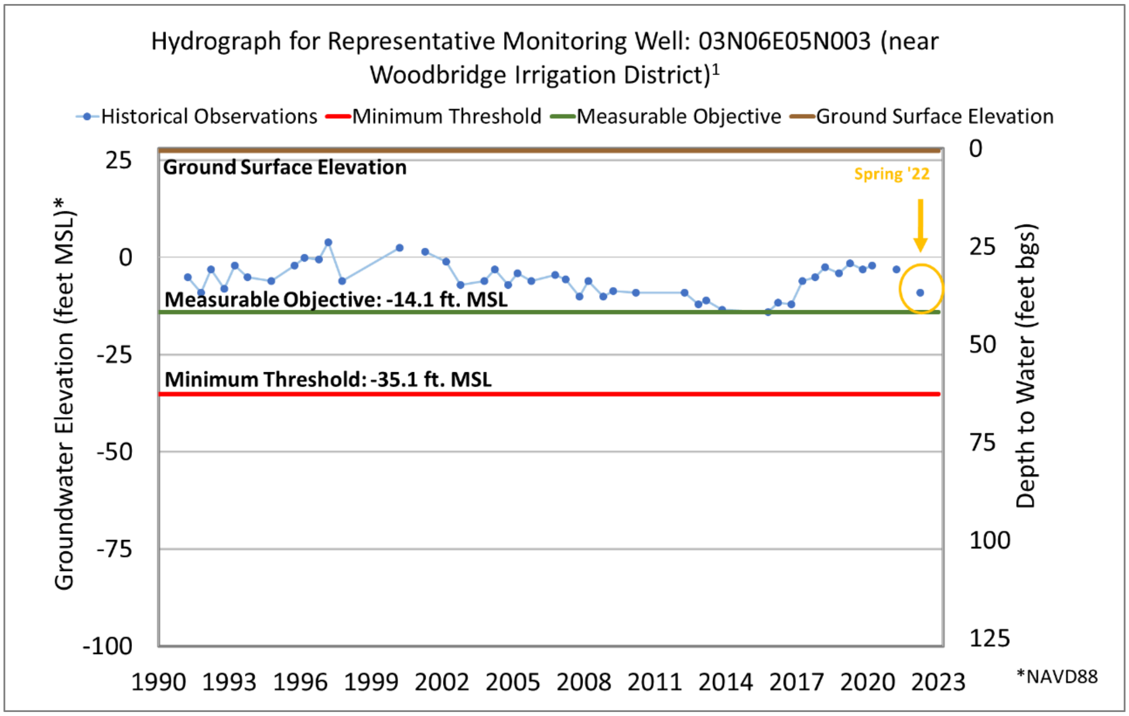

Hydrograph for Representative Monitoring Well: Hirschfeld (OID-8) (GSA: Oakdale Irrigation District)
Historical Observations
Minimum Threshold
Measurable Objective
Ground Surface Elevation
Ground Surface Elevation
Spring '22
Measurable Objective: 31.5 ft. MSL
Minimum Threshold: 8.0 ft. MSL
Groundwater Elevation (feet MSL)*
Depth to Water (feet bgs)
125
100
75
50
25
0
0
25
50
75
100
125
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
2023
*NAVD88


Hydrograph for Representative Monitoring Well: Burnett (OID-4) (GSA: Oakdale Irrigation District)
Historical Observations
Minimum Threshold
Measurable Objective
Ground Surface Elevation
Ground Surface Elevation
Spring '22
Measurable Objective: 79.7 ft. MSL
Minimum Threshold: 60.7 ft. MSL
Groundwater Elevation (feet MSL)*
Depth to Water (feet bgs)
175
150
125
100
75
50
25
0
0
25
50
75
100
125
150
175
1990 1993 1996 1999 2002 2005 2008 2011 2014 2017 2020 2023
*NAVD88

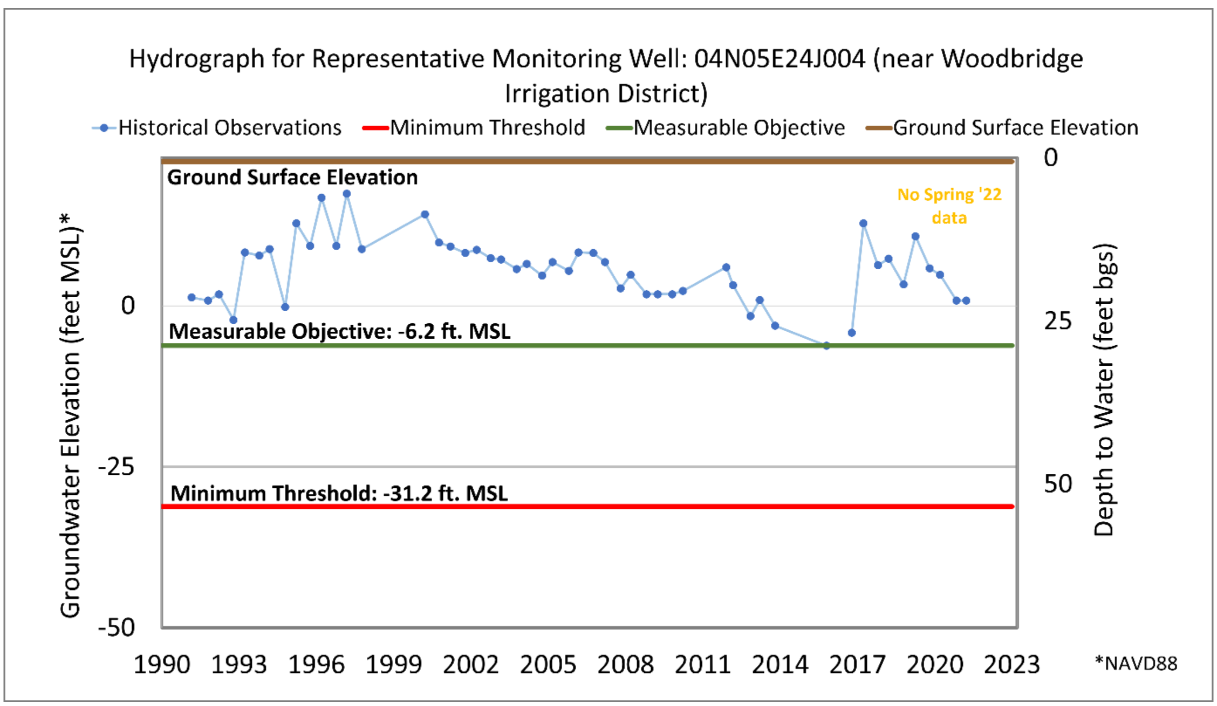

Hydrograph for Representative Monitoring Well: 02S08E08A001 (GSA: South San Joaquin GSA)
Historical Observations
Minimum Threshold
Measurable Objective
Ground Surface Elevation
Ground Surface Elevation
Spring '22
Measurable Objective: 24.0 ft. MSL
Minimum Threshold: 0.6 ft. MSL
Groundwater Elevation (ft. MSL)*
Depth to Water (ft. bgs)
50
25
0
0
25
50
1990 1993 1996 1999 2002 2005 2008 2011 2014 2017 2020 2023
*NAVD88

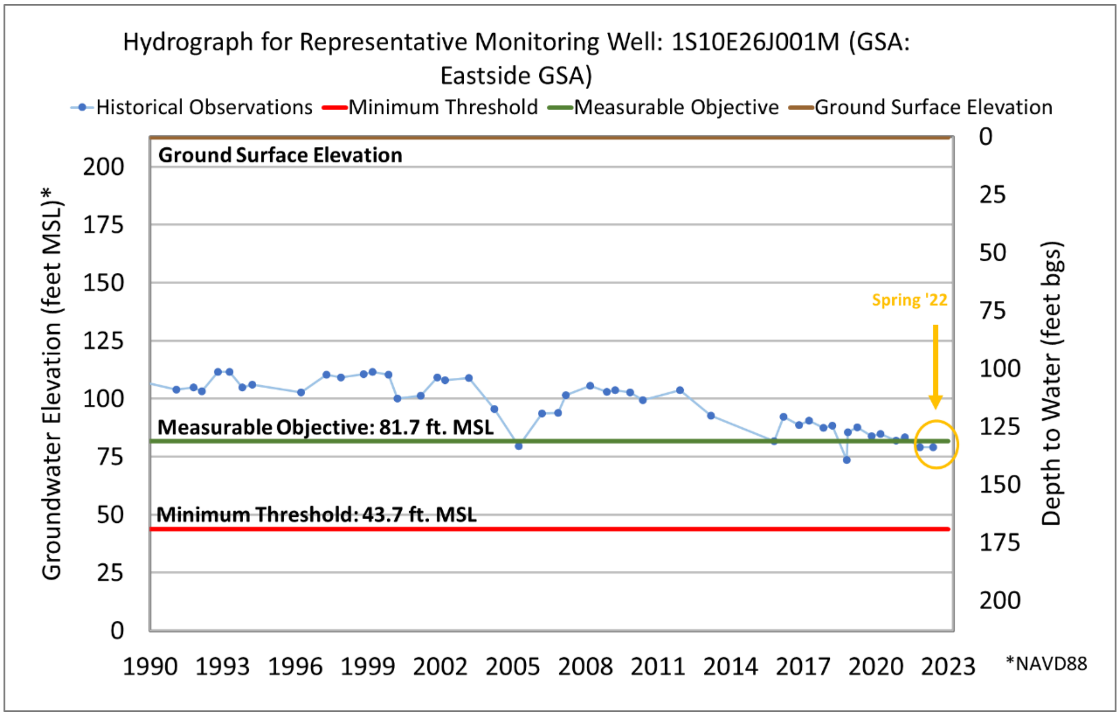

Hydrograph for Representative Monitoring Well: 02N07E03D001 (GSA: Stockton East Water District)
Historical Observations
Minimum Threshold
Measurable Objective
Ground Surface Elevation
Groundwater Elevation (feet MSL)*
Depth to Water (feet bgs)
Ground Surface Elevation
Measurable Objective: -79.7 ft. MSL
Minimum Threshold: -122.8 ft. MSL
Spring '22
50
25
0
-25
-50
-75
-100
-125
-150
0
25
50
75
100
125
150
175
200
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
2023
*NAVD88

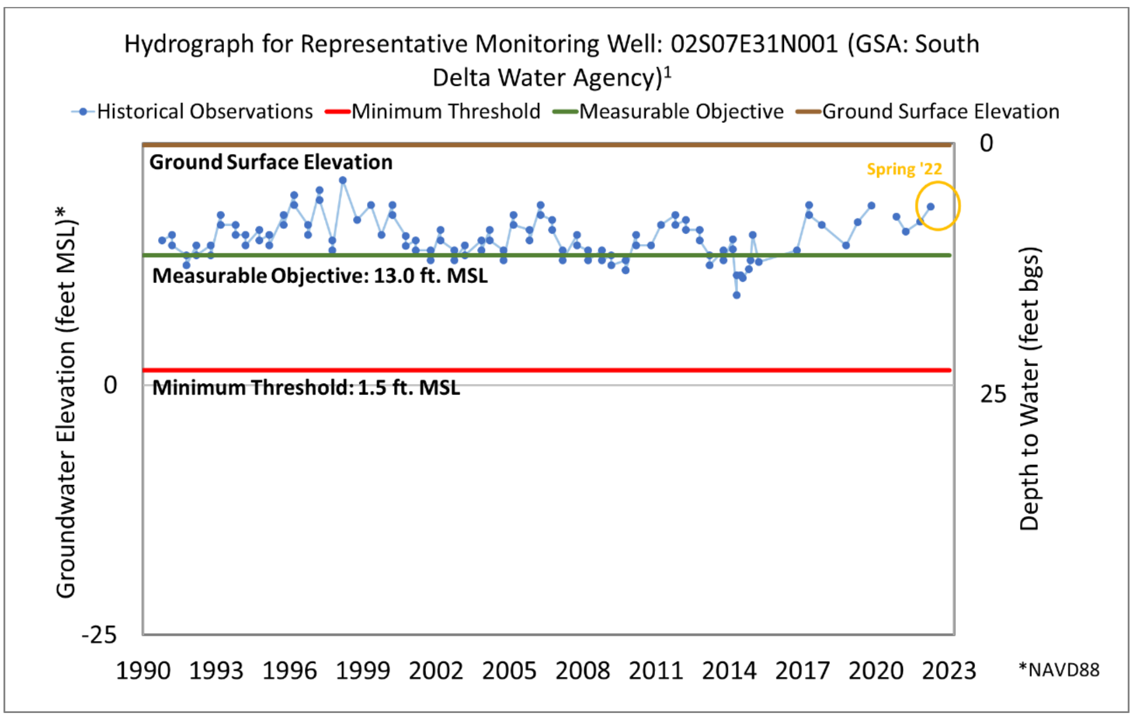

Hydrograph for Representative Monitoring Well: 04N05E36H003 (near Woodbridge Irrigation District)
Historical Observations
Minimum Threshold
Measurable Objective
Ground Surface Elevation
Groundwater Elevation (feet MSL)*
Depth to Water (feet bgs)
Ground Surface Elevation
Measurable Objective: -5.1 ft. MSL
Minimum Threshold: -31.1 ft. MSL
Spring '22
0
-25
-50
0
25
50
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
2023
*NAVD88



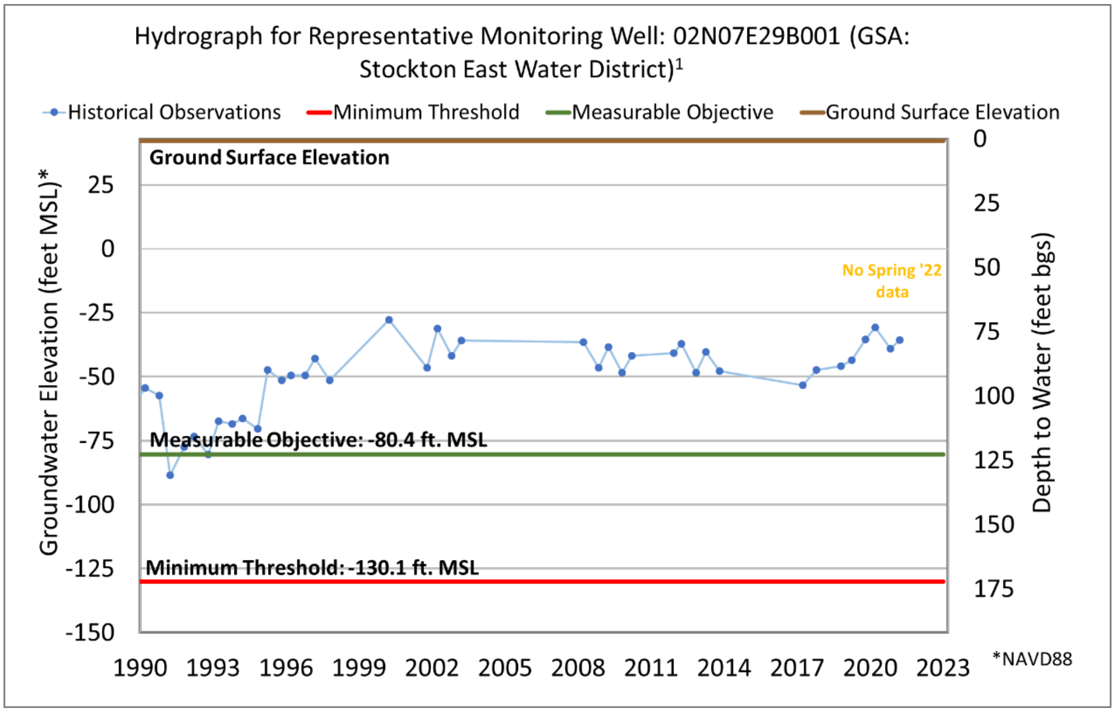
[1]The dataset shown in this hydrograph has been revised to remove the 2000 outlier.



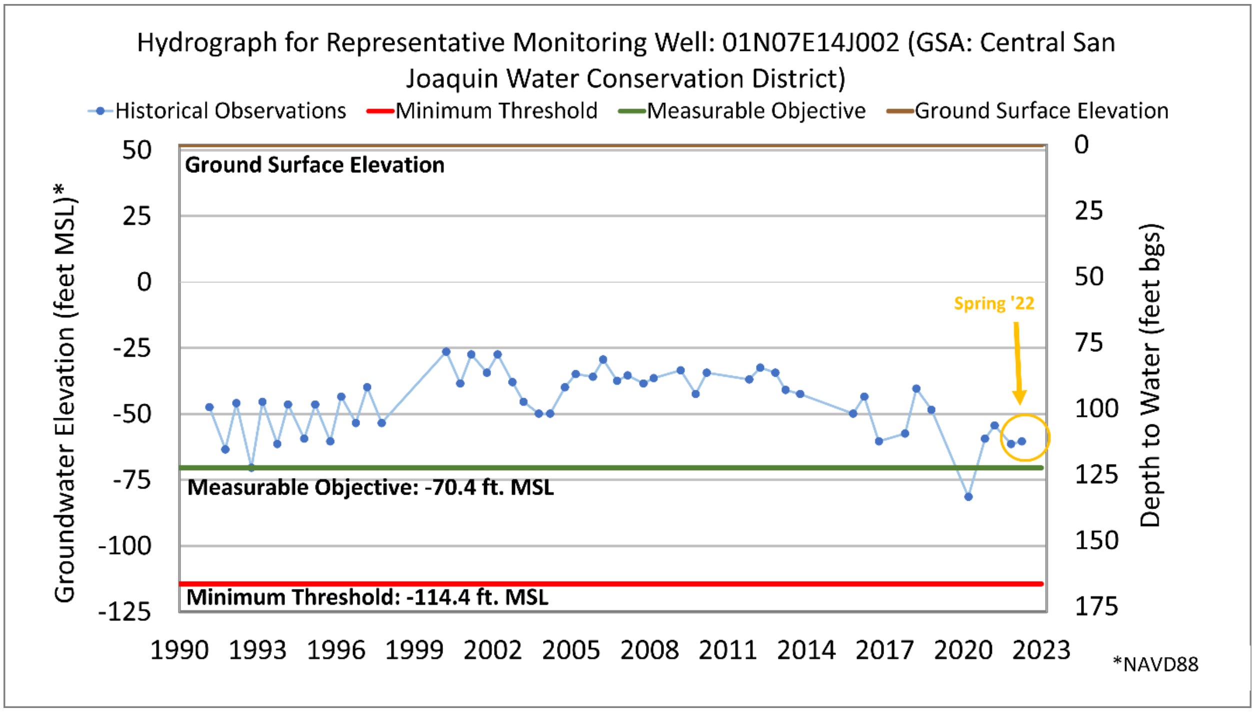


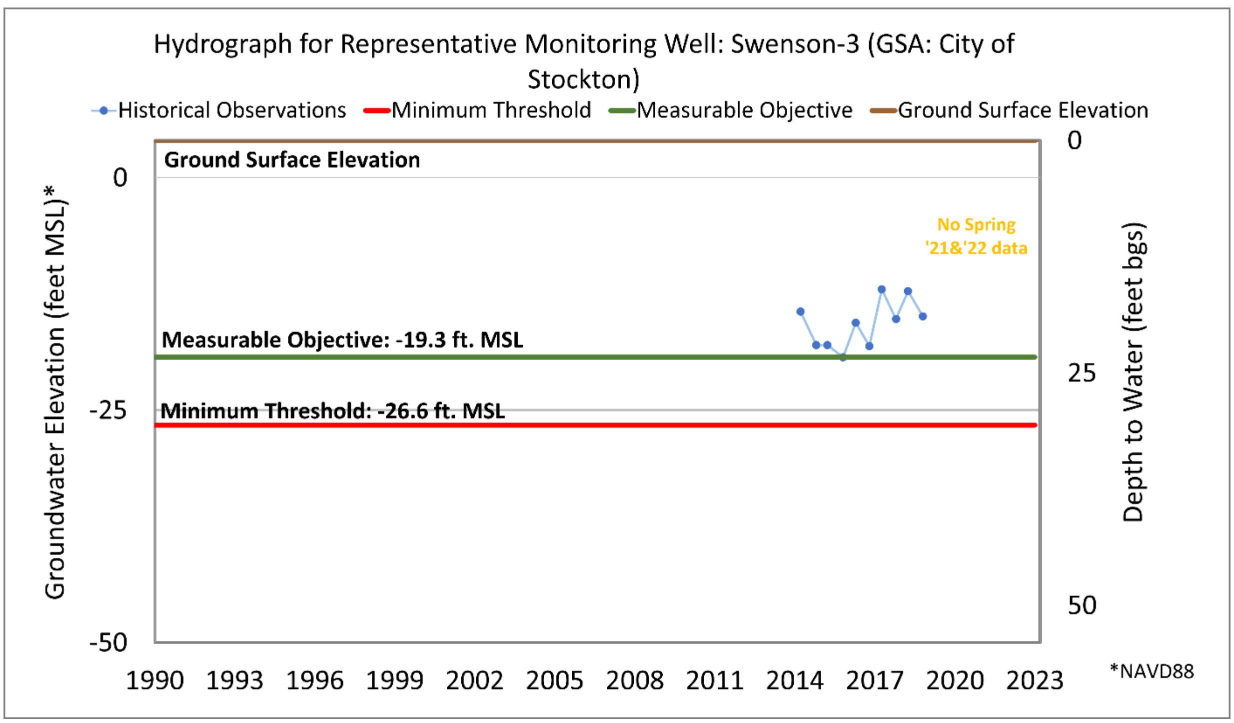


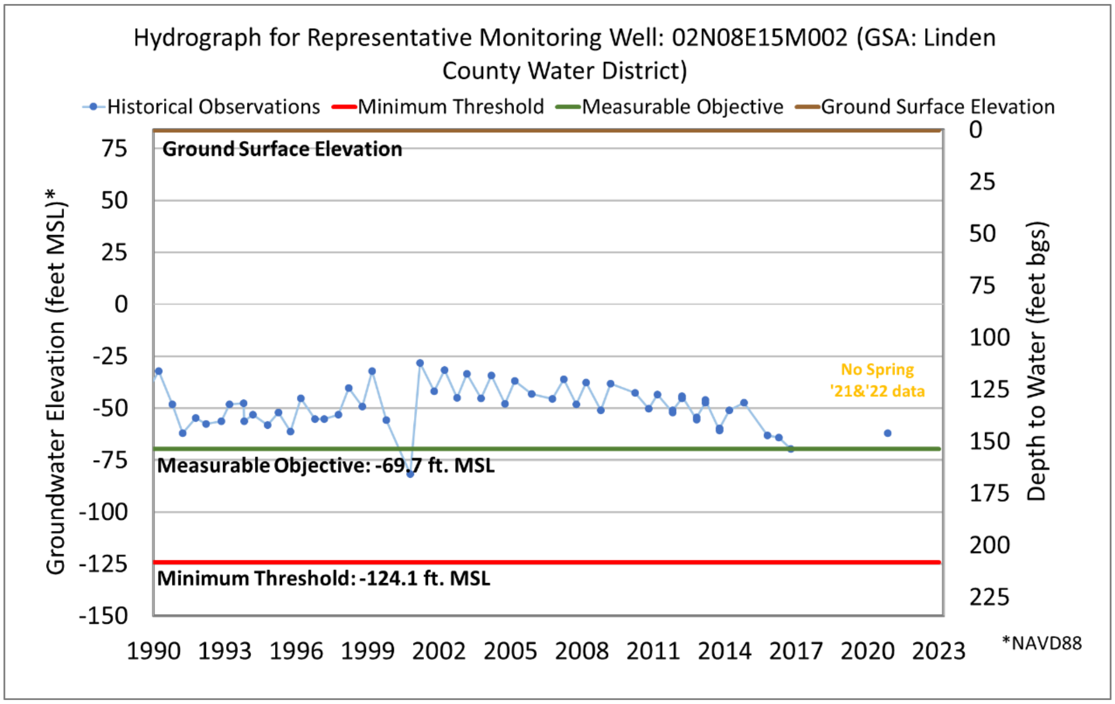
[1]Groundwater level data for WY 1991-2018 was provided by South Delta Water Agency, as reported in the GSP. Groundwater level data for WY 2019 was provided by San Joaquin County.

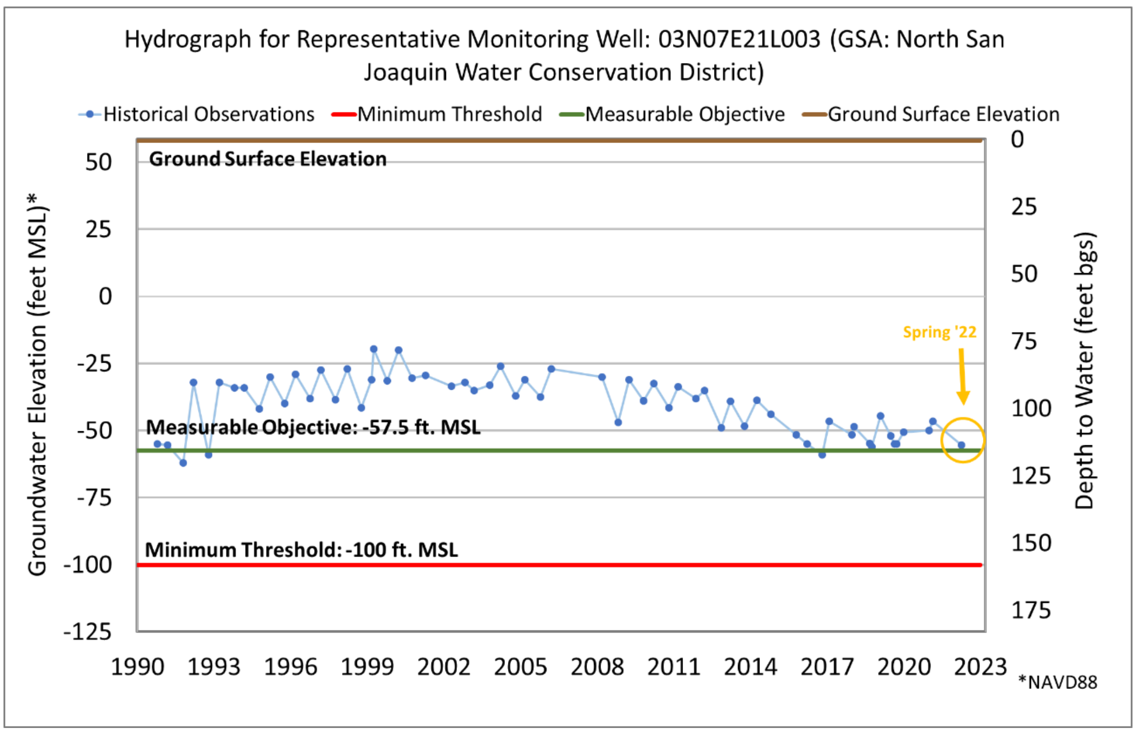


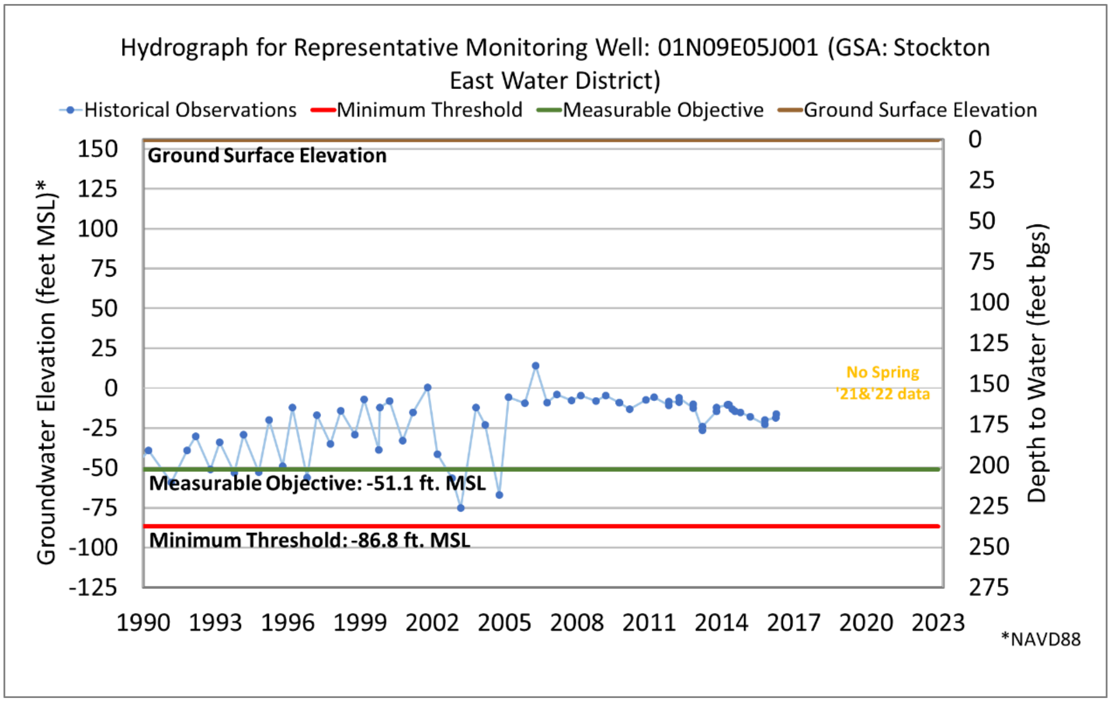
[1]Groundwater level data for WY 1991-2018 was provided by Stockton East Water District, as reported in the GSP. Groundwater level data for WY 2019-2020 was provided by San Joaquin County.


Hydrograph for Representative Monitoring Well: 01N07E14J002 (GSA: Central San Joaquin Water Conservation District)
Historical Observations
Minimum Threshold
Measurable Objective
Ground Surface Elevation
Ground Surface Elevation
Spring '22
Measurable Objective: -70.4 ft. MSL
Minimum Threshold: -114.4 ft. MSL
Groundwater Elevation (feet MSL)*
Depth to Water (feet bgs)
50
25
0
-25
-50
-75
-100
-125
0
25
50
75
100
125
150
175
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
2023
*NAVD88


Hydrograph for Representative Monitoring Well: Swenson-3 (GSA: City of Stockton)
Historical Observations
Minimum Threshold
Measurable Objective
Ground Surface Elevation
Ground Surface Elevation
No Spring '21&'22 data
Measurable Objective: -19.3 ft. MSL
Minimum Threshold: -26.6 ft. MSL
Groundwater Elevation (feet MSL)*
Depth to Water (feet bgs)
0
-25
-50
0
25
50
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
2023
*NAVD88


Hydrograph for Representative Monitoring Well: 02N08E15M002 (GSA: Linden County Water District)
Historical Observations
Minimum Threshold
Measurable Objective
Ground Surface Elevation
Ground Surface Elevation
No Spring '21&'22 data
Measurable Objective: -69.7 ft. MSL
Minimum Threshold: -124.1 ft. MSL
Groundwater Elevation (feet MSL)*
Depth to Water (feet bgs)
*NAVD88


Hydrograph for Representative Monitoring Well: 03N07E21L003 (GSA: North San Joaquin Water Conservation District)
Historical Observations
Minimum Threshold
Measurable Objective
Ground Surface Elevation
Ground Surface Elevation
Spring '22
Measurable Objective: -57.5 ft. MSL
Minimum Threshold: -100 ft. MSL
Groundwater Elevation (feet MSL)*
Depth to Water (feet bgs)
*NAVD88


Hydrograph for Representative Monitoring Well: 01N09E05J001 (GSA: Stockton East Water District)
Historical Observations
Minimum Threshold
Measurable Objective
Ground Surface Elevation
Groundwater Elevation (feet MSL)*
Depth to Water (feet bgs)
Ground Surface Elevation
Measurable Objective: -51.1 ft. MSL
Minimum Threshold: -86.8 ft. MSL
No Spring '21&'22 data
150
125
100
75
50
25
0
-25
-50
-75
-100
-125
0
25
50
75
100
125
150
175
200
225
250
275
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
2023
*NAVD88

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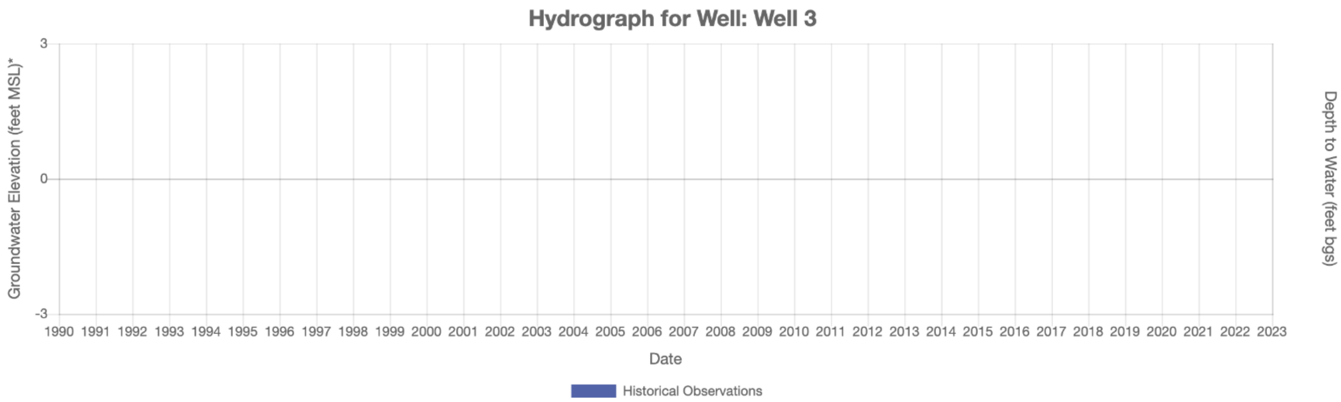
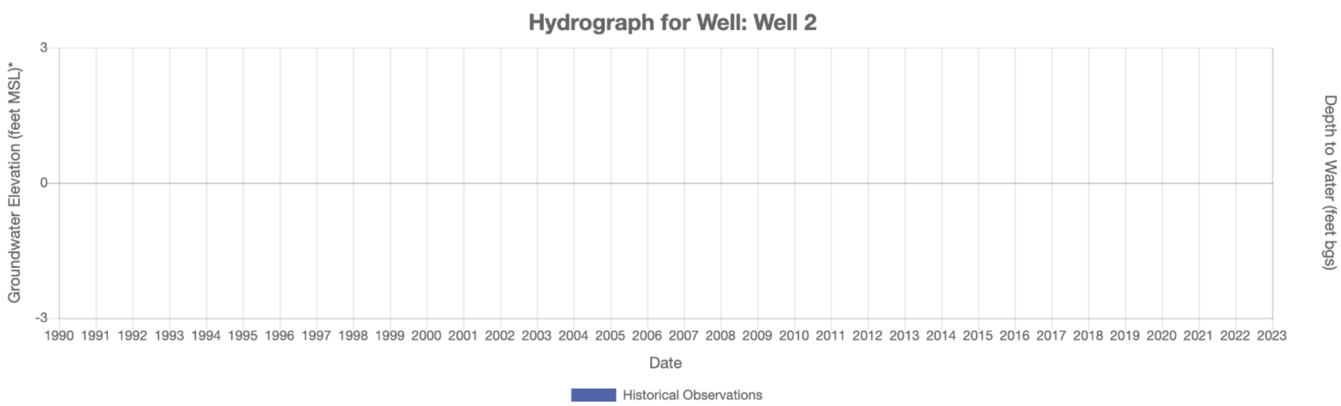
APPENDIX C – BROAD MONITORING NETWORK WELL HYDROGRAPHS

Note: Included in Appendix C are the 76 broad network CASGEM well historical hydrographs and 52 broad network nested well historical hydrographs listed in Appendix 4-A of the GSP. Wells for which historical data are not available are included as hydrographs with no data points. Future annual reports will report on the monitoring carried out at these wells, along with those in the representative monitoring network, as the GSP is implemented. Additionally, 15 local wells that have historically been monitored for water quality will also be monitored for water levels as the GSP is further implemented. These data will also be reported on in future annual reports.

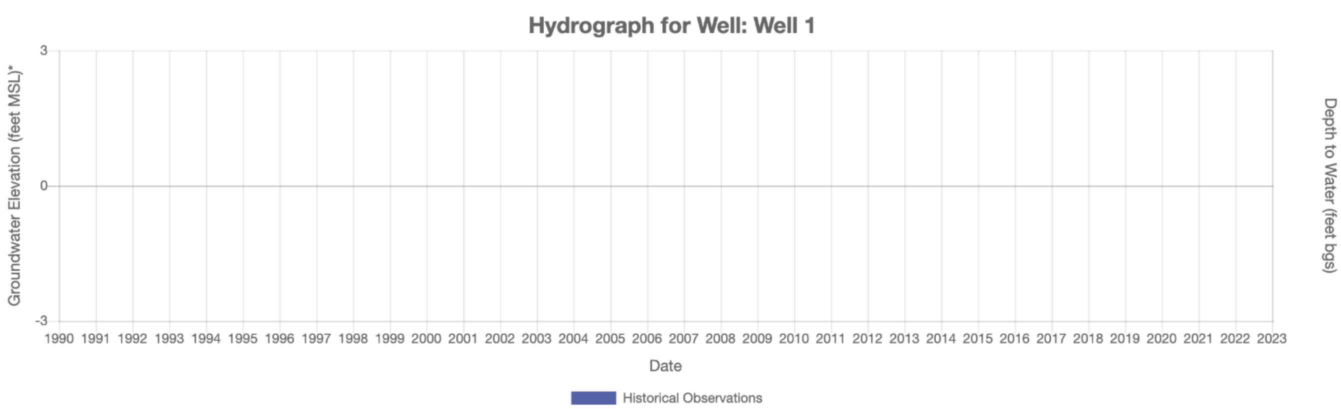
Ground Surface Elevation: 0 ft.



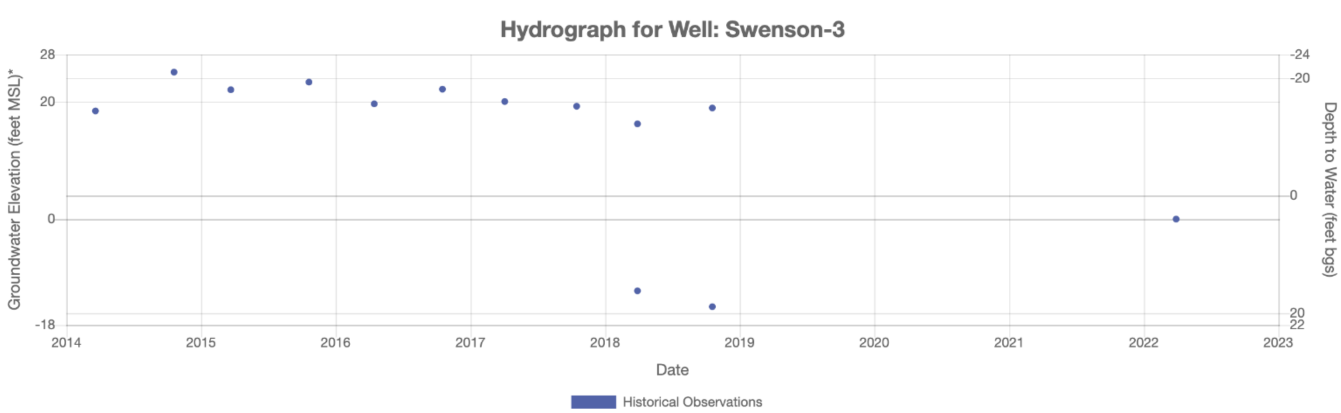
Ground Surface Elevation: 0 ft.



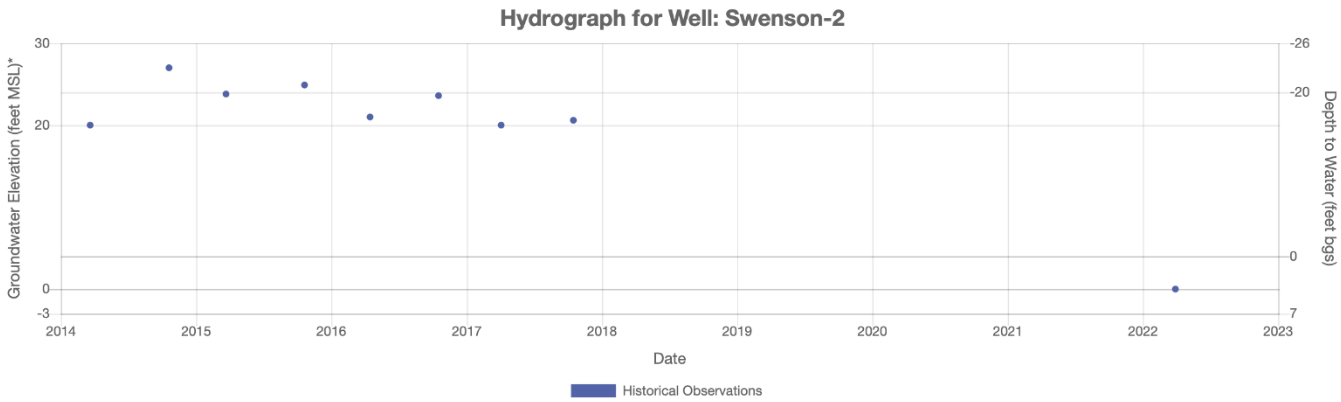
Ground Surface Elevation: 0 ft.



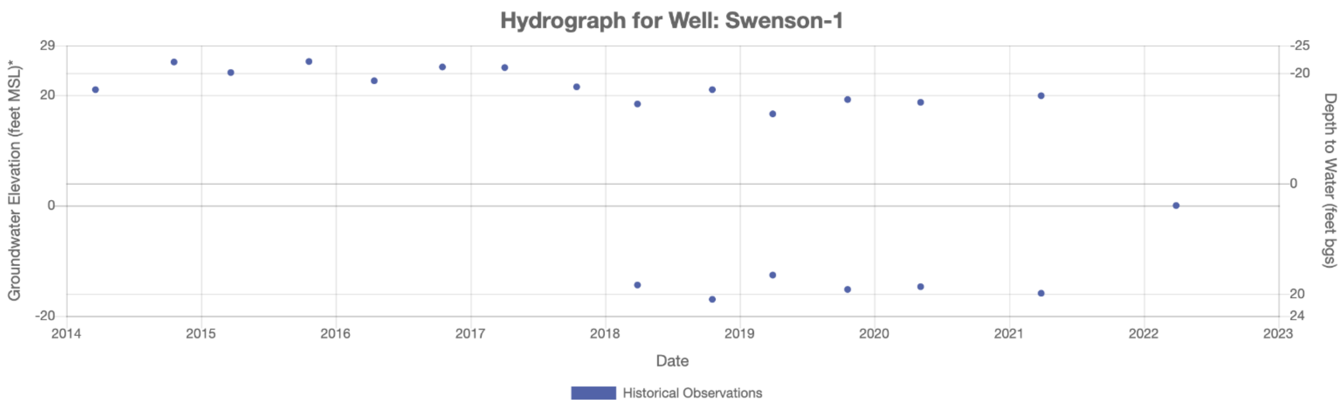
Ground Surface Elevation: 4 ft.



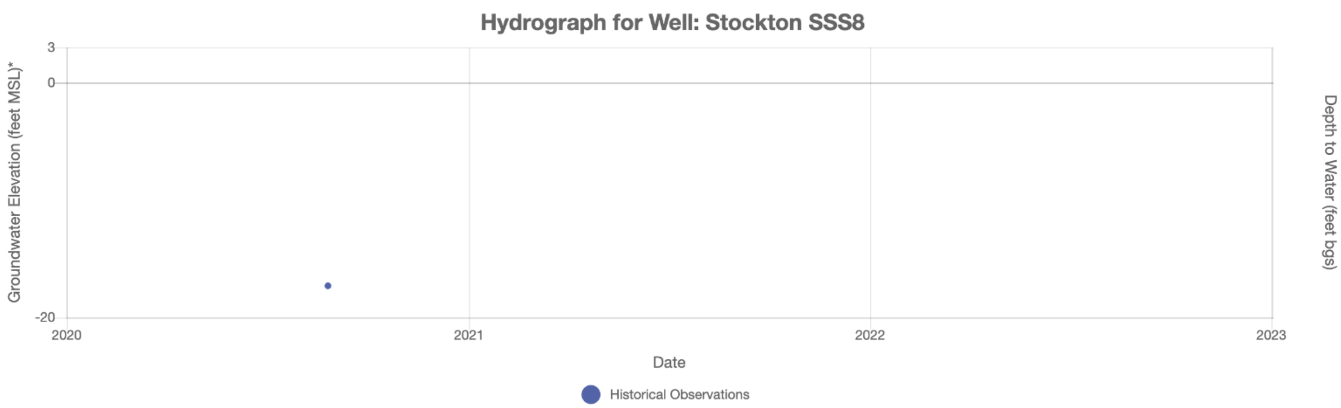
Ground Surface Elevation: 4 ft.



Ground Surface Elevation: 4 ft.

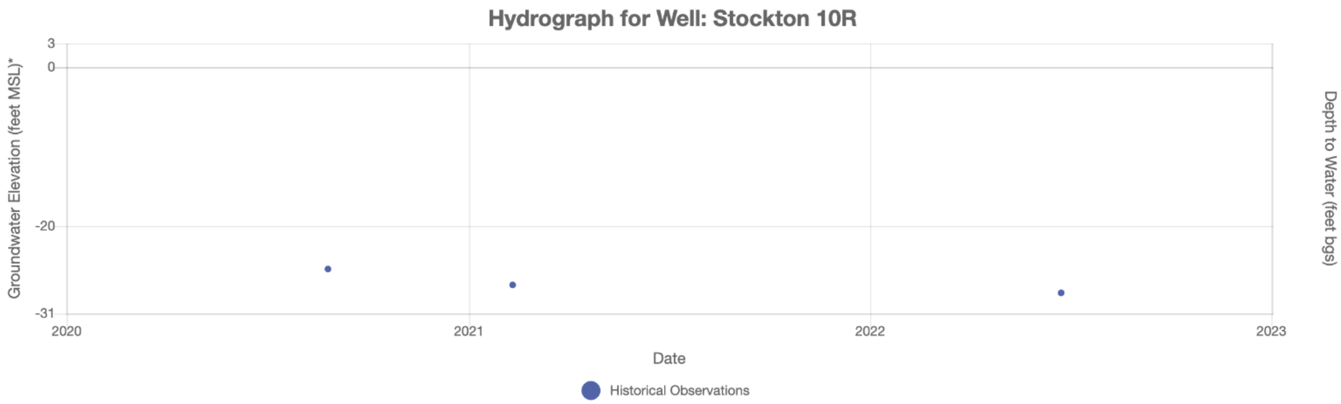


Ground Surface Elevation: 0 ft.

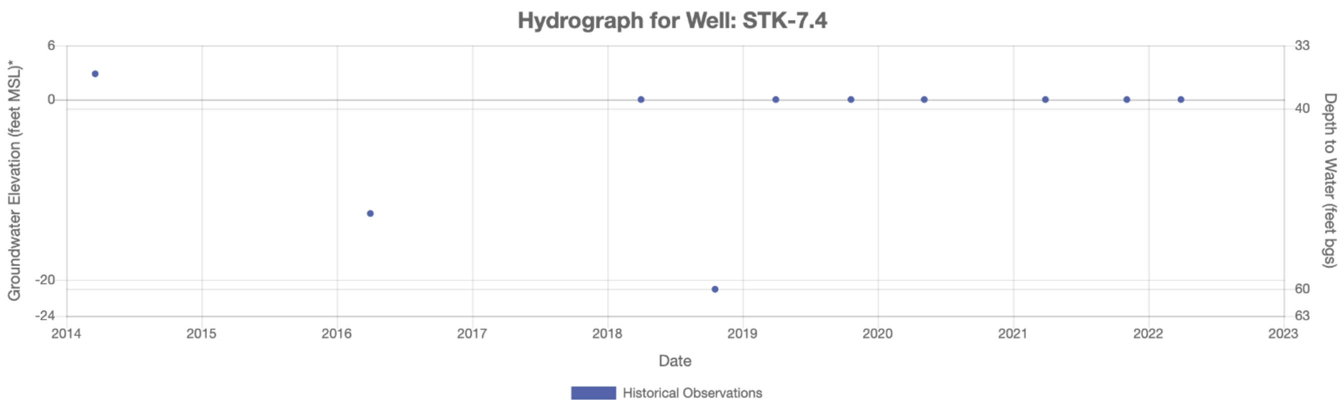


Ground Surface Elevation: 0 ft.

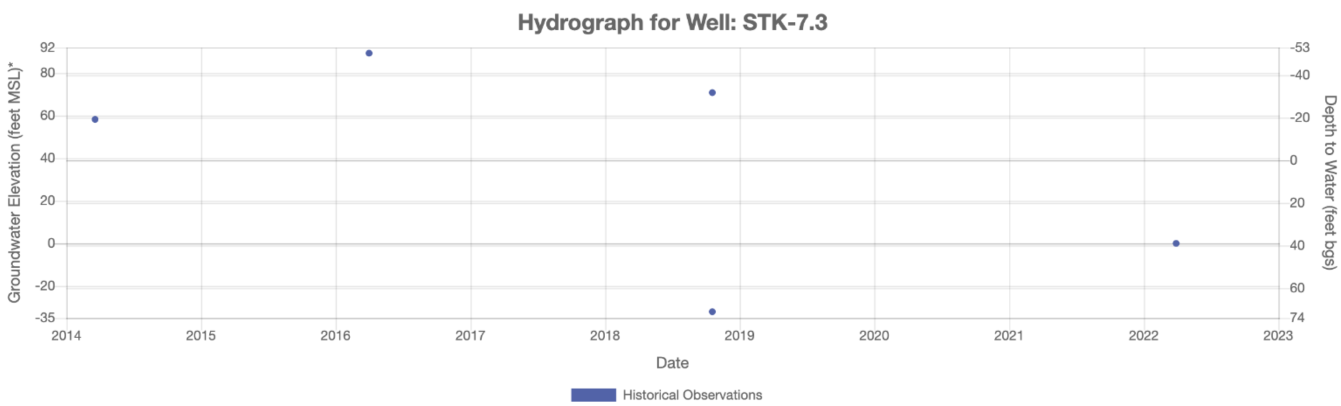
Ground Surface Elevation: 0 ft.



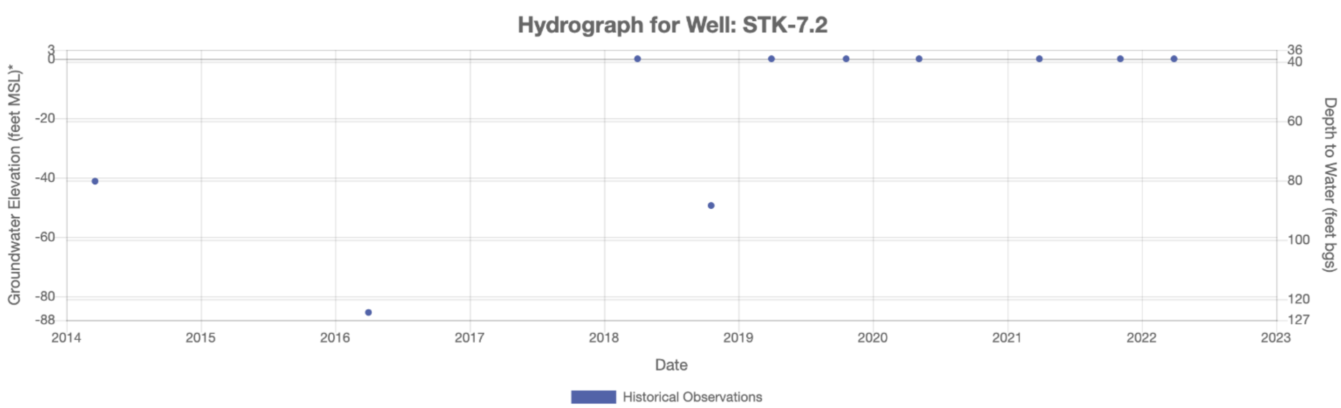
Ground Surface Elevation: 39 ft.



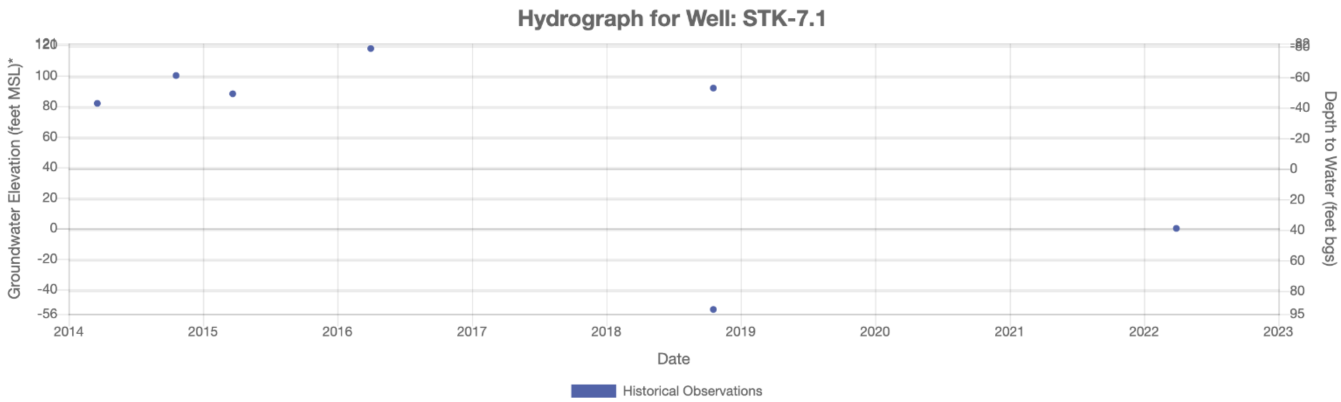
Ground Surface Elevation: 39 ft.



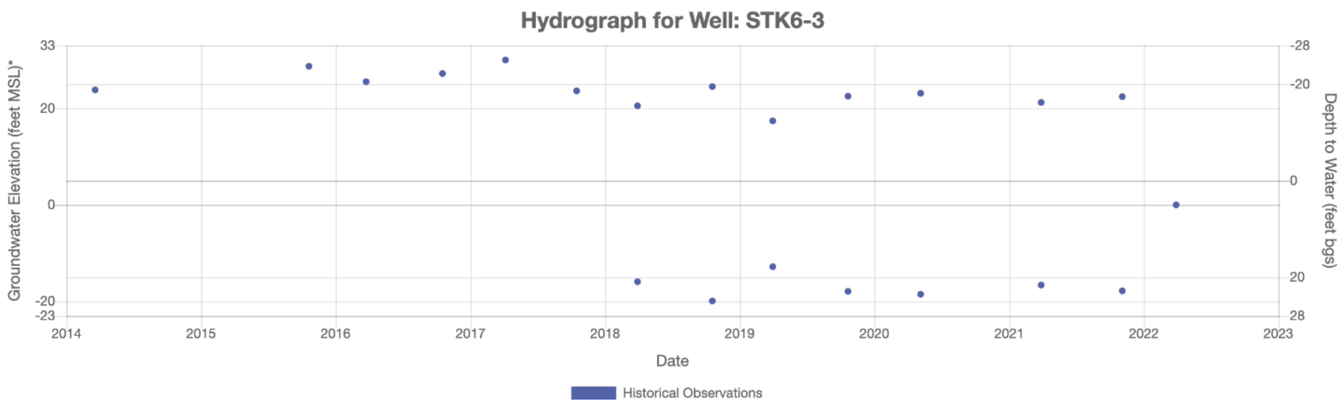
Ground Surface Elevation: 39 ft.



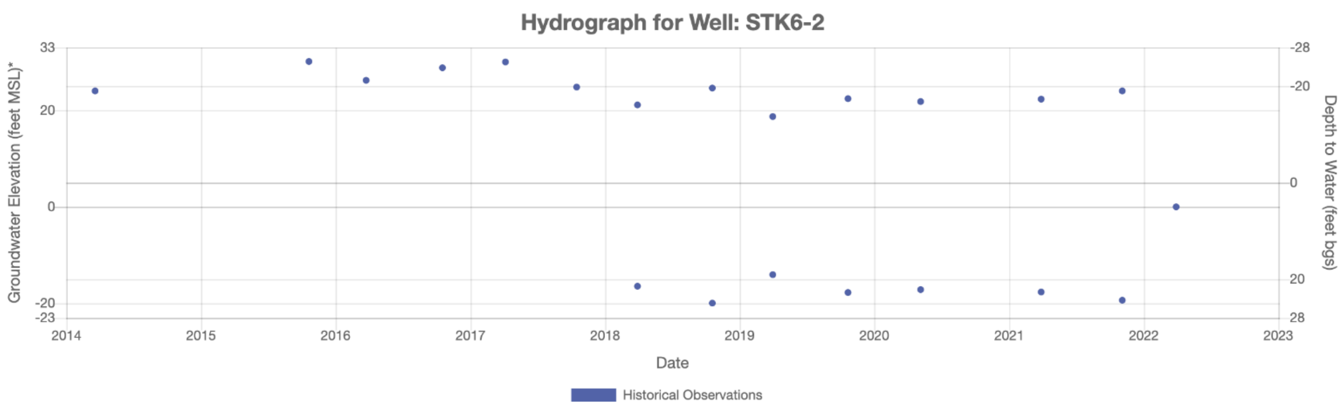
Ground Surface Elevation: 39 ft.



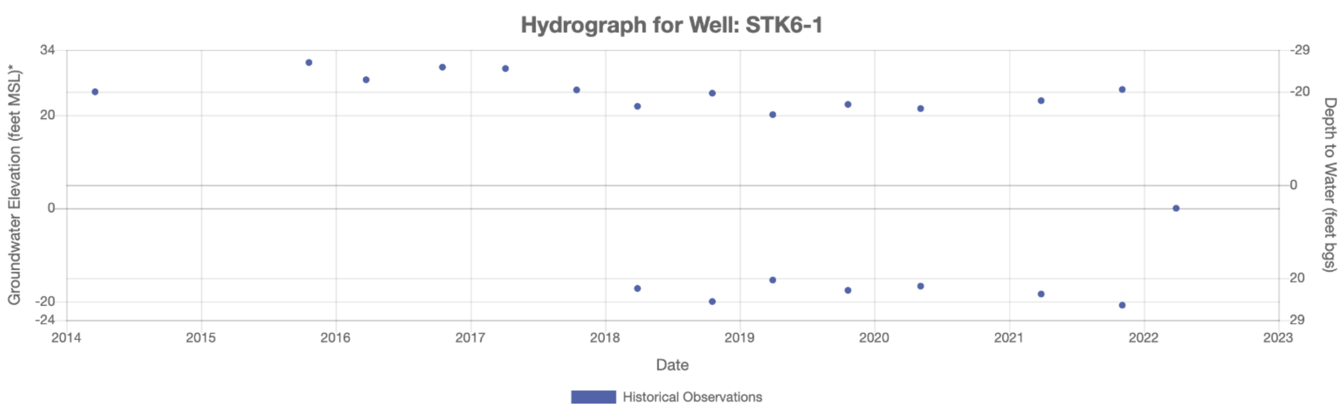
Ground Surface Elevation: 5 ft.



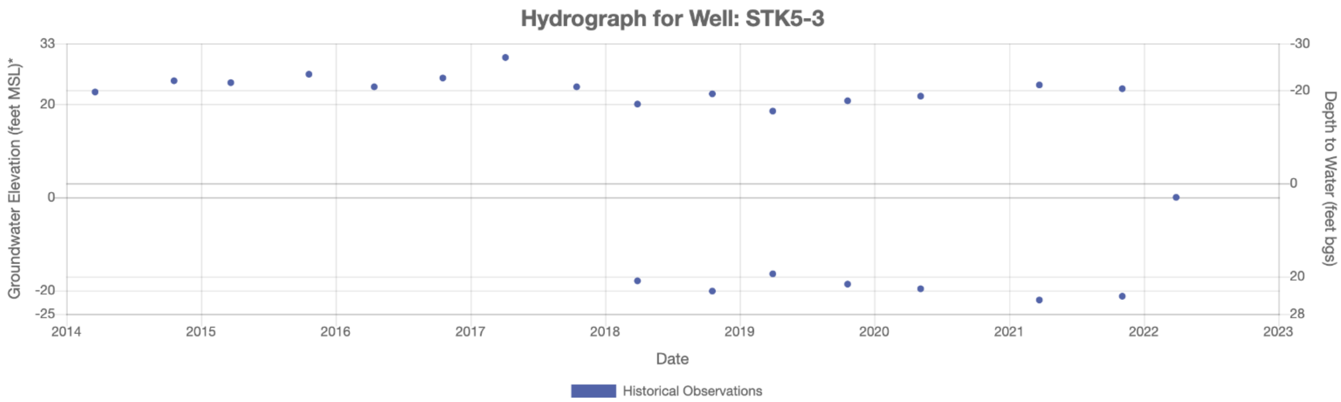
Ground Surface Elevation: 5 ft.



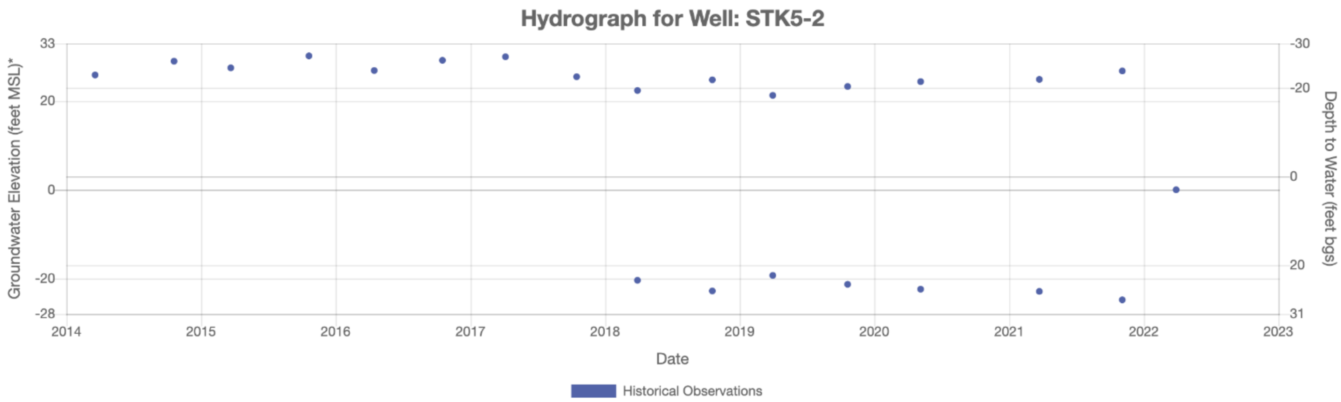
Ground Surface Elevation: 5 ft.



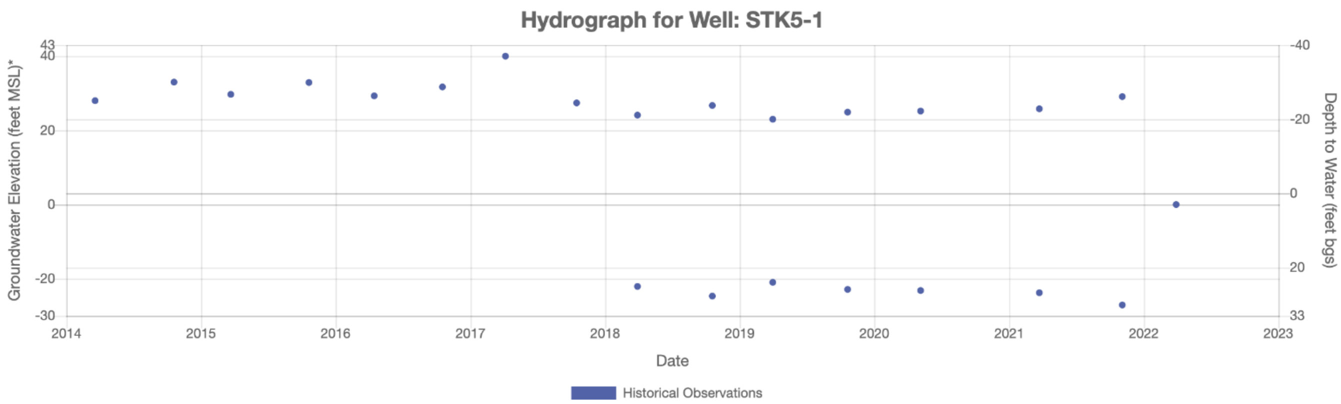
Ground Surface Elevation: 3 ft.



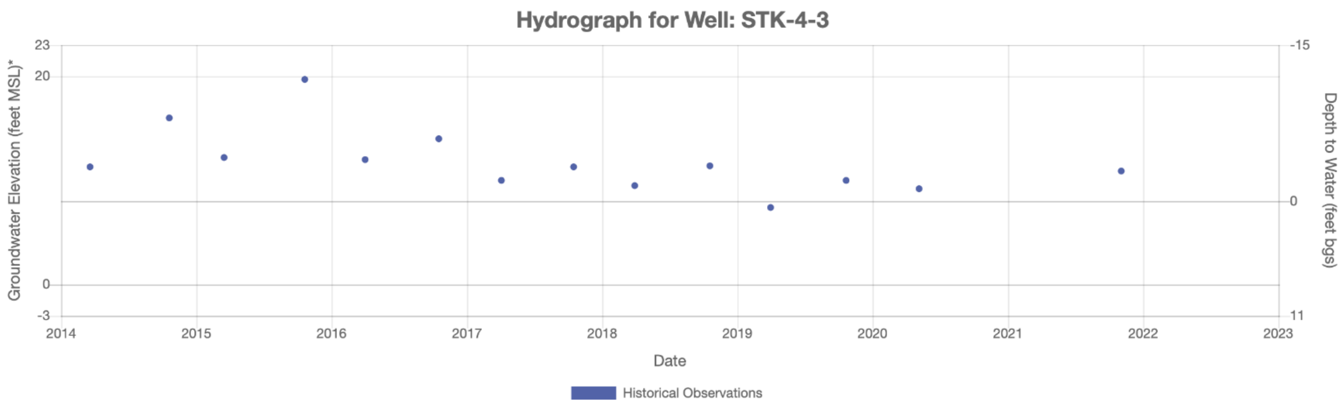
Ground Surface Elevation: 3 ft.



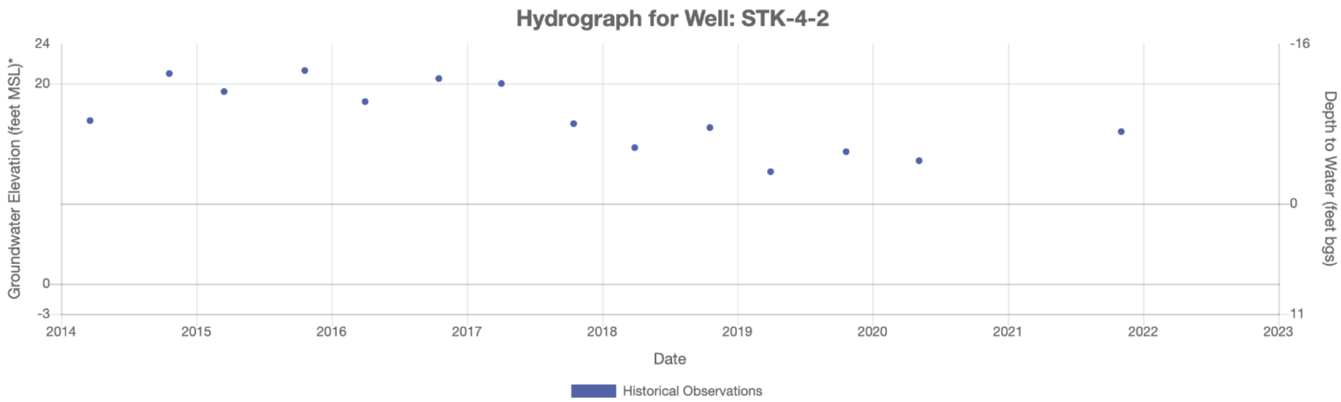
Ground Surface Elevation: 3 ft.



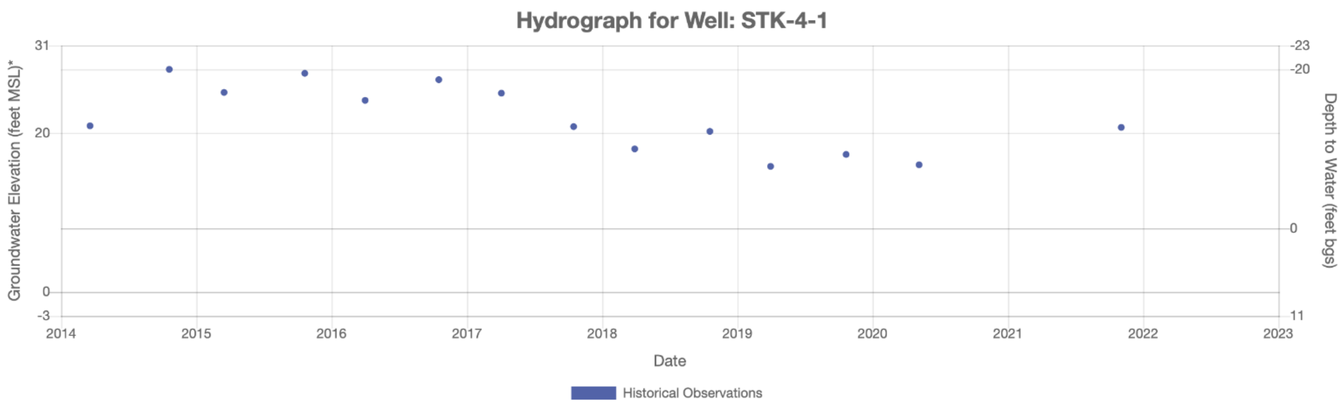
Ground Surface Elevation: 8 ft.



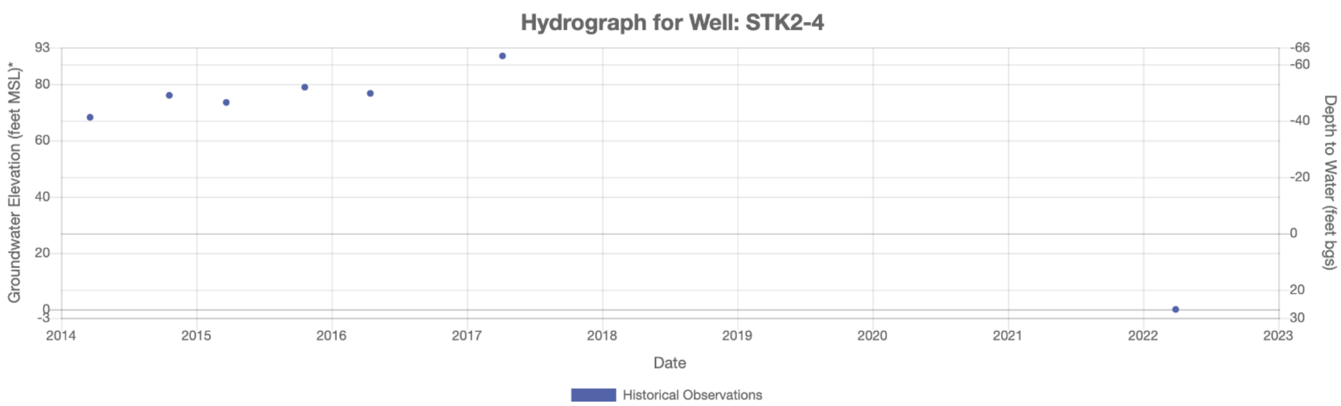
Ground Surface Elevation: 8 ft.



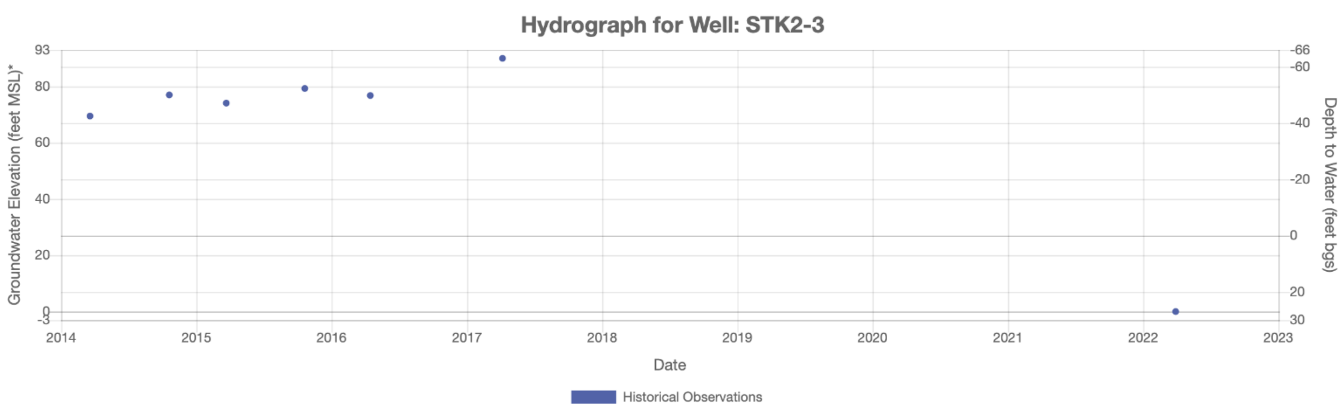
Ground Surface Elevation: 8 ft.



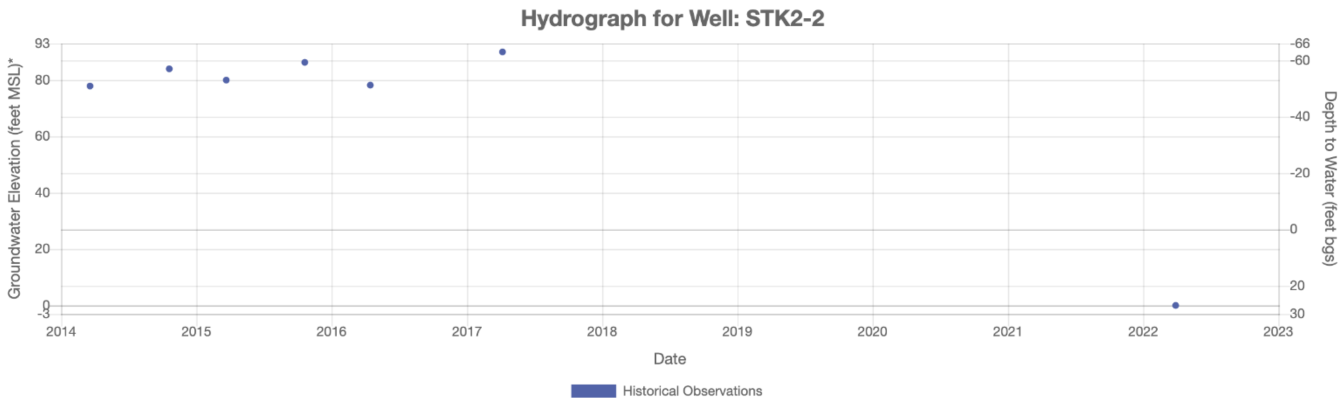
Ground Surface Elevation: 27 ft.



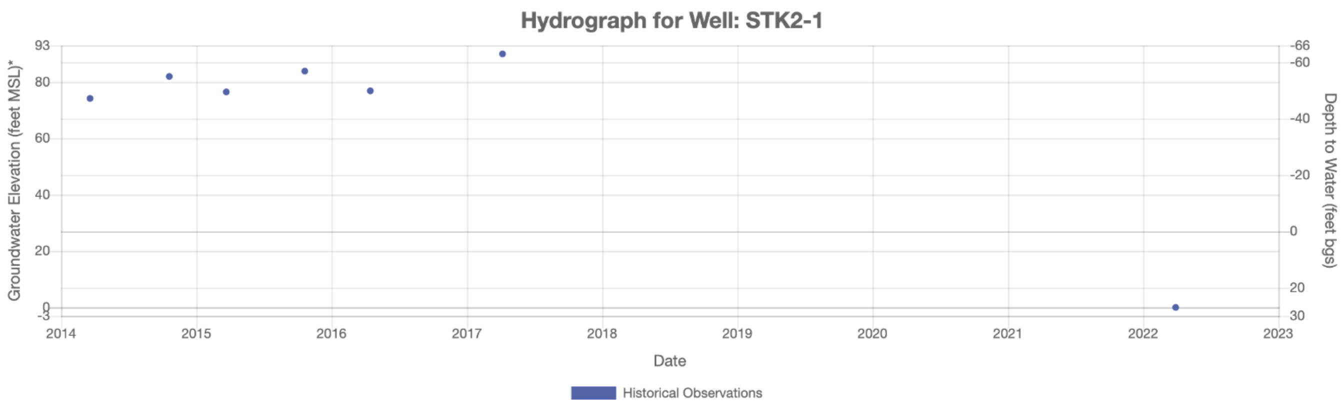
Ground Surface Elevation: 27 ft.



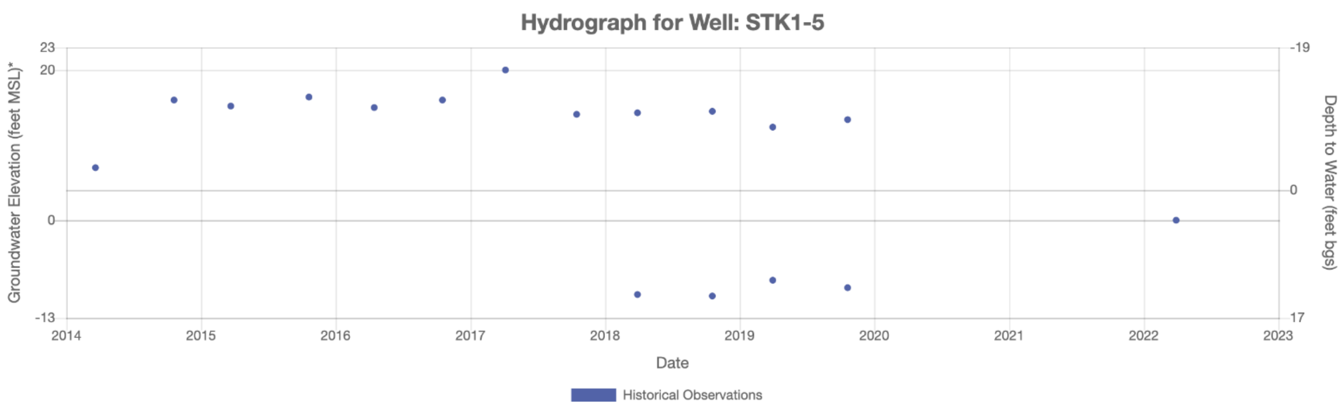
Ground Surface Elevation: 27 ft.



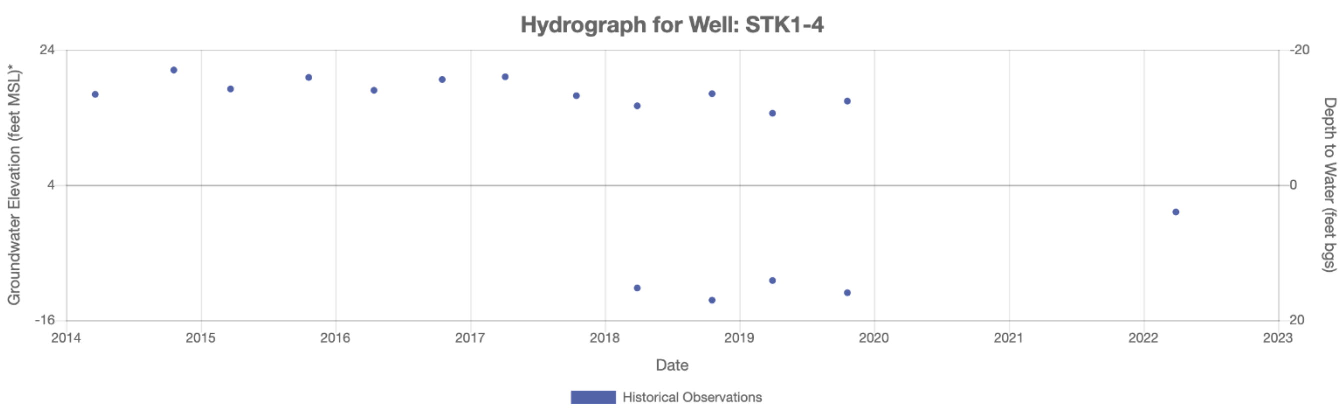
Ground Surface Elevation: 27 ft.



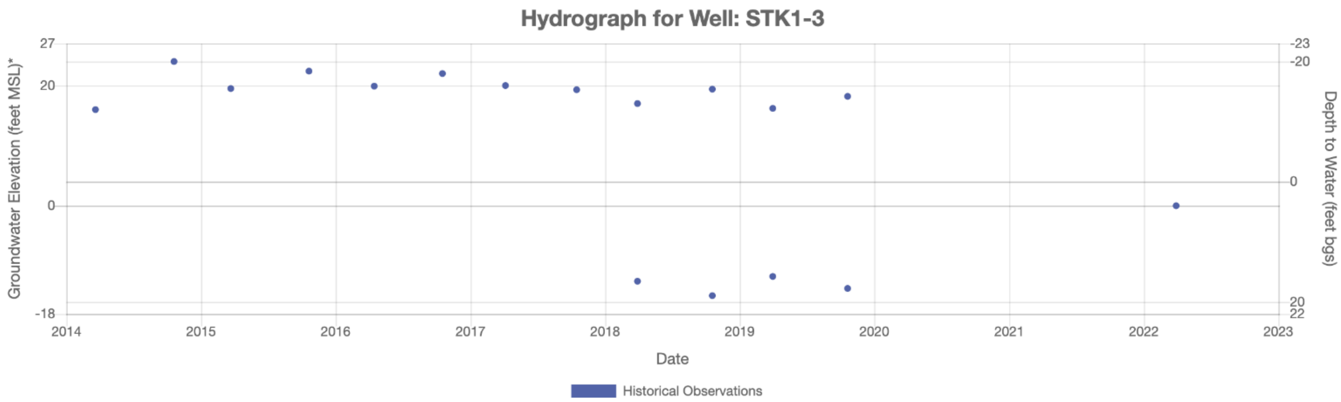
Ground Surface Elevation: 4 ft.



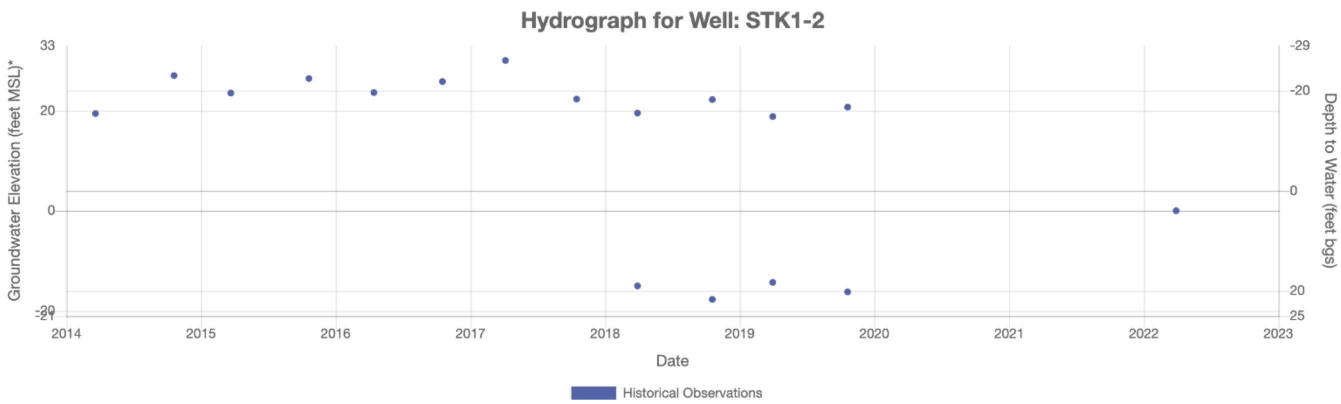
Ground Surface Elevation: 4 ft.



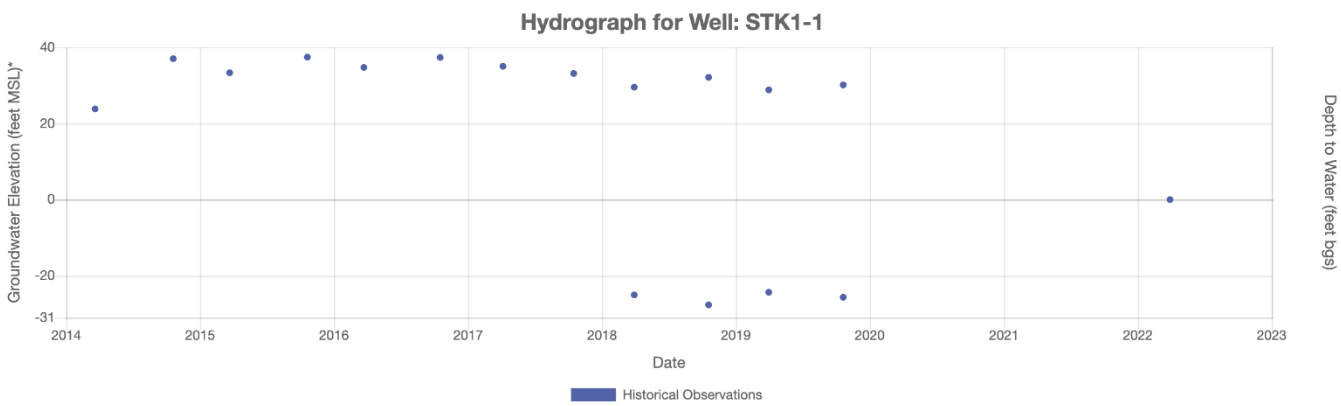
Ground Surface Elevation: 4 ft.



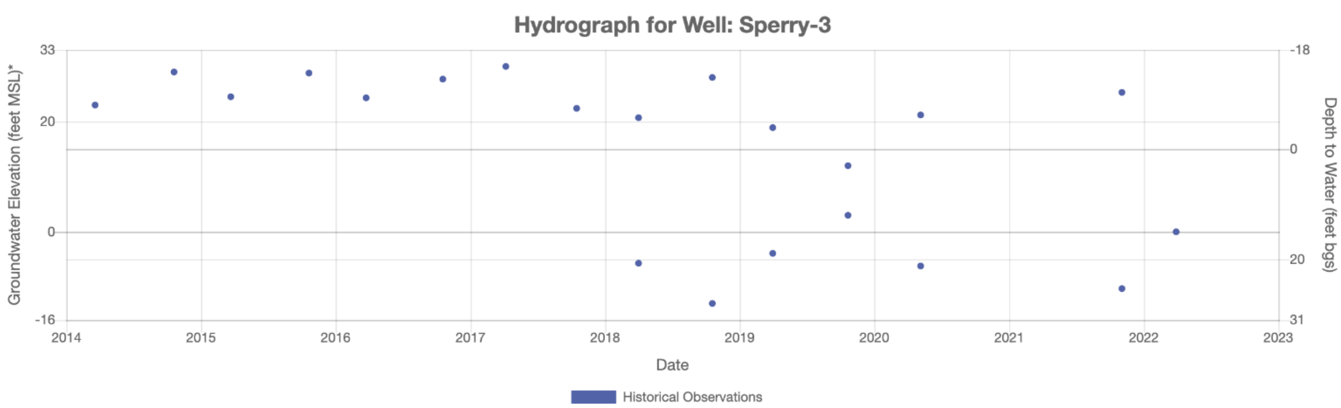
Ground Surface Elevation: 4 ft.



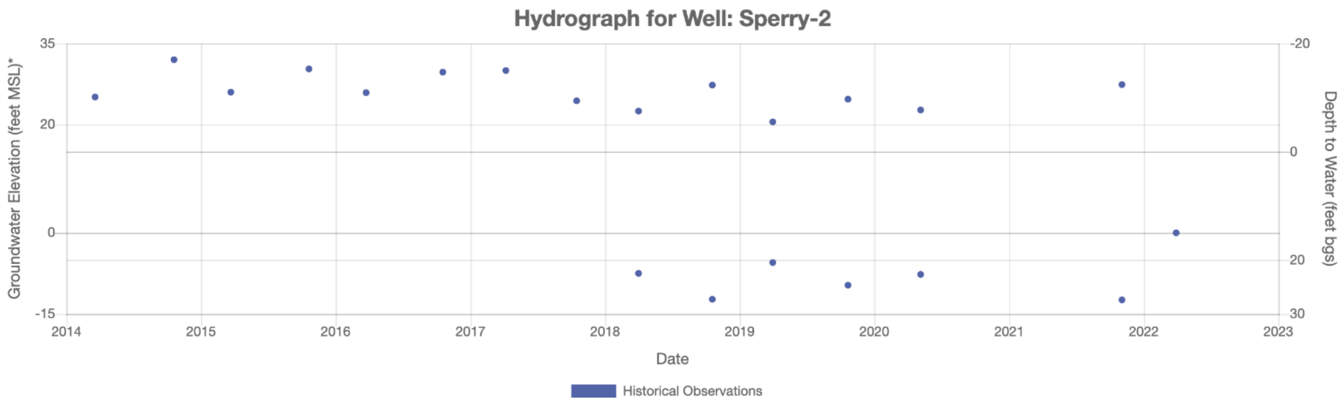
Ground Surface Elevation: 0 ft.



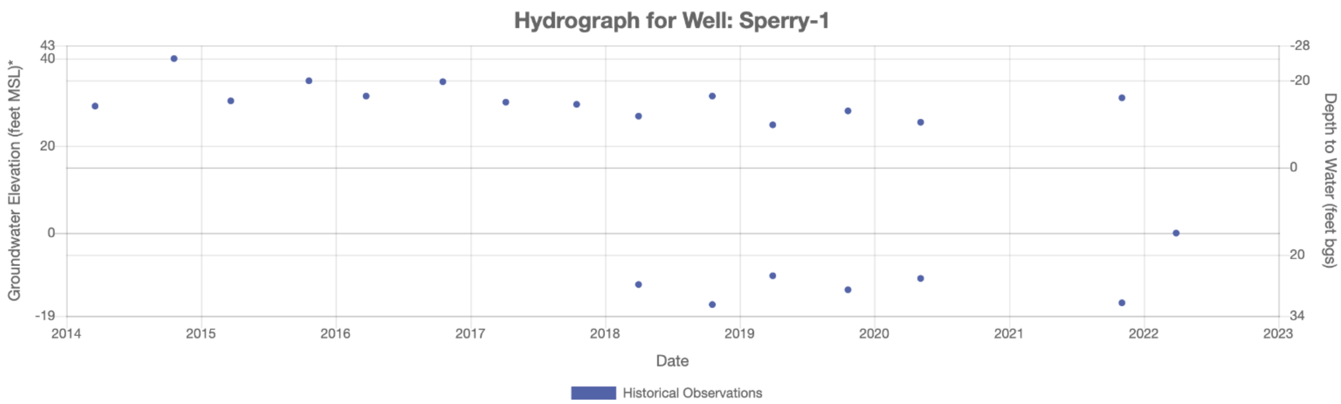
Ground Surface Elevation: 15 ft.



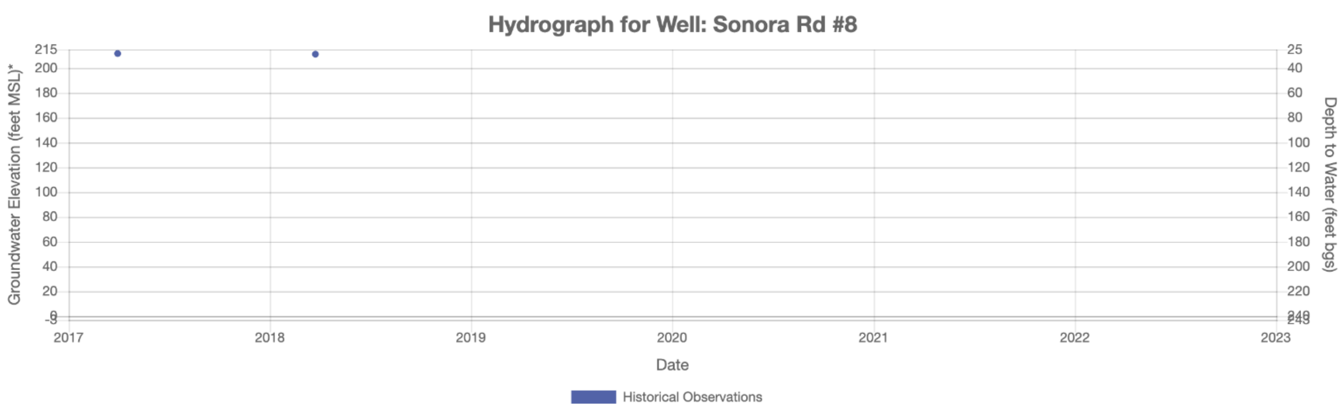
Ground Surface Elevation: 15 ft.



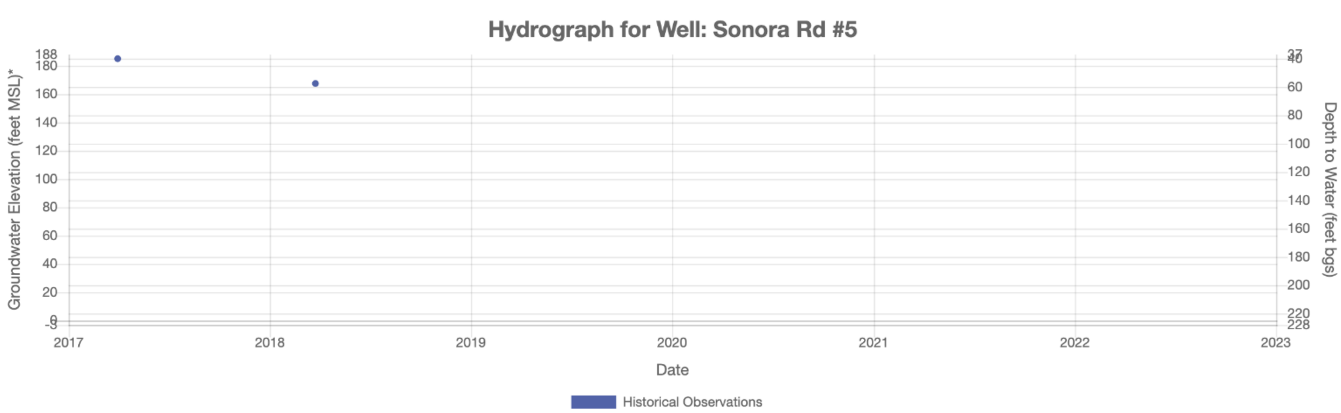
Ground Surface Elevation: 15 ft.



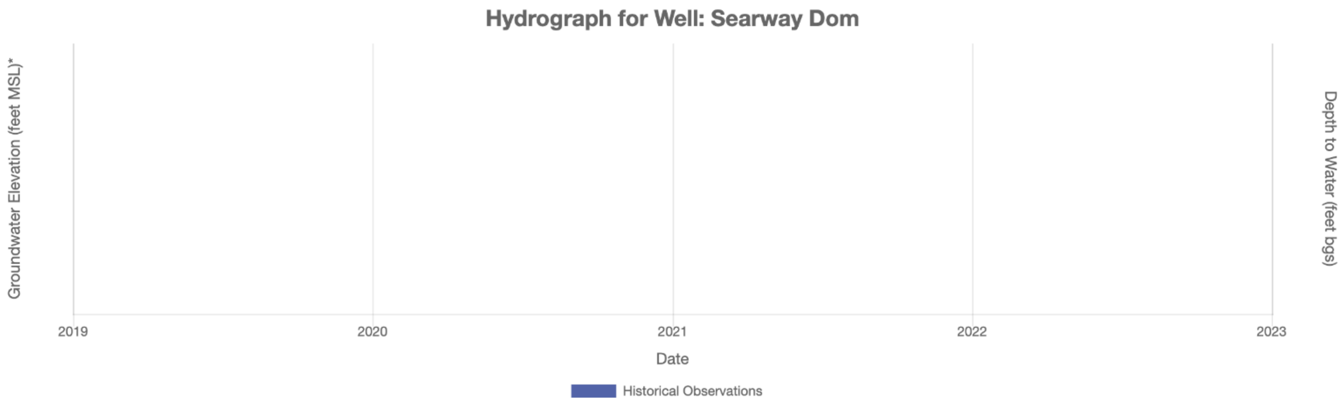
Ground Surface Elevation: 240 ft.



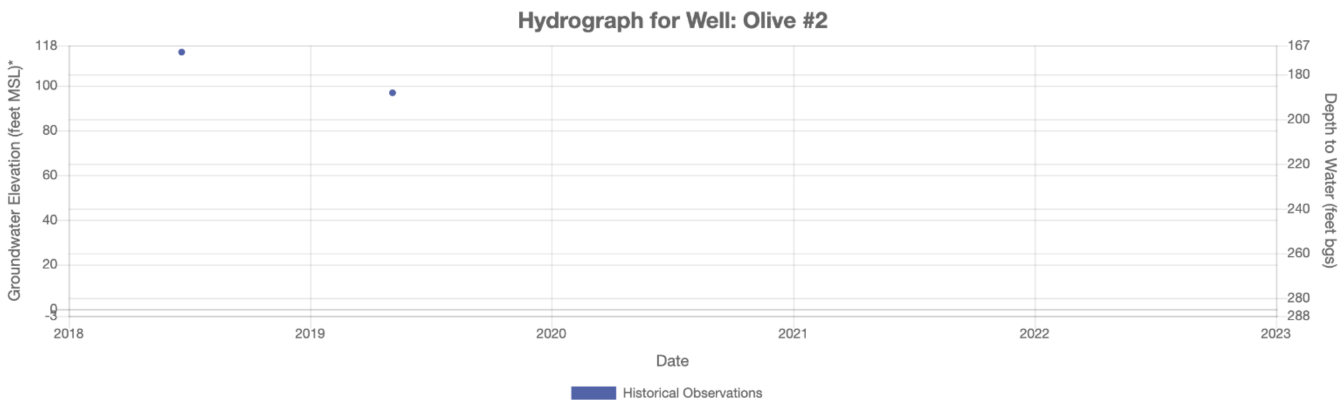
Ground Surface Elevation: 225 ft.



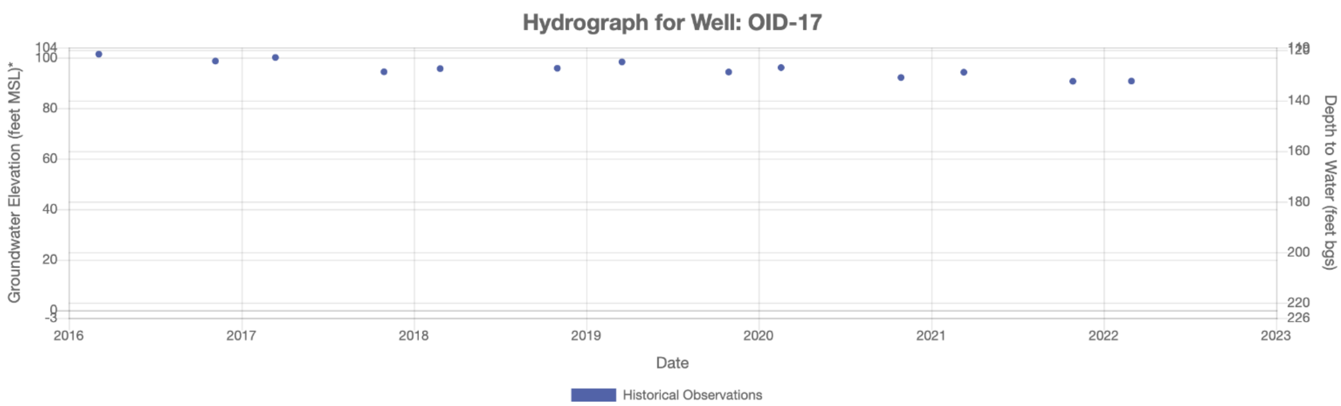
Ground Surface Elevation: 240 ft.



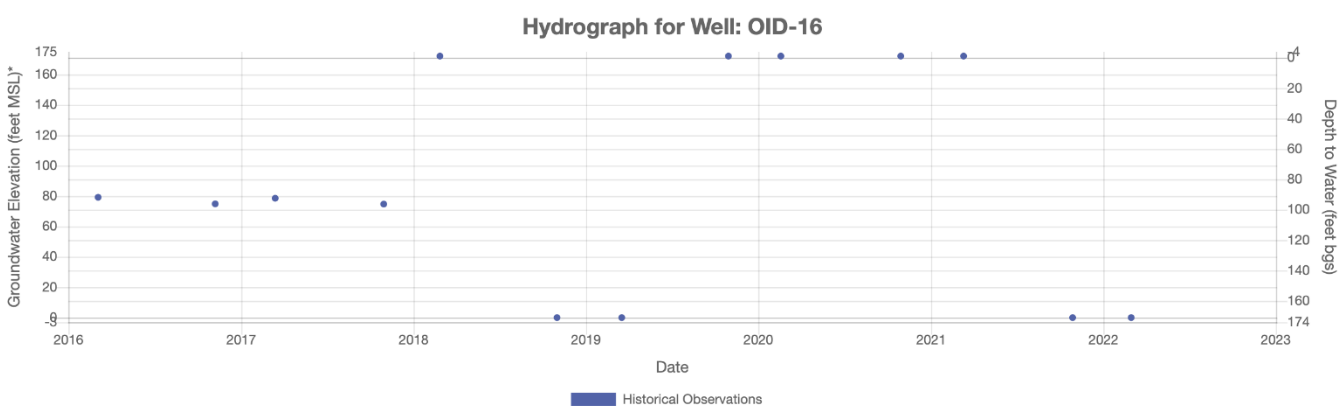
Ground Surface Elevation: 285 ft.



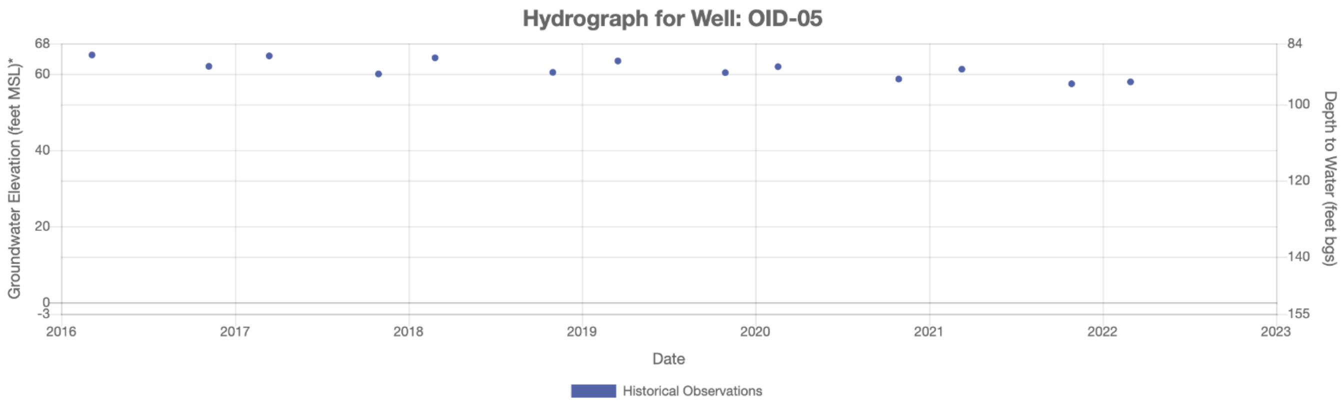
Ground Surface Elevation: 223 ft.



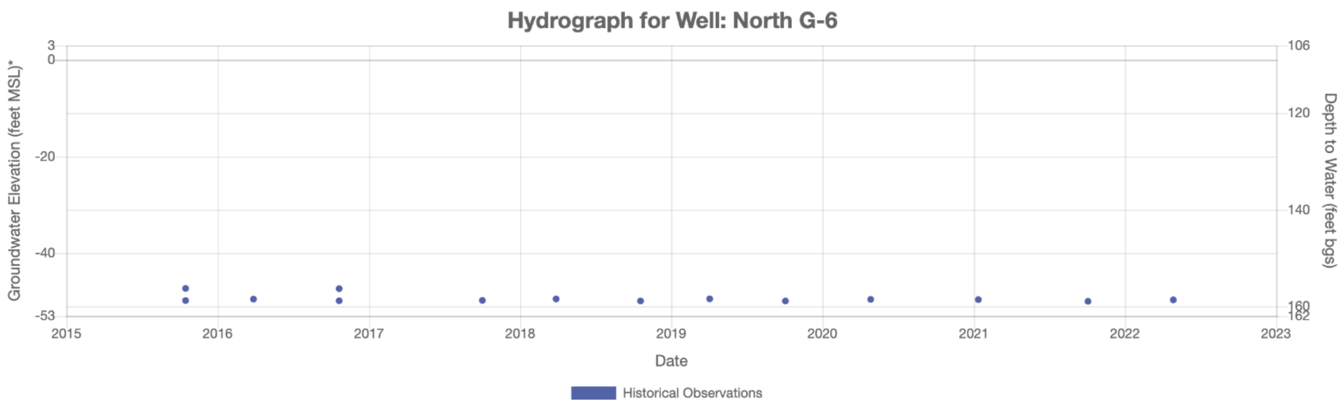
Ground Surface Elevation: 172 ft.



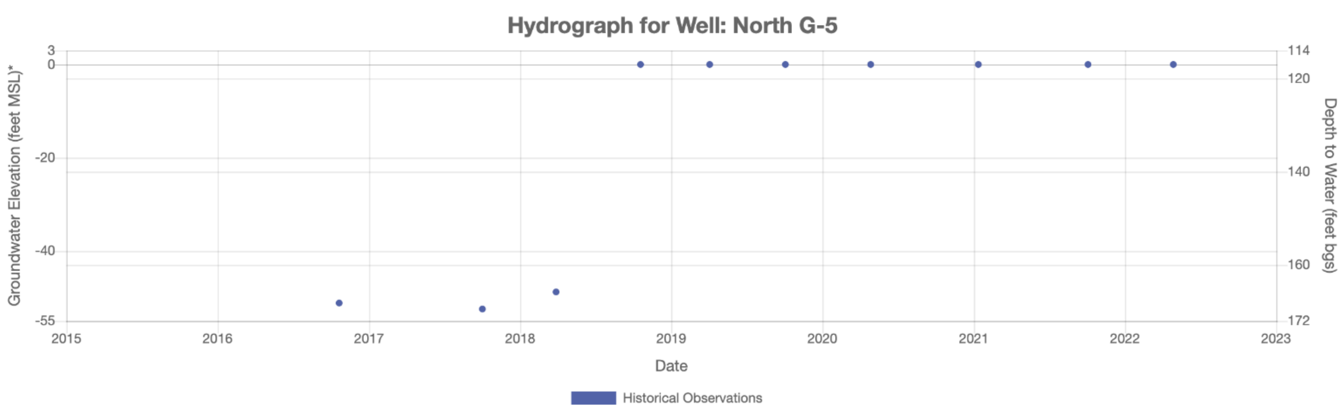
Ground Surface Elevation: 152 ft.



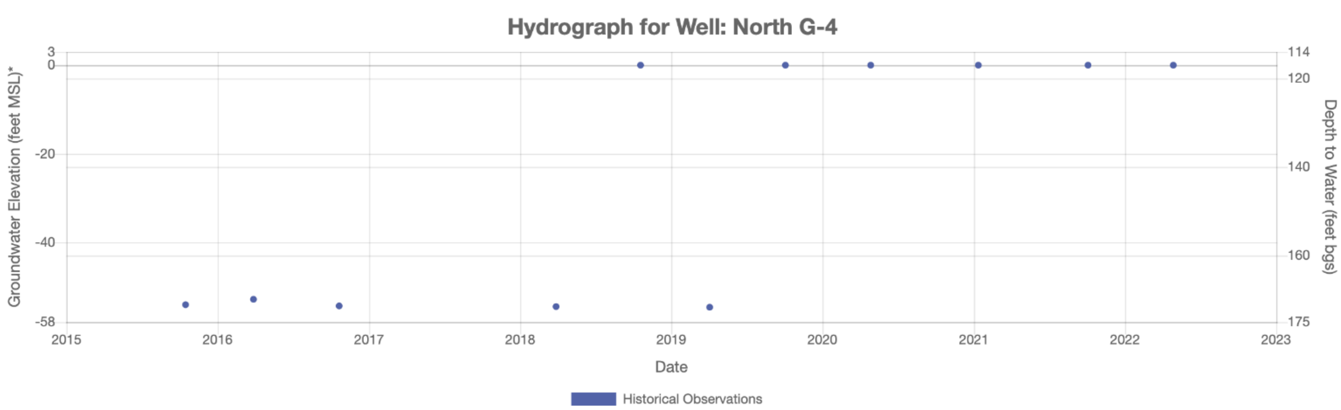
Ground Surface Elevation: 110 ft.



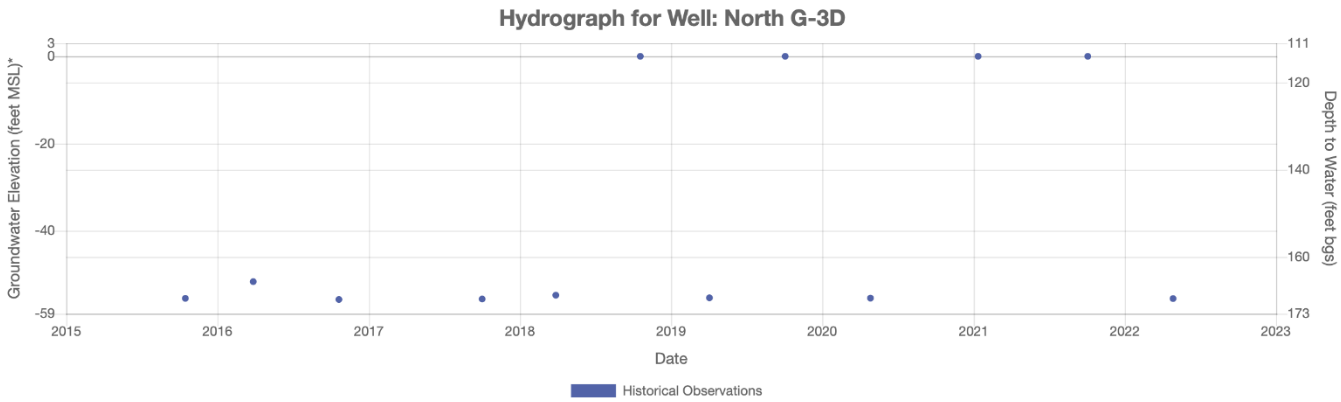
Ground Surface Elevation: 117 ft.



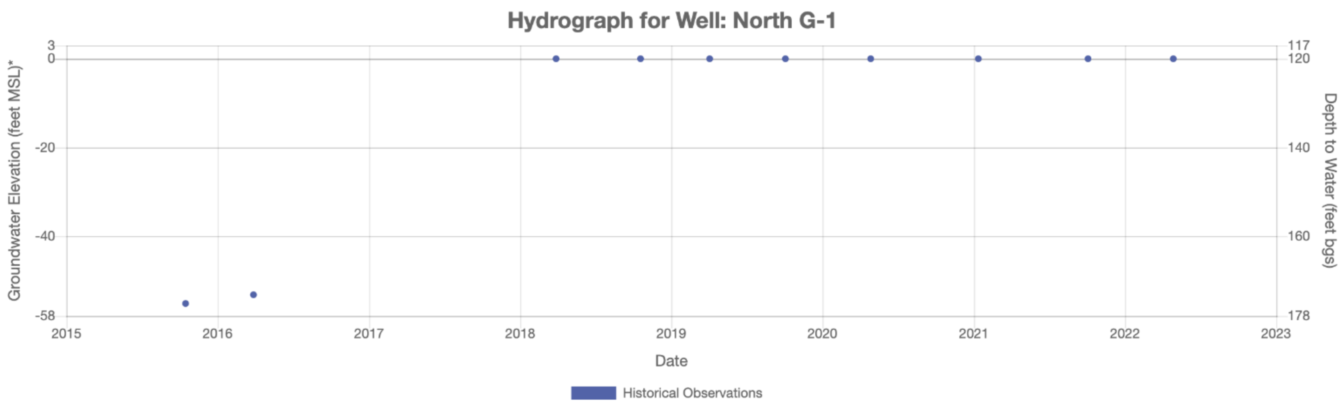
Ground Surface Elevation: 117 ft.



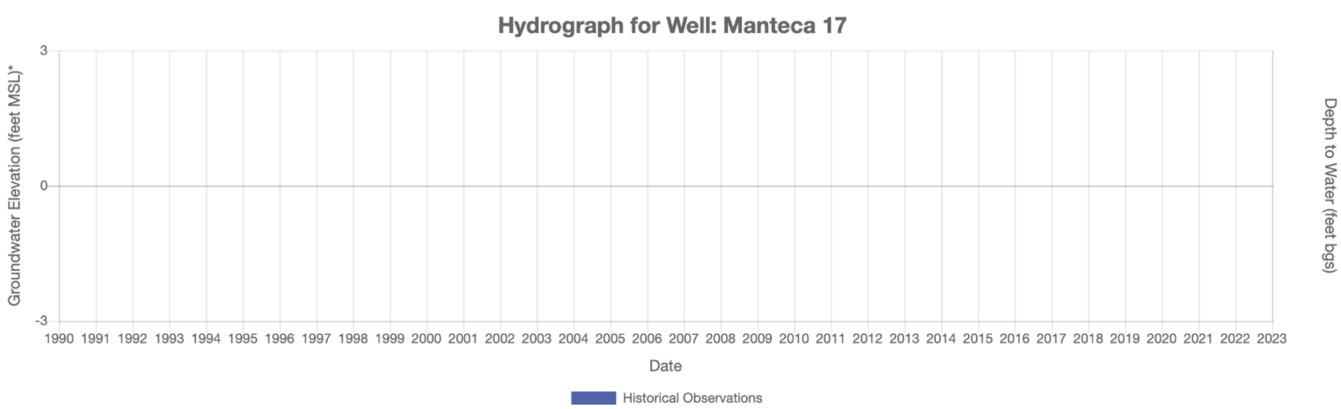
Ground Surface Elevation: 114 ft.



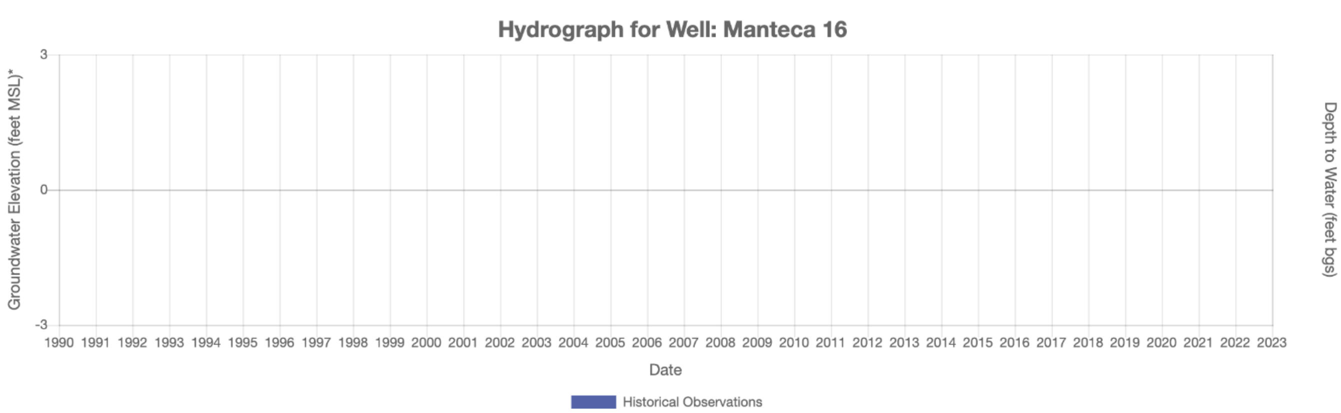
Ground Surface Elevation: 121 ft.



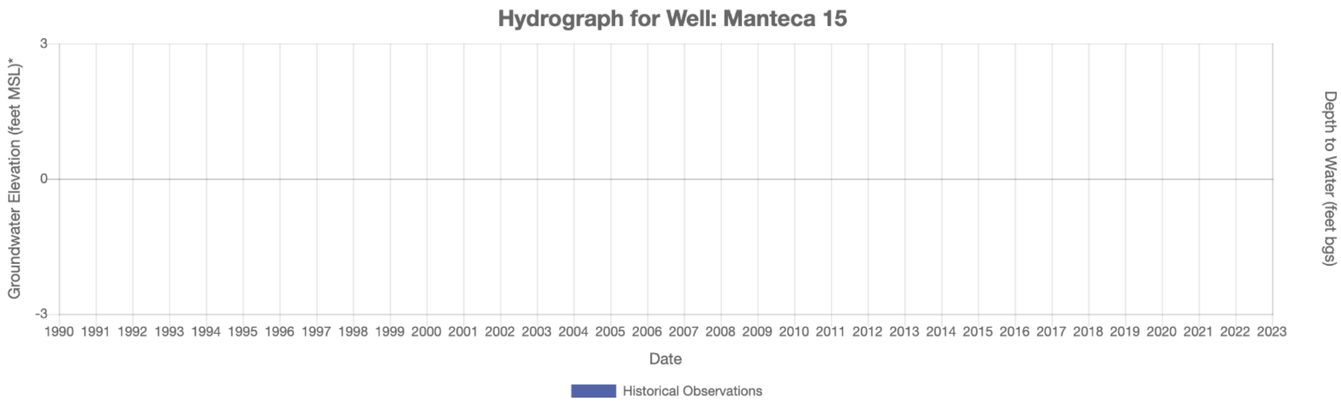
Ground Surface Elevation: 0 ft.



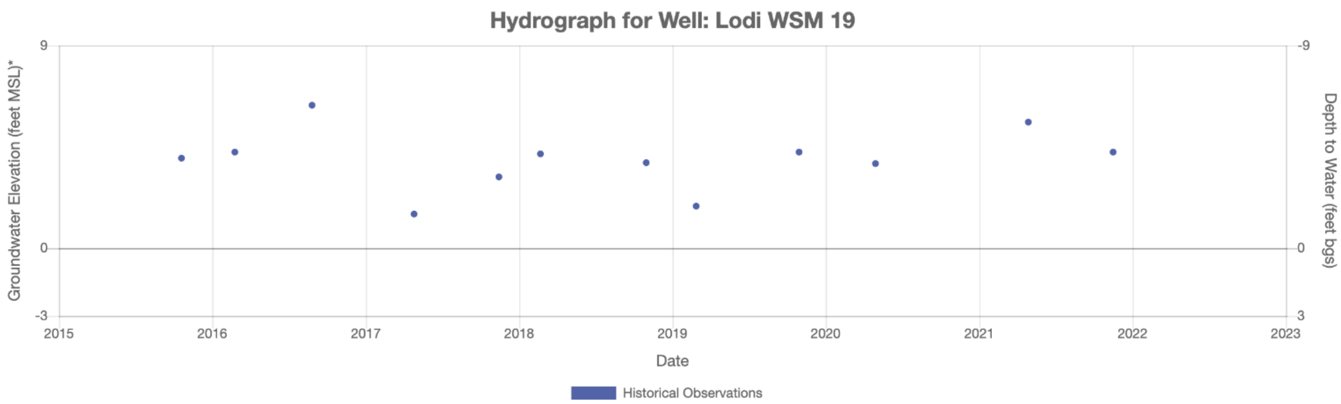
Ground Surface Elevation: 0 ft.



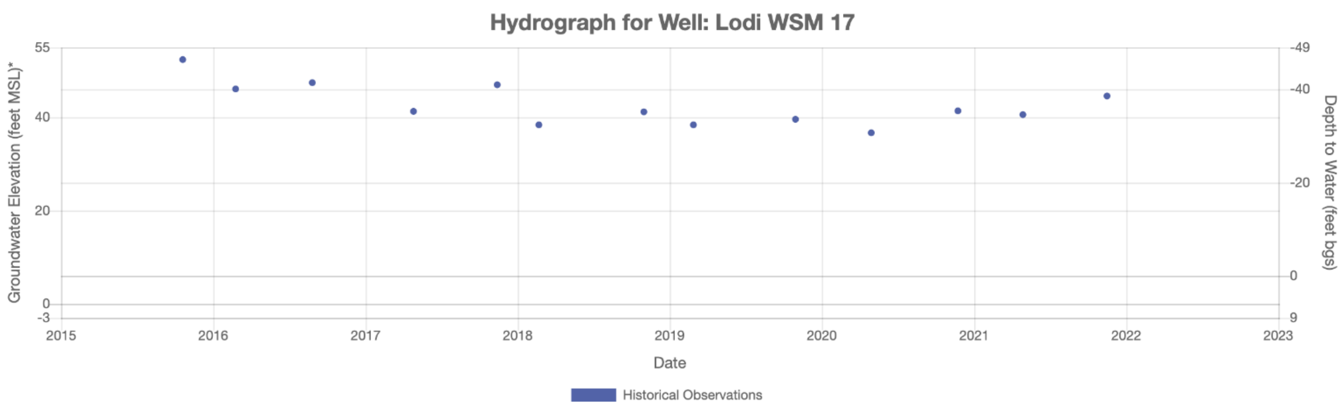
Ground Surface Elevation: 0 ft.



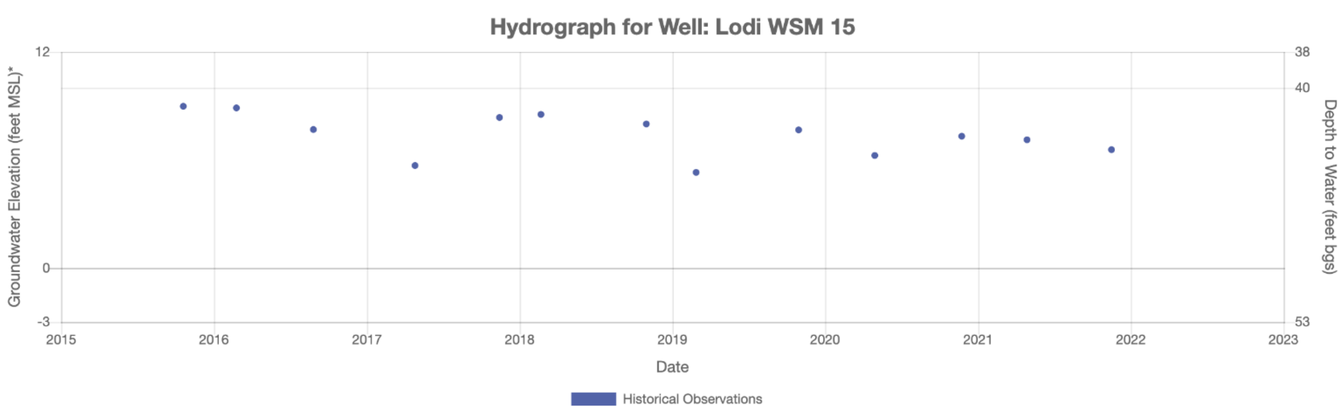
Ground Surface Elevation: -1 ft.



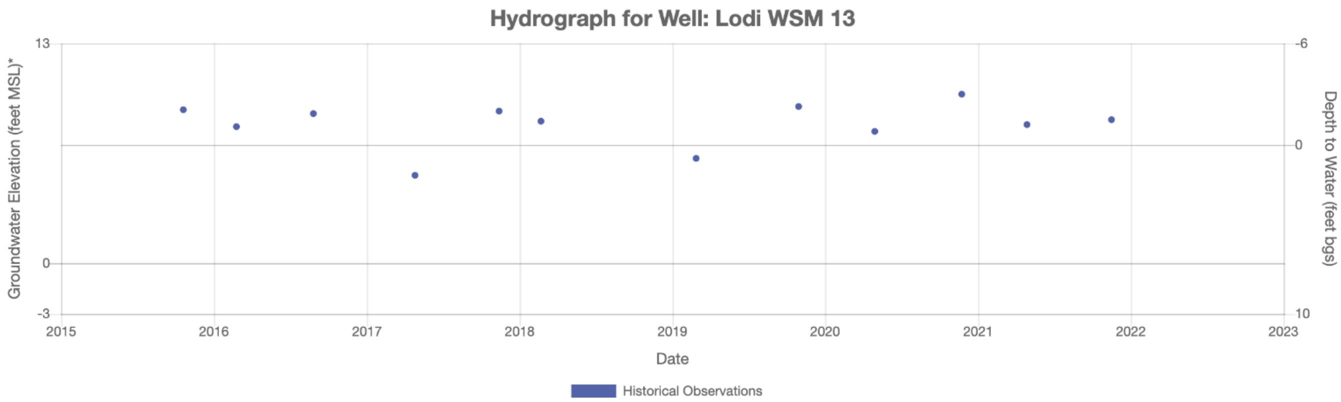
Ground Surface Elevation: 6 ft.



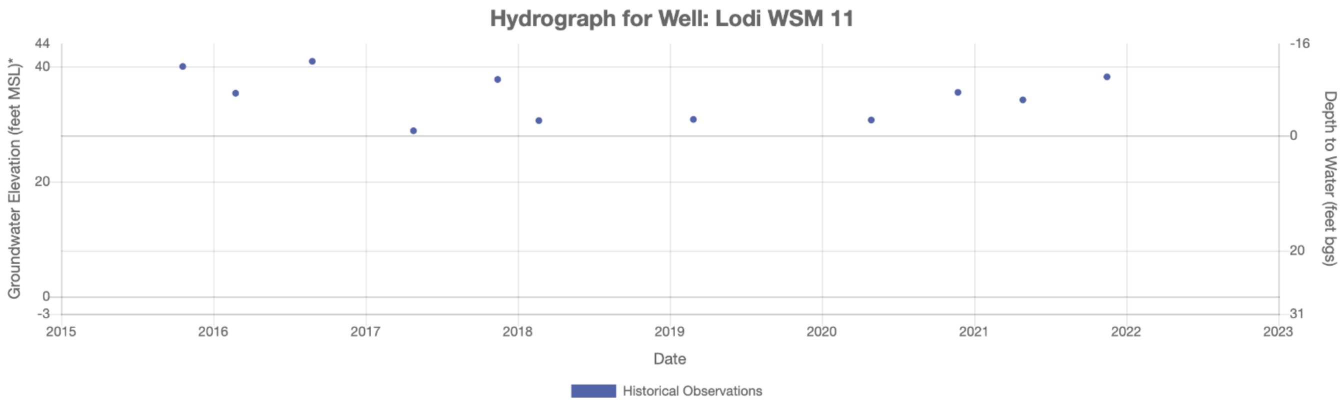
Ground Surface Elevation: 51 ft.



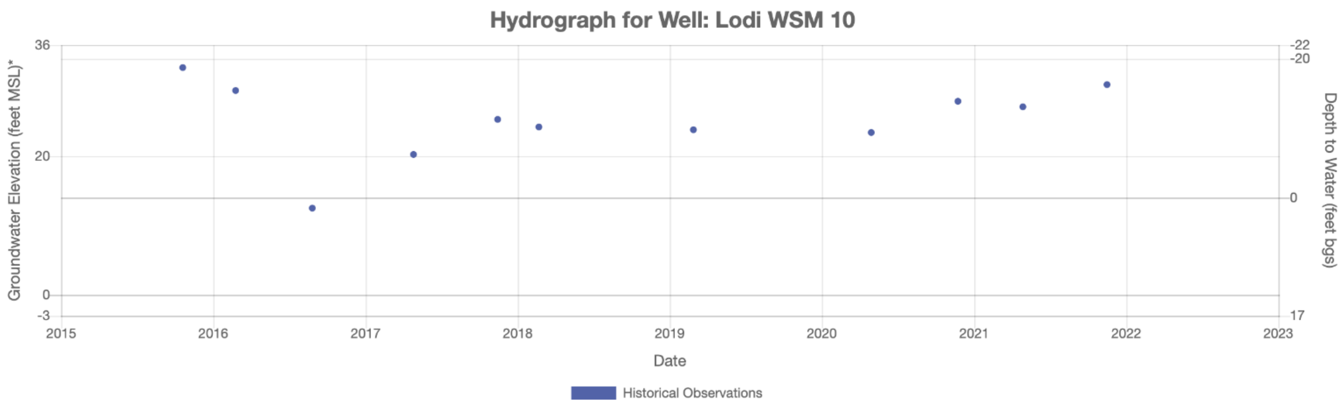
Ground Surface Elevation: 8 ft.



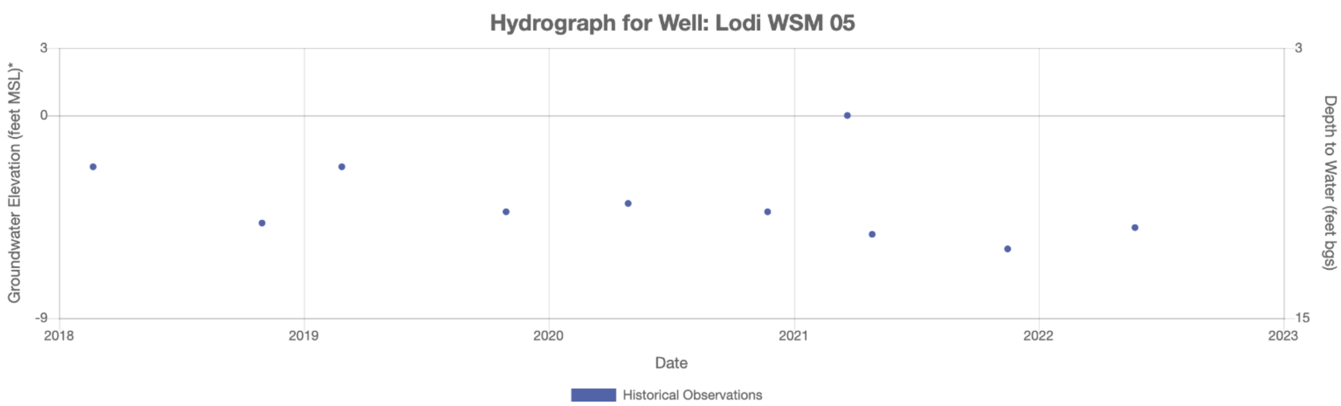
Ground Surface Elevation: 28 ft.



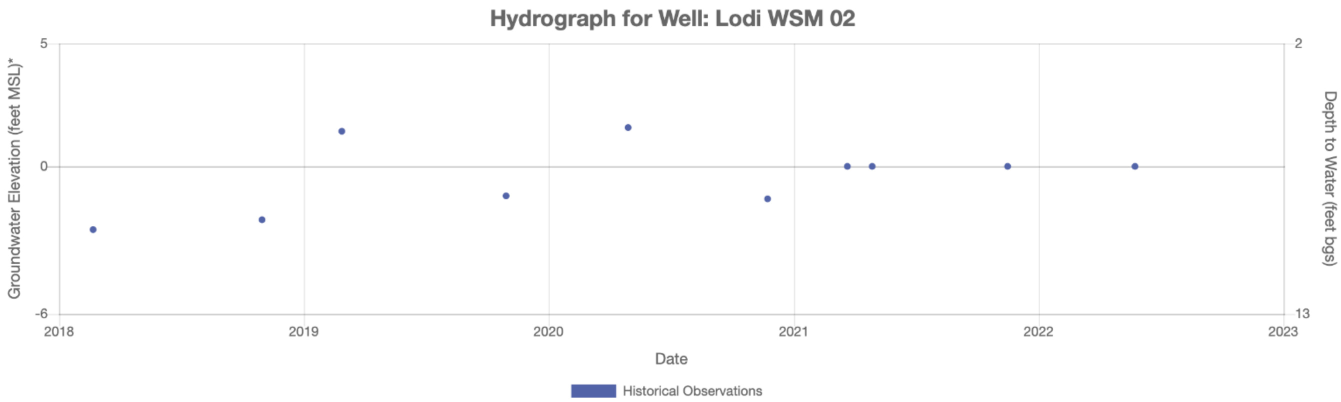
Ground Surface Elevation: 14 ft.



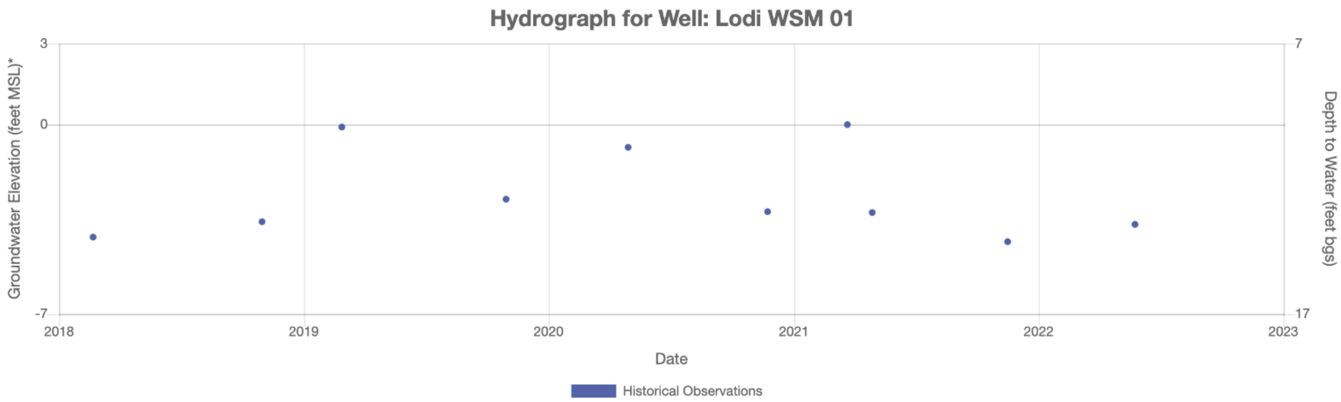
Ground Surface Elevation: 7 ft.



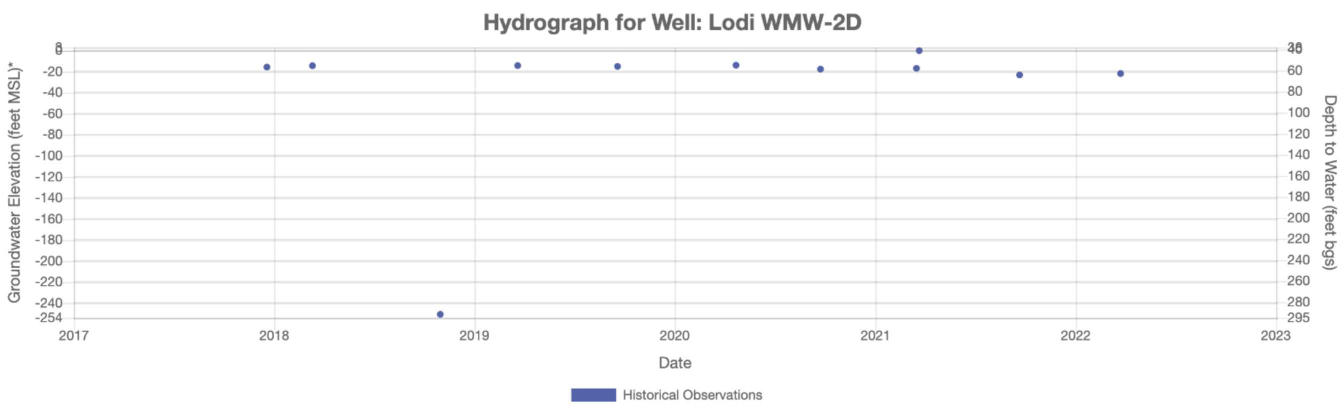
Ground Surface Elevation: 7 ft.



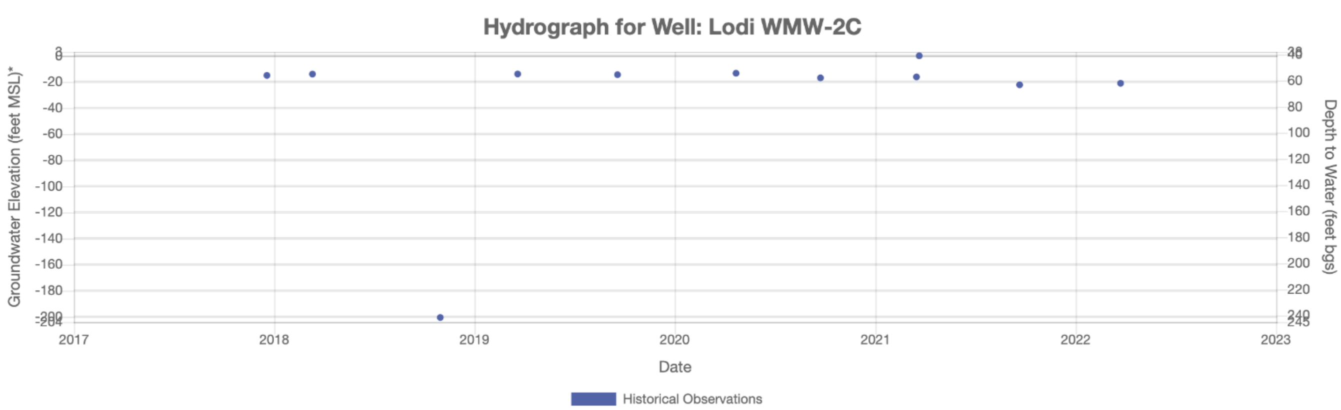
Ground Surface Elevation: 10 ft.



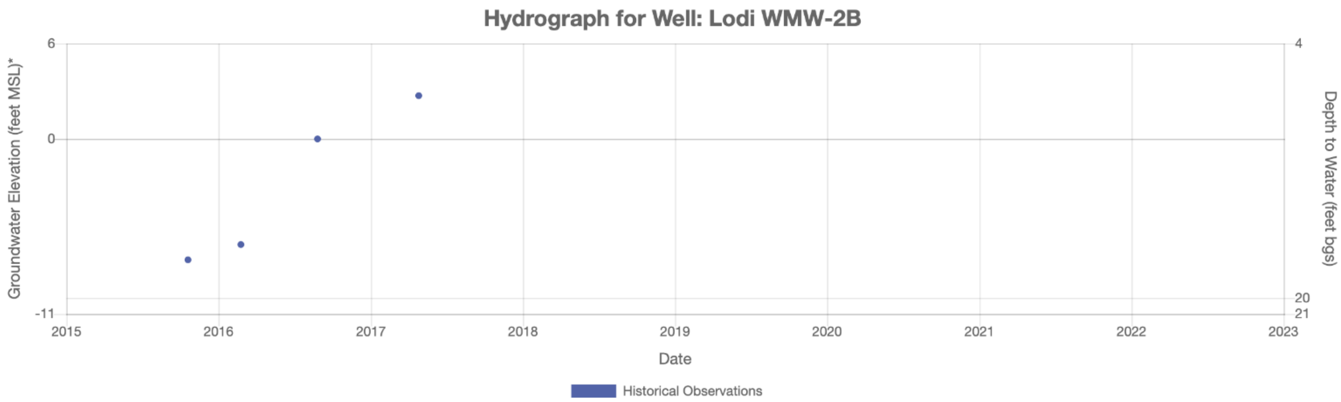
Ground Surface Elevation: 42 ft.



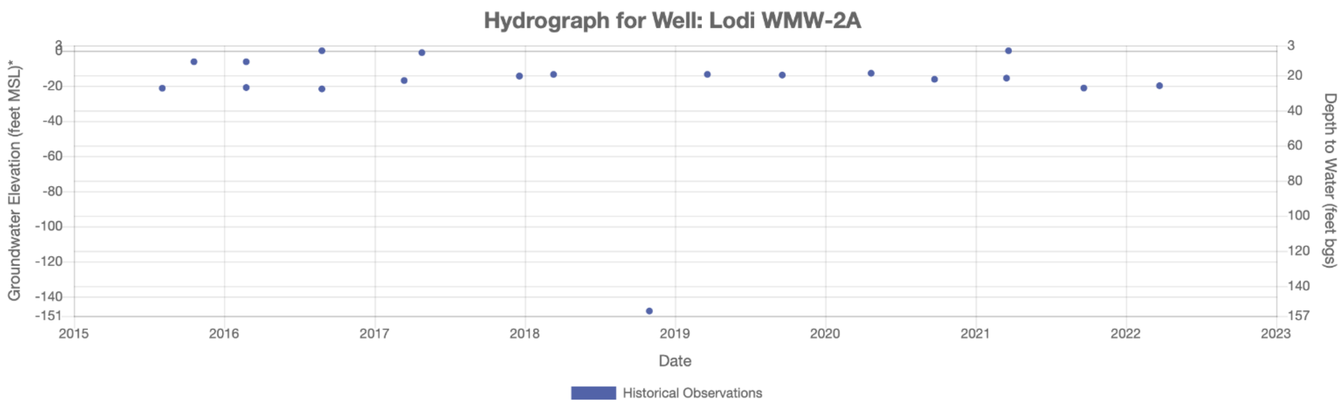
Ground Surface Elevation: 42 ft.



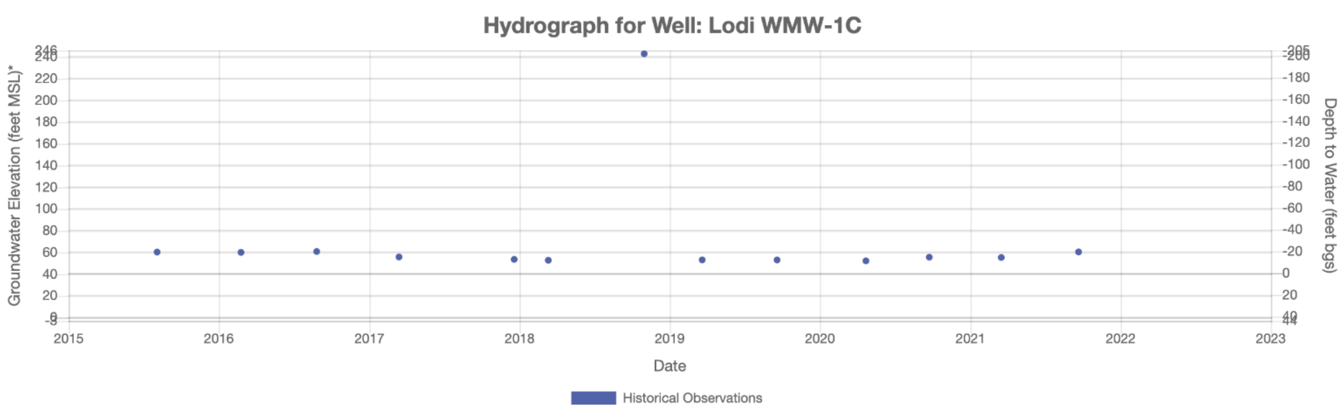
Ground Surface Elevation: 10 ft.



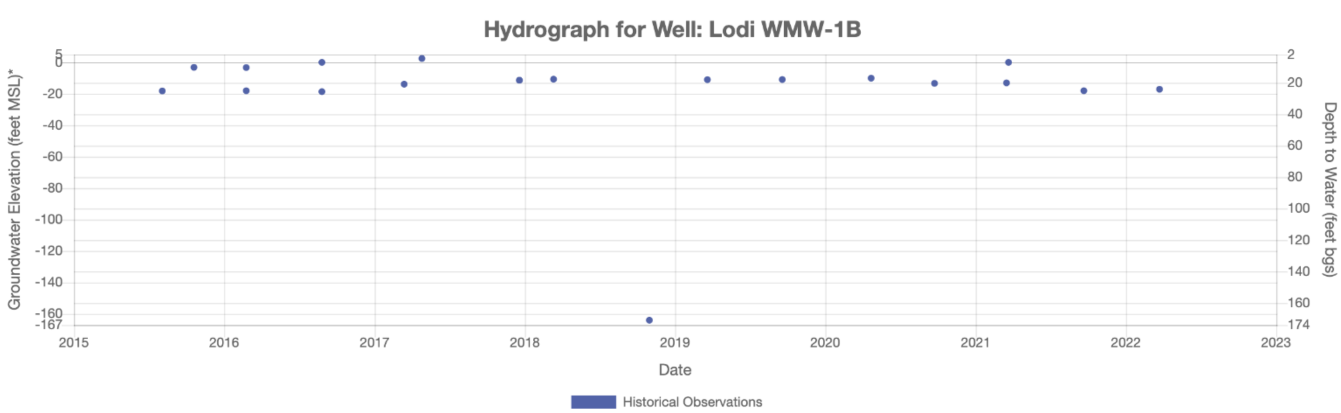
Ground Surface Elevation: 7 ft.



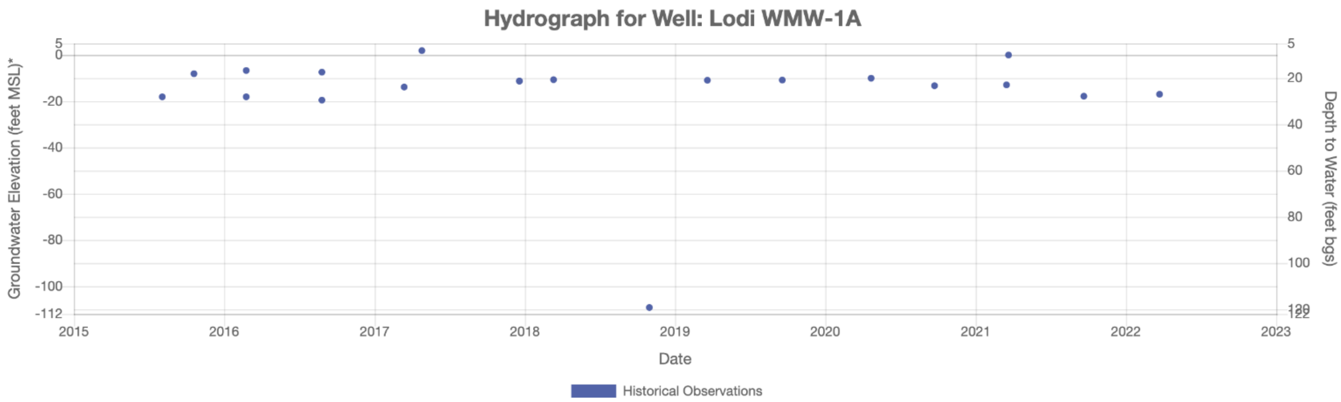
Ground Surface Elevation: 42 ft.



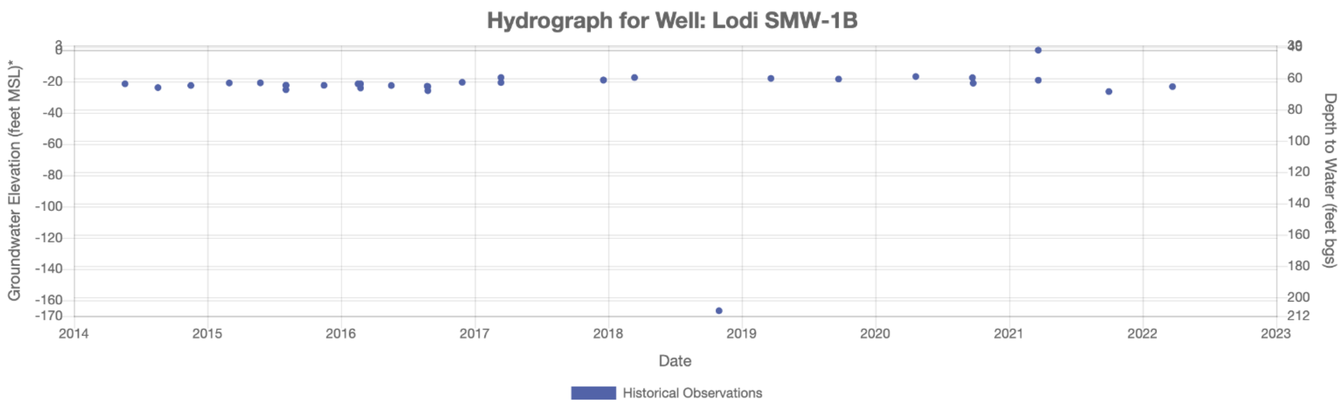
Ground Surface Elevation: 7 ft.



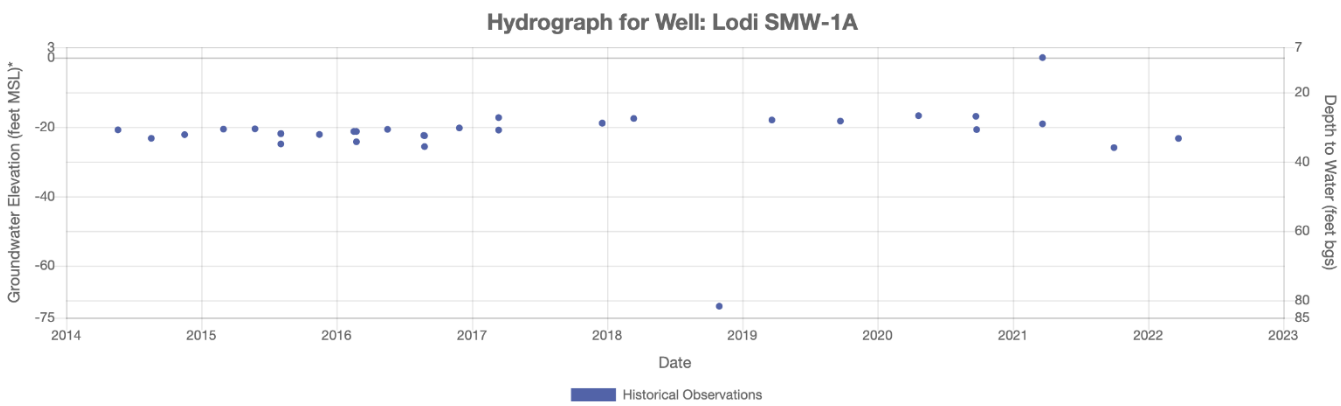
Ground Surface Elevation: 10 ft.



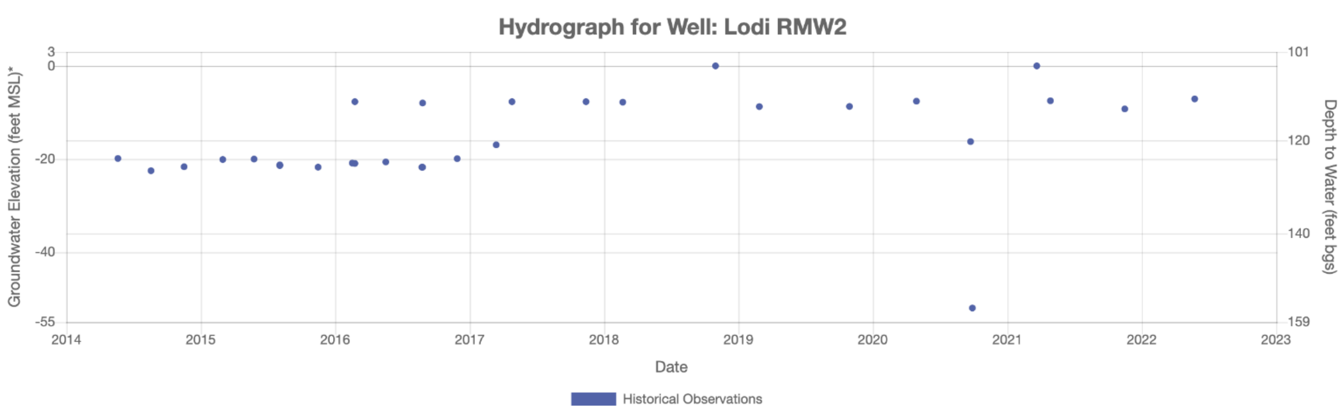
Ground Surface Elevation: 42 ft.



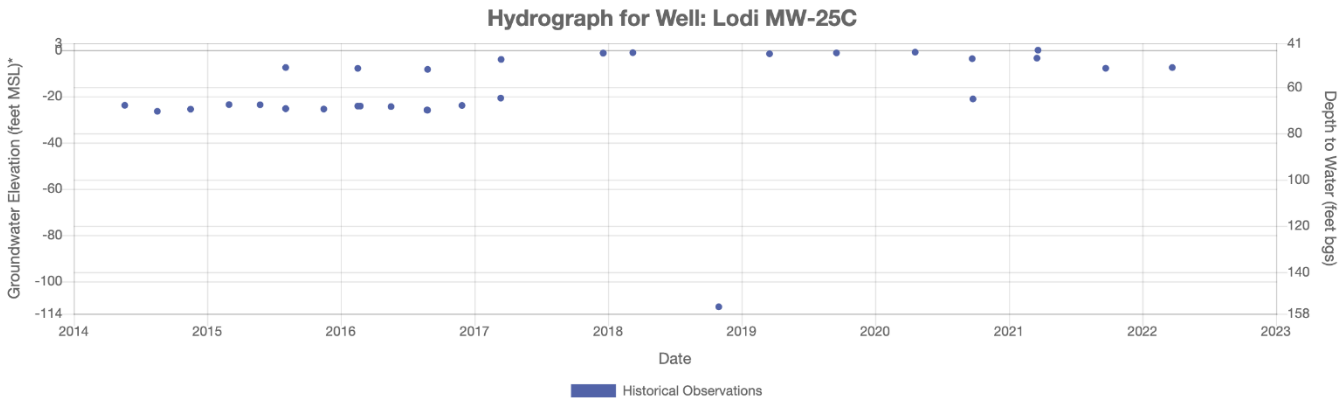
Ground Surface Elevation: 10 ft.



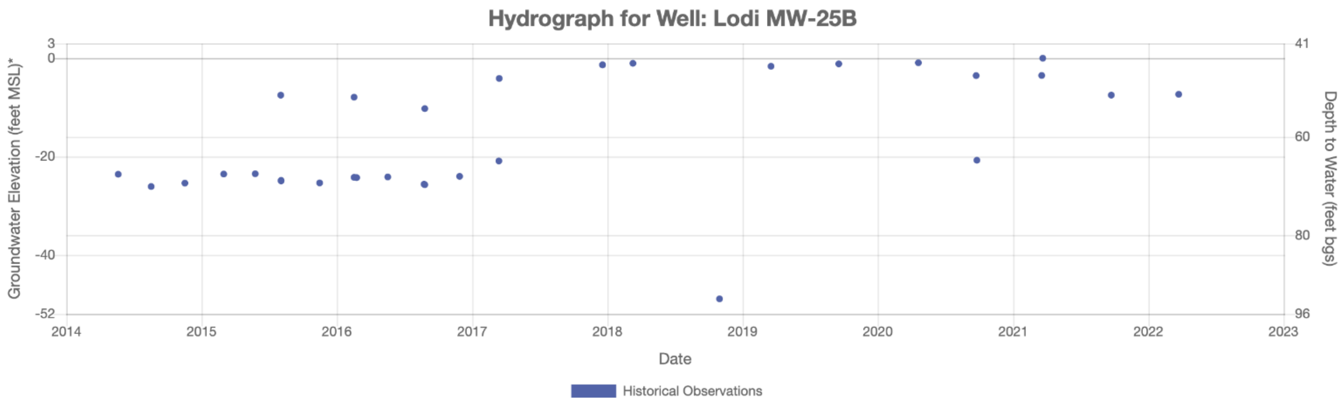
Ground Surface Elevation: 105 ft.



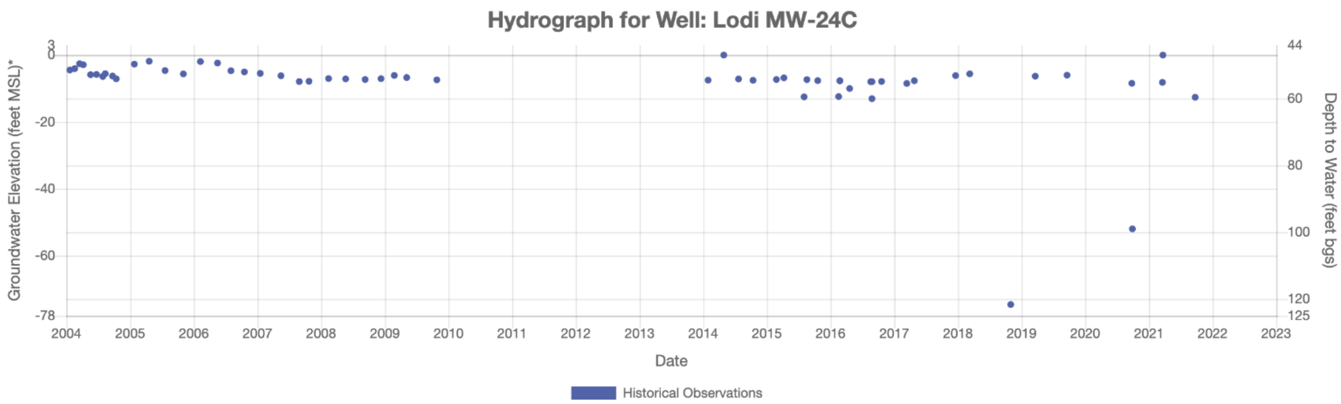
Ground Surface Elevation: 45 ft.



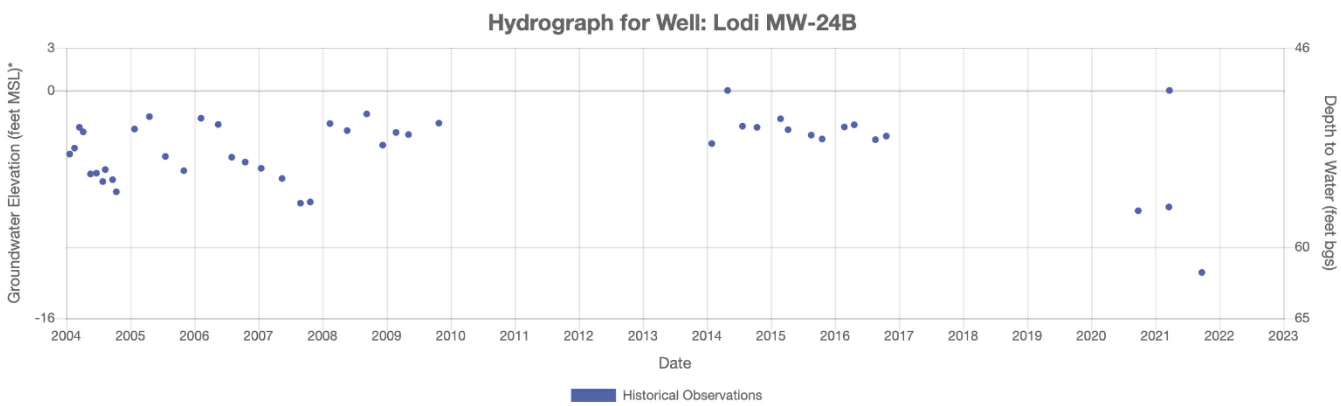
Ground Surface Elevation: 45 ft.



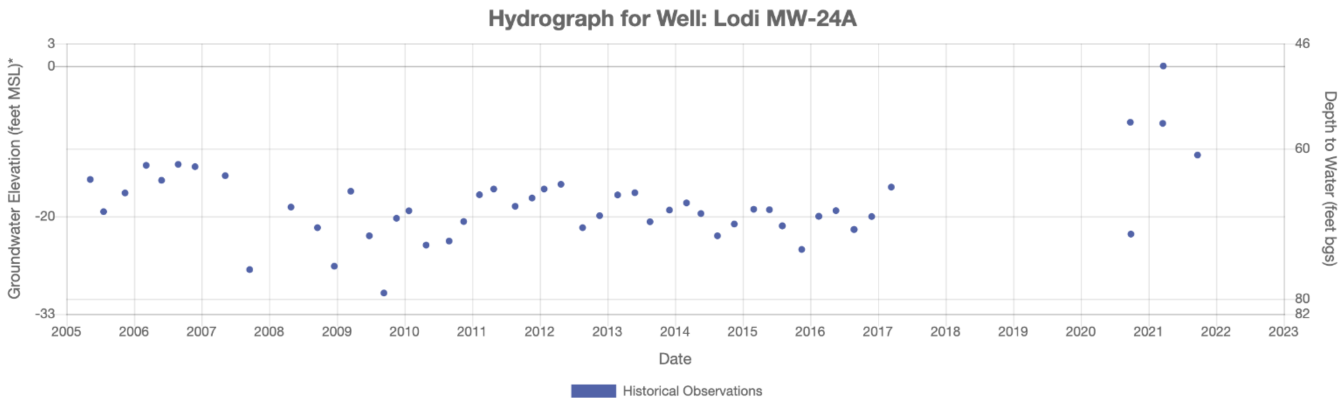
Ground Surface Elevation: 47 ft.



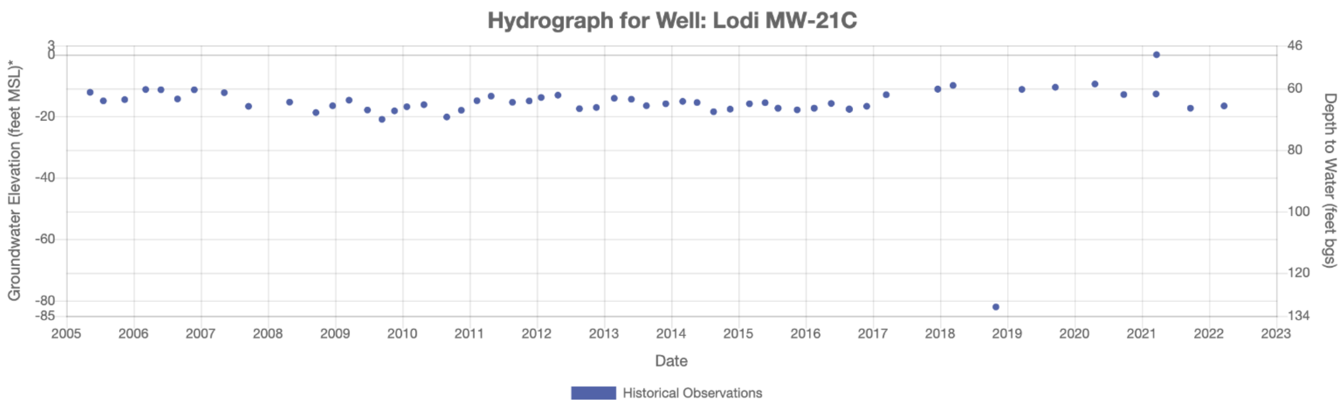
Ground Surface Elevation: 50 ft.



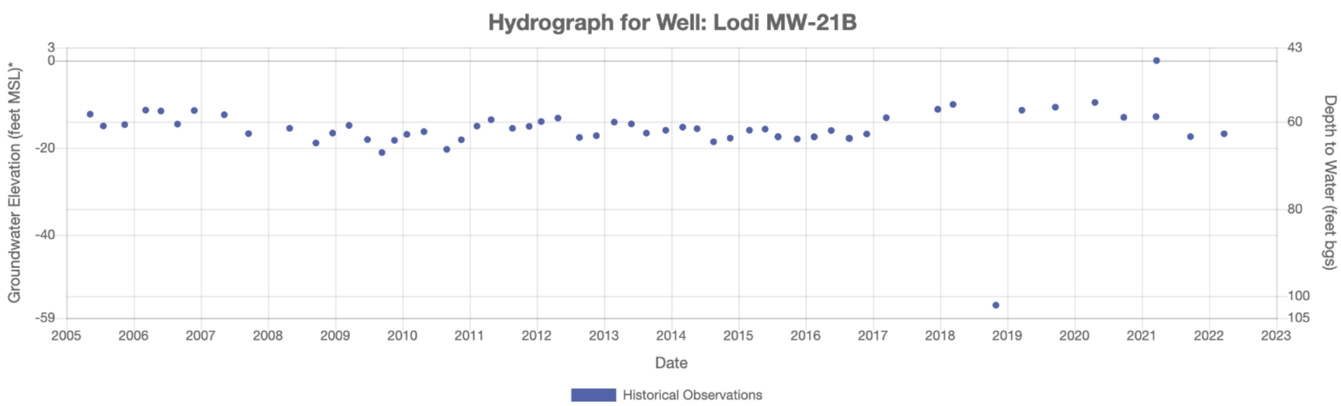
Ground Surface Elevation: 50 ft.



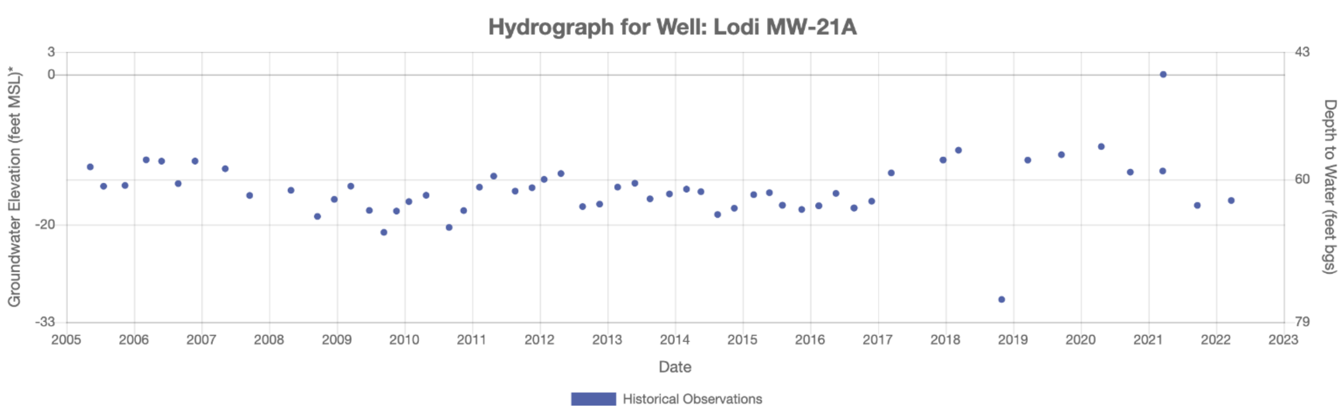
Ground Surface Elevation: 50 ft.



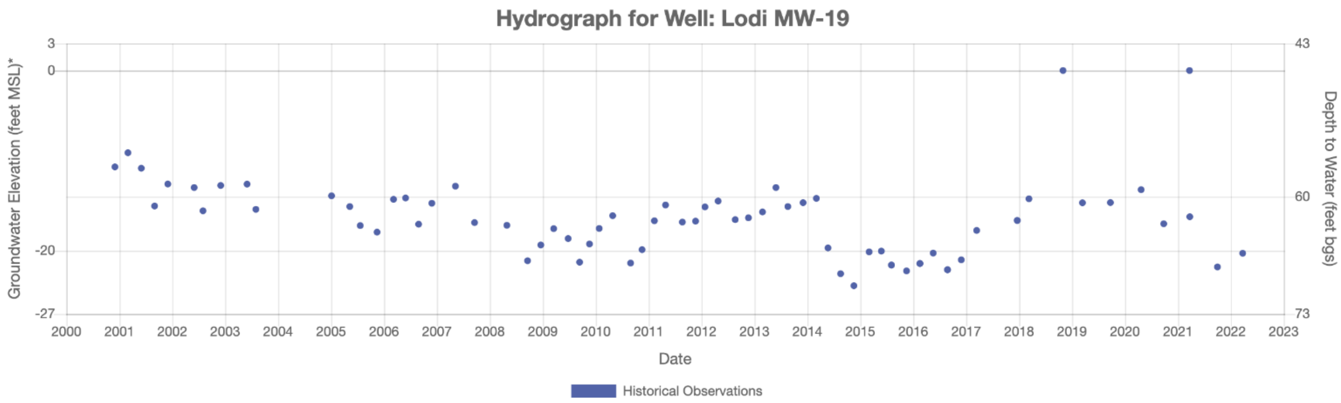
Ground Surface Elevation: 46 ft.



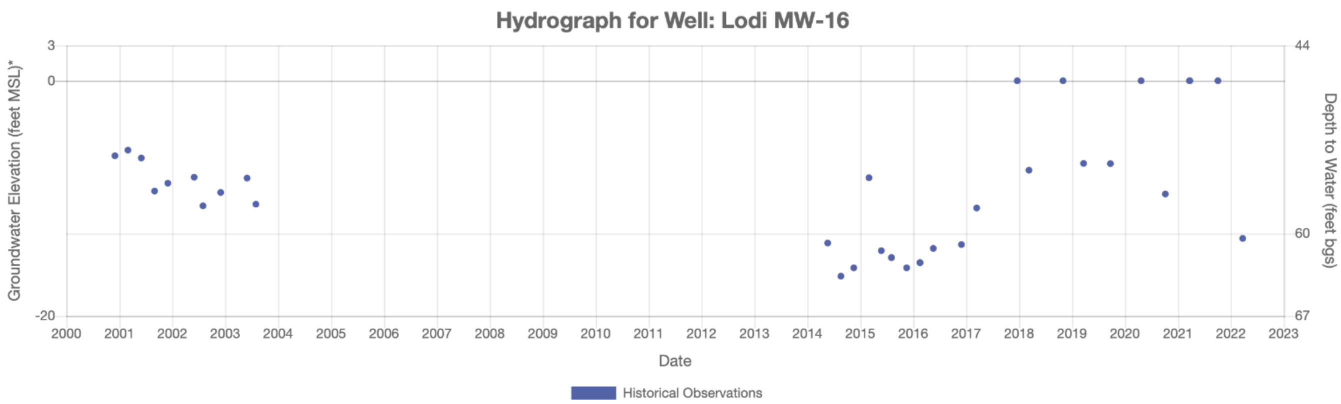
Ground Surface Elevation: 46 ft.



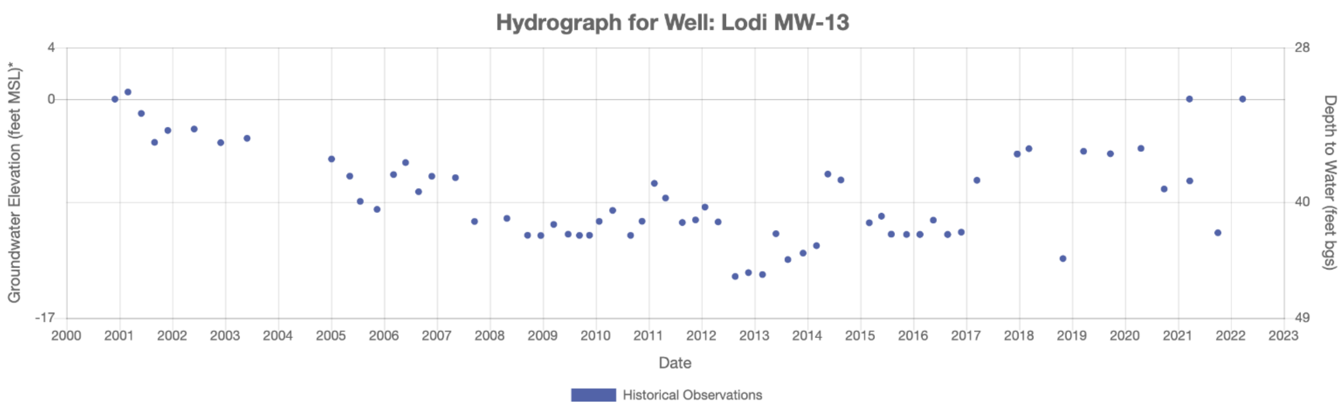
Ground Surface Elevation: 46 ft.



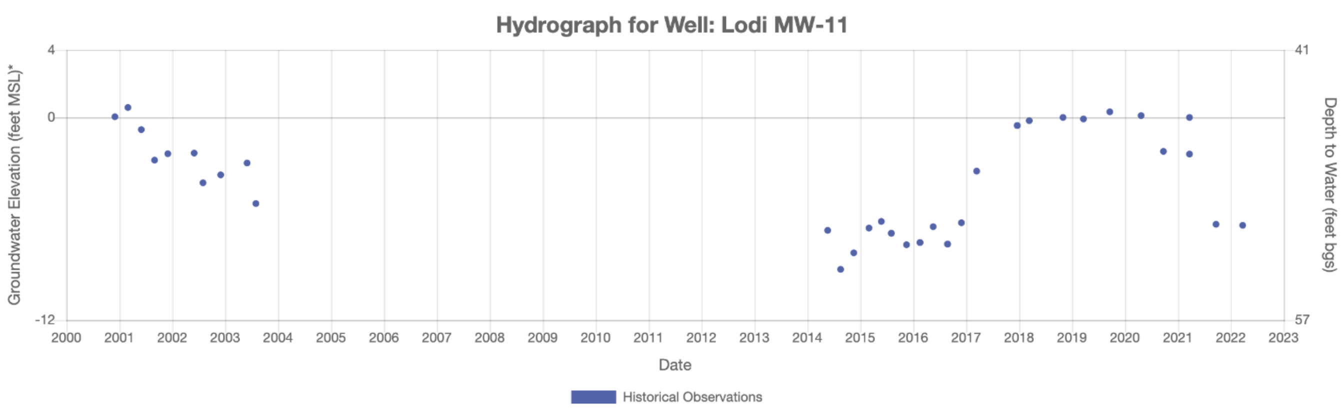
Ground Surface Elevation: 47 ft.



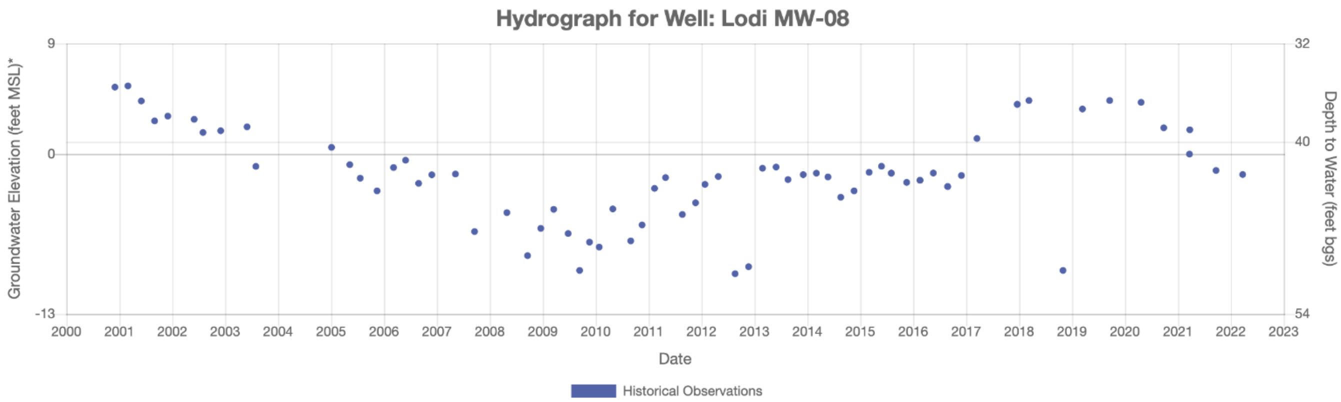
Ground Surface Elevation: 32 ft.



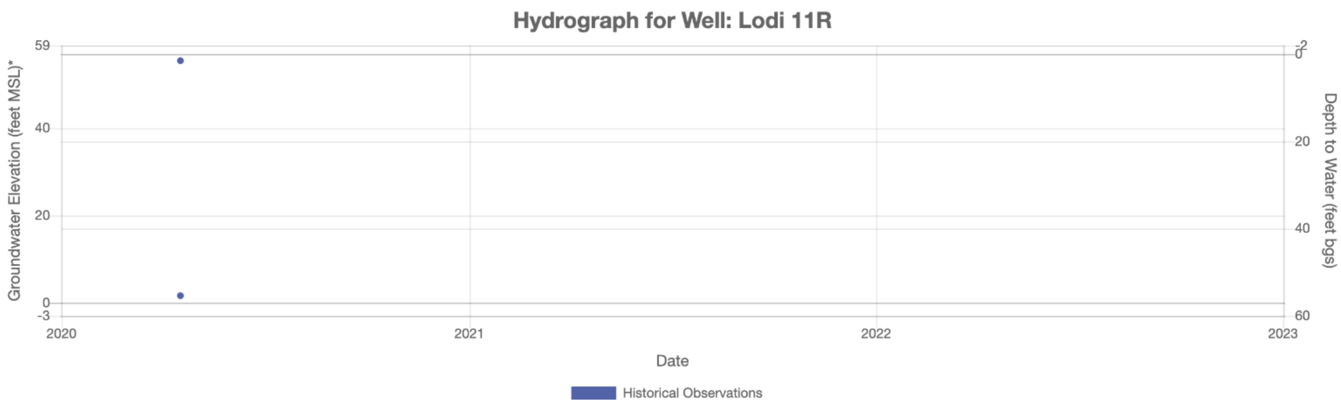
Ground Surface Elevation: 45 ft.



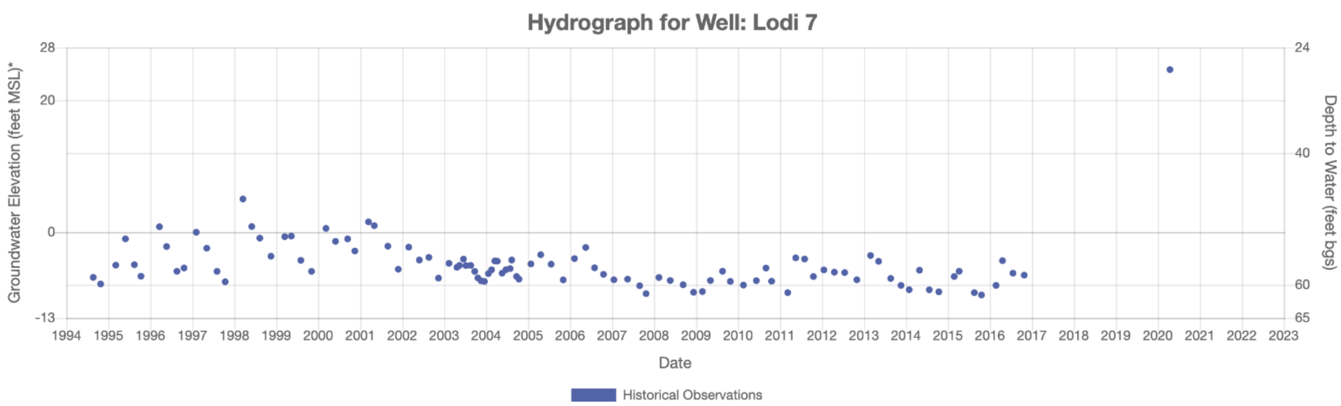
Ground Surface Elevation: 41 ft.



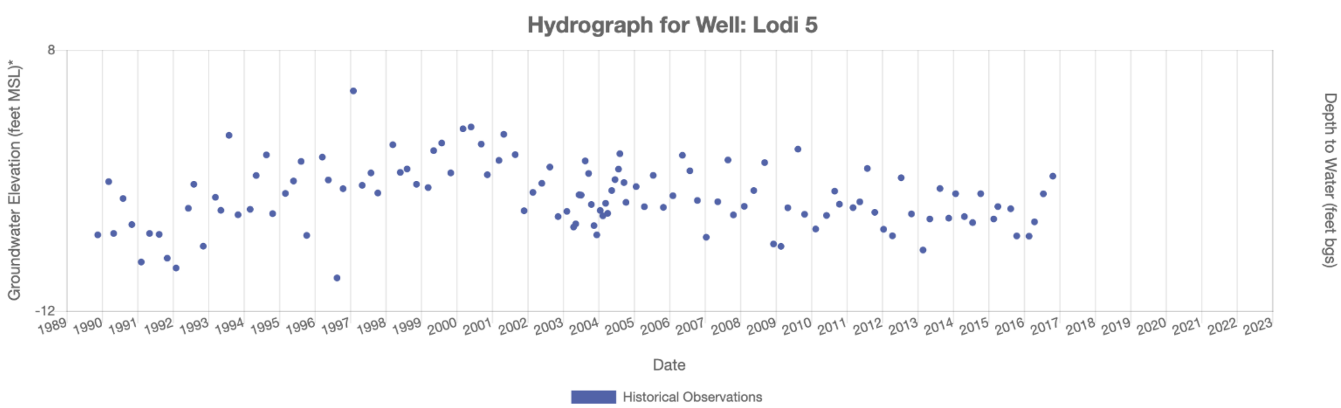
Ground Surface Elevation: 57 ft.



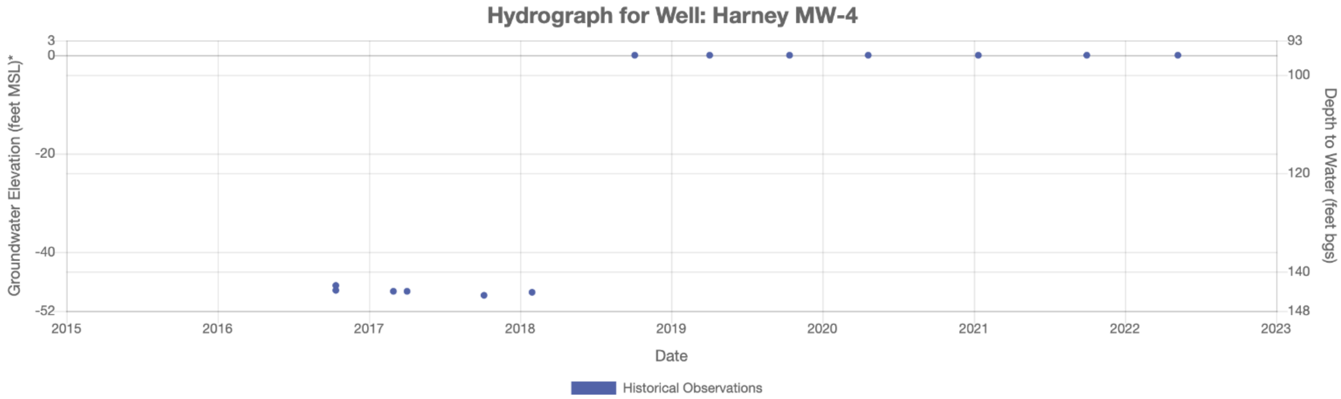
Ground Surface Elevation: 53 ft.



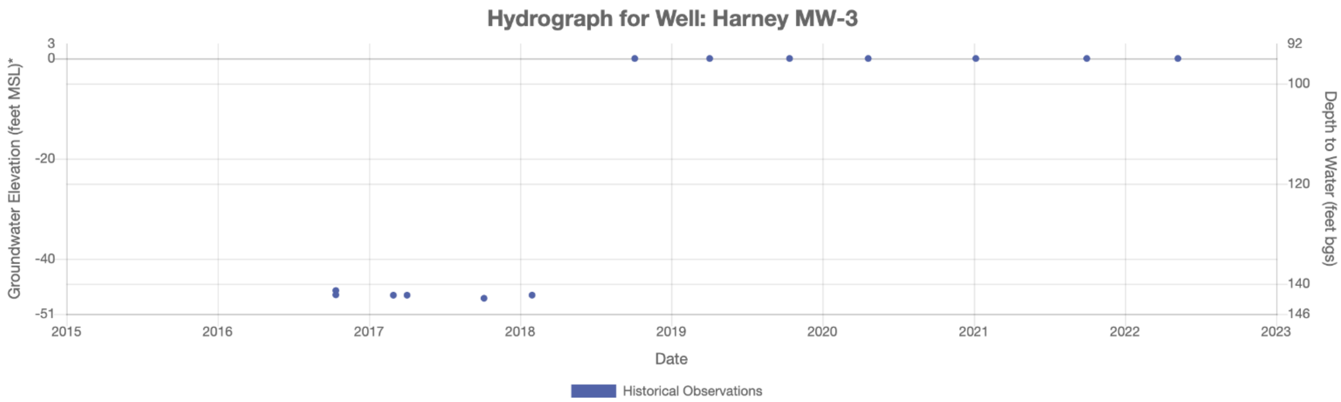
Ground Surface Elevation: 0 ft.



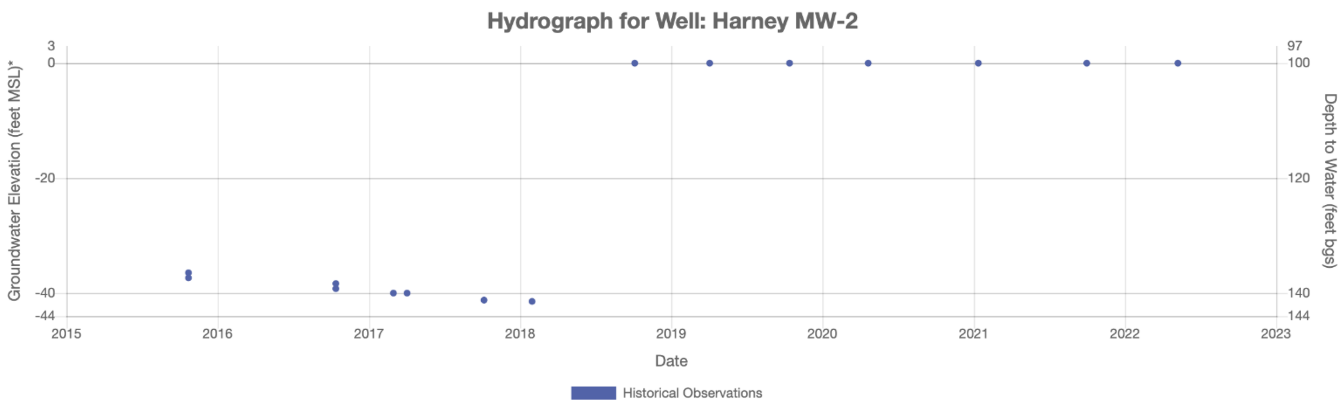
Ground Surface Elevation: 97 ft.



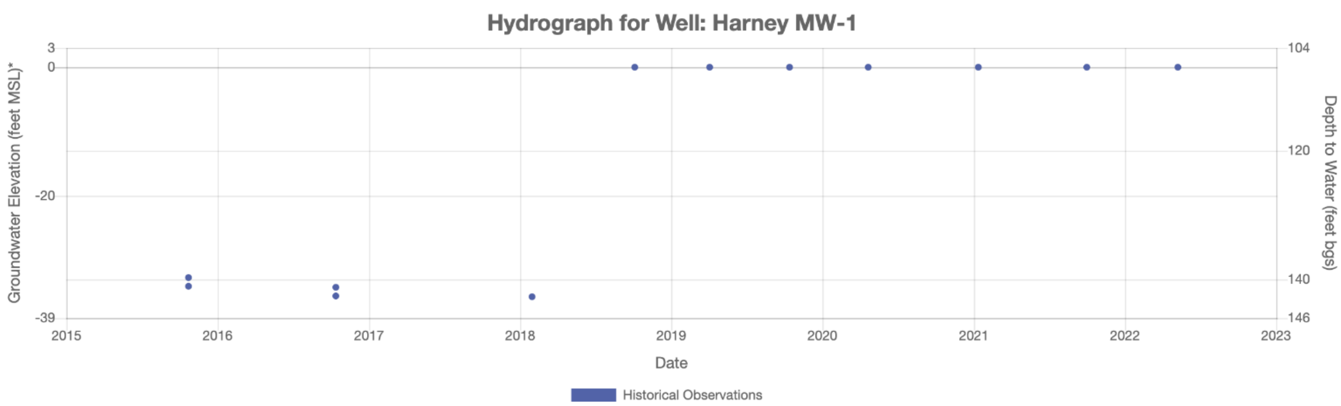
Ground Surface Elevation: 96 ft.



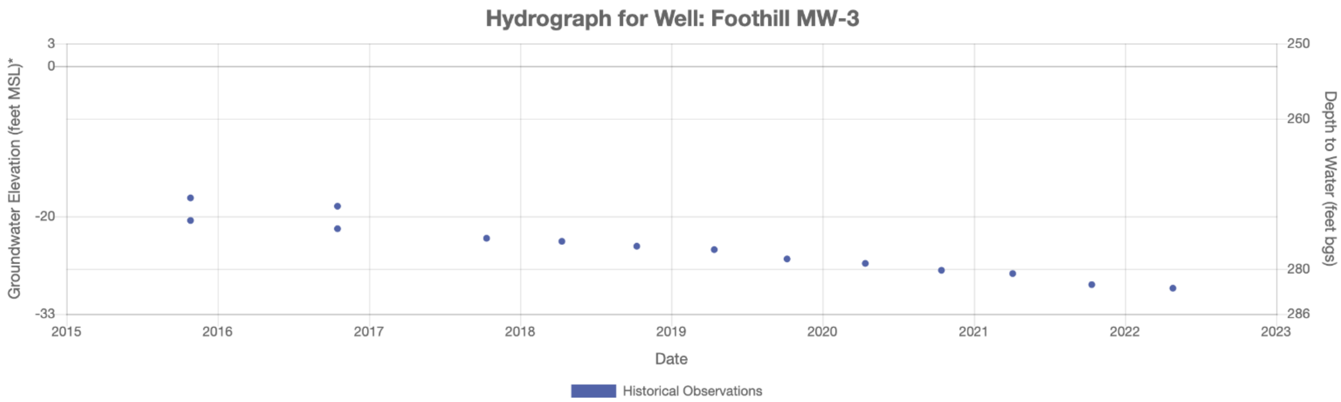
Ground Surface Elevation: 100 ft.



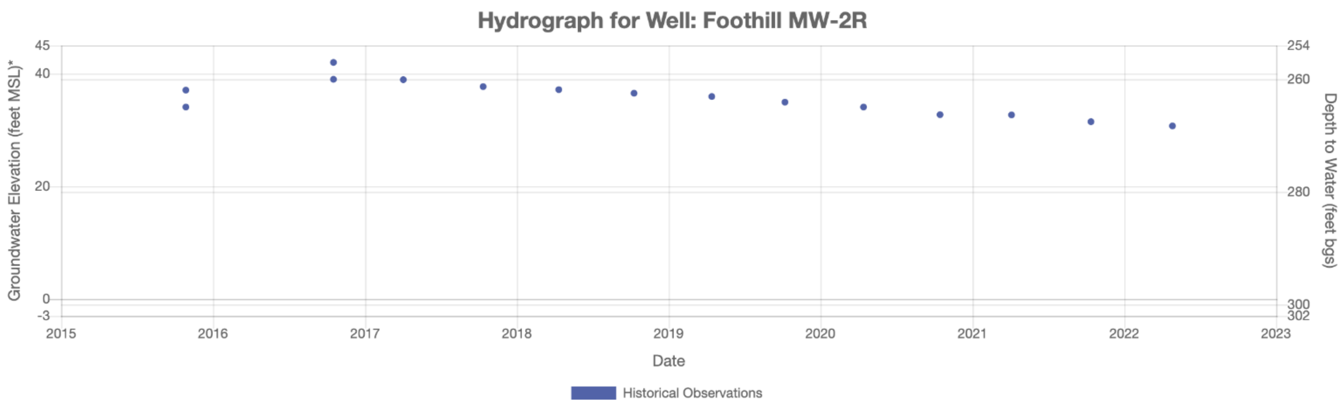
Ground Surface Elevation: 108 ft.



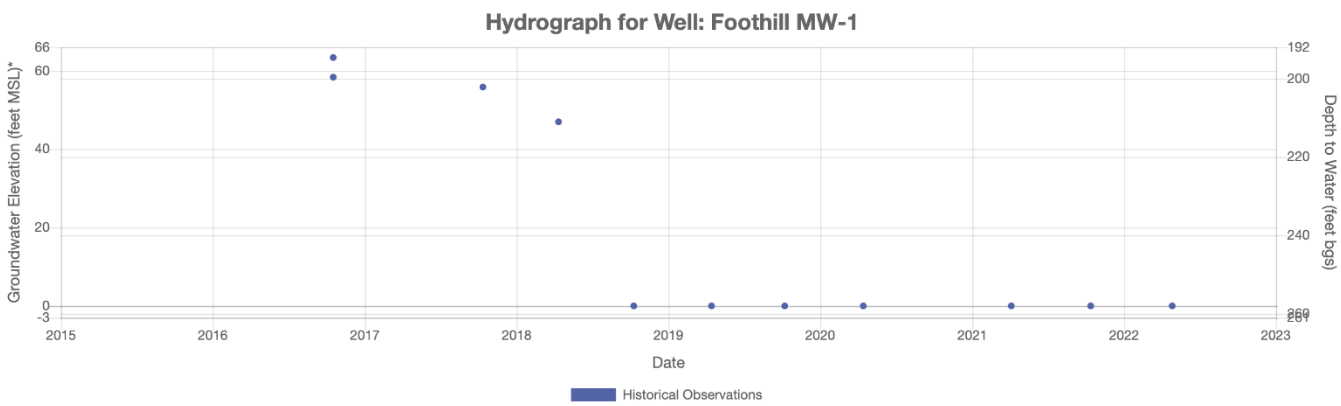
Ground Surface Elevation: 254 ft.



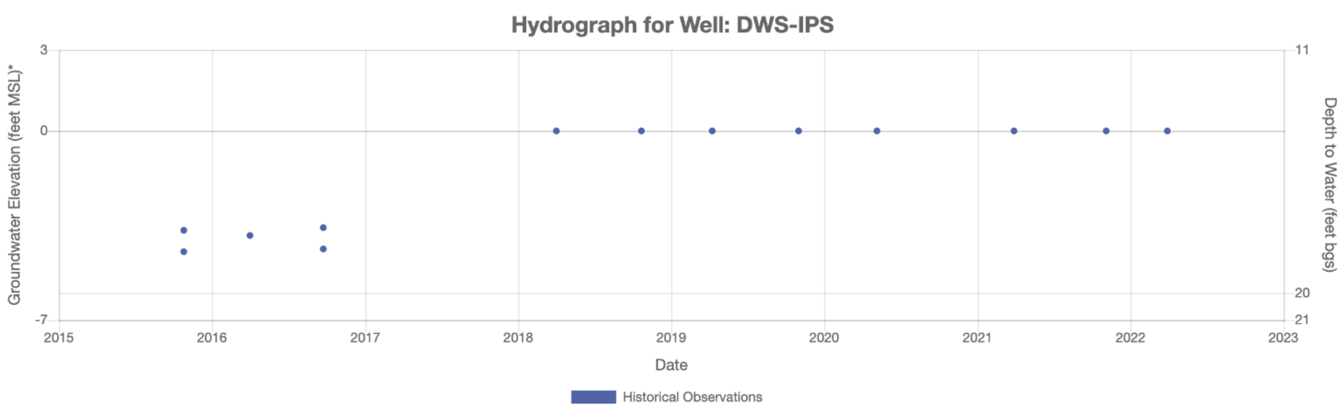
Ground Surface Elevation: 300 ft.



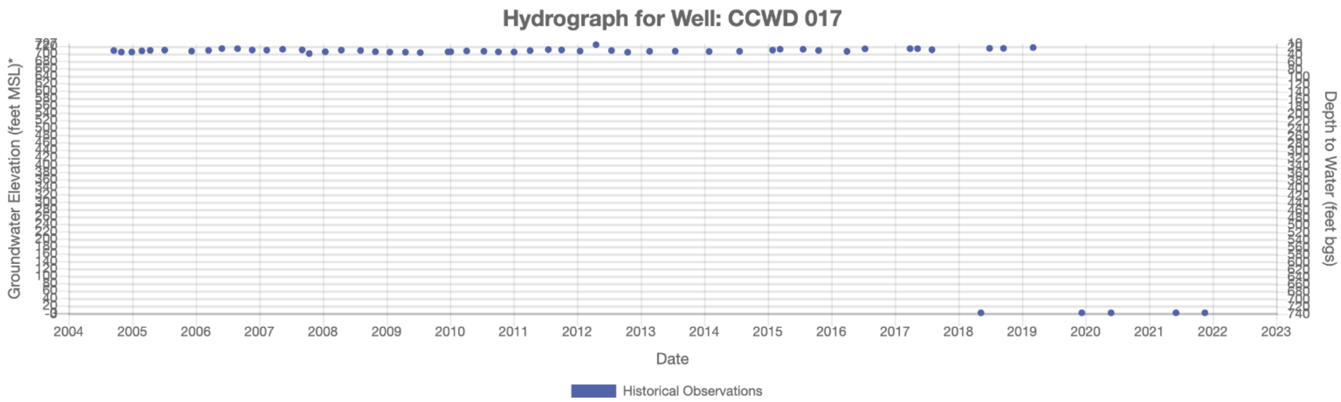
Ground Surface Elevation: 258 ft.



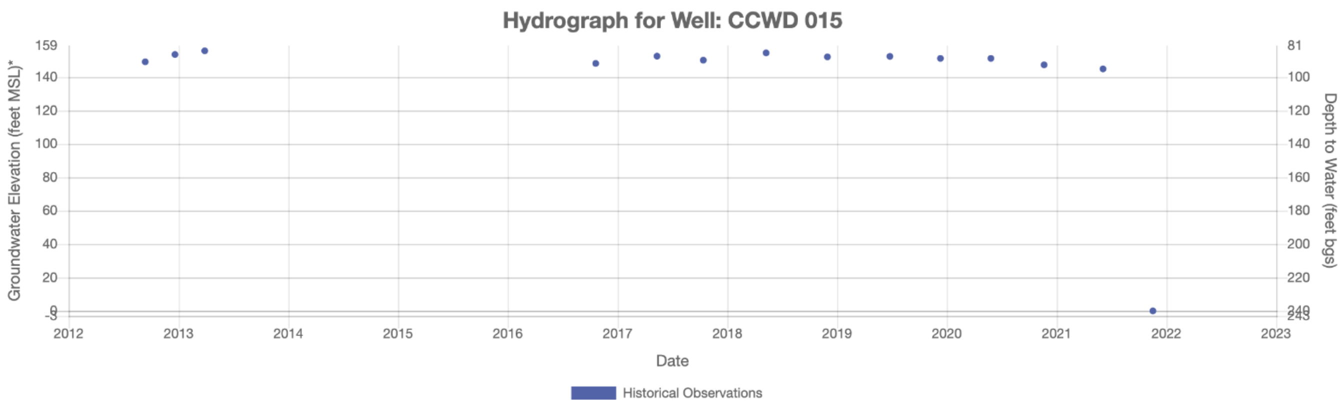
Ground Surface Elevation: 14 ft.



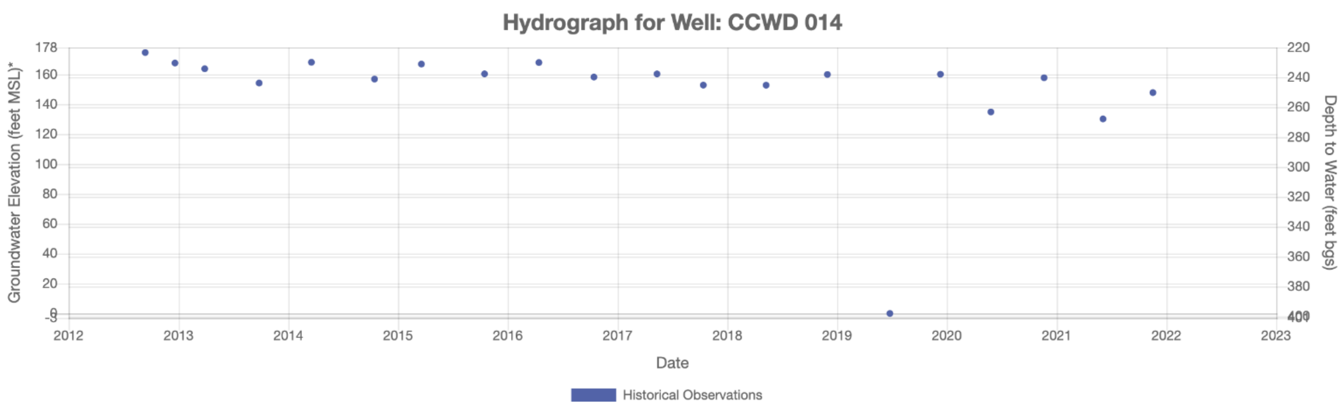
Ground Surface Elevation: 737 ft.



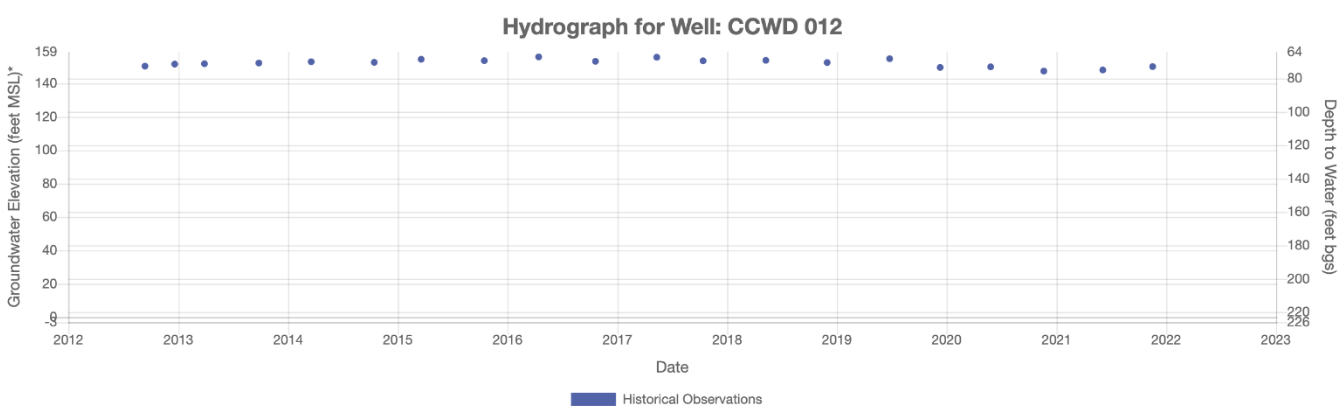
Ground Surface Elevation: 240 ft.



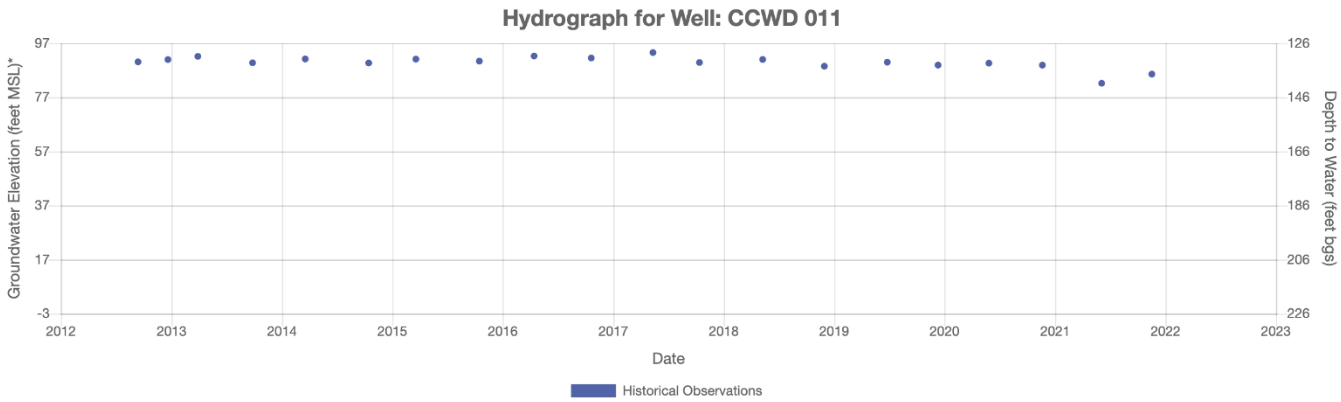
Ground Surface Elevation: 398 ft.



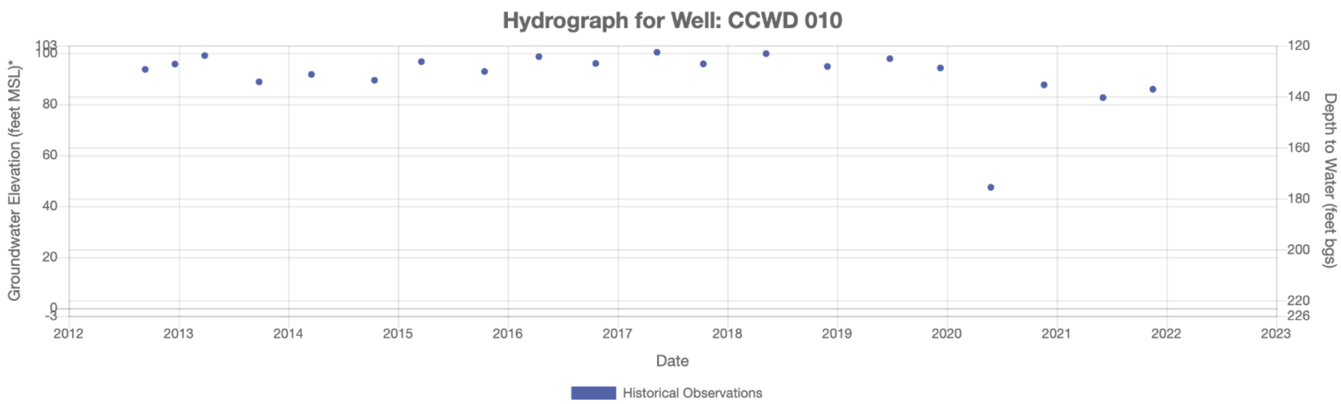
Ground Surface Elevation: 223 ft.



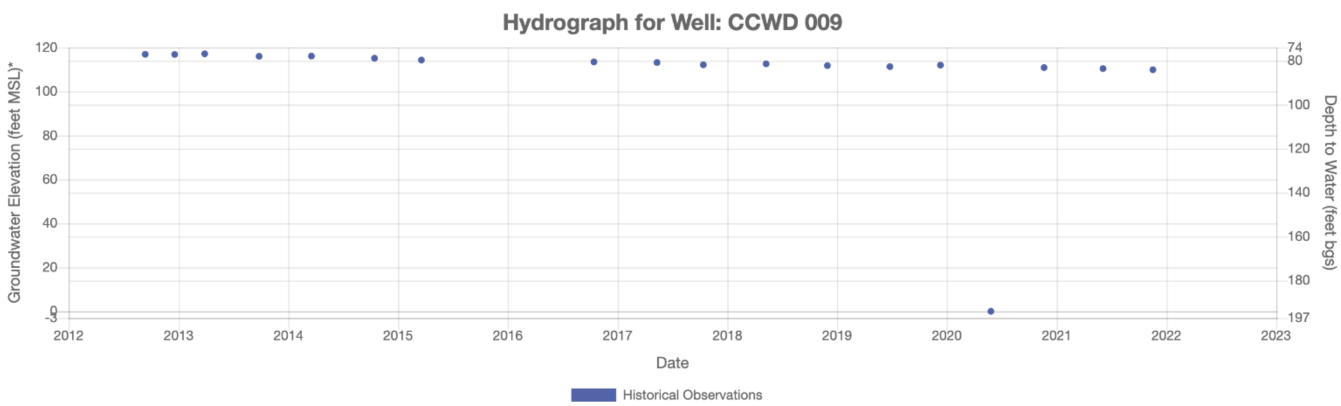
Ground Surface Elevation: 223 ft.



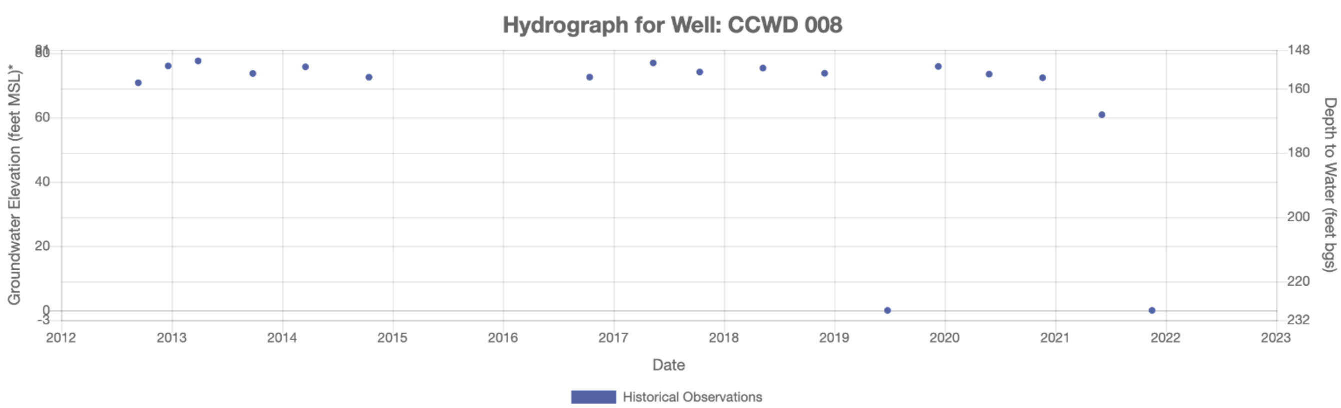
Ground Surface Elevation: 223 ft.



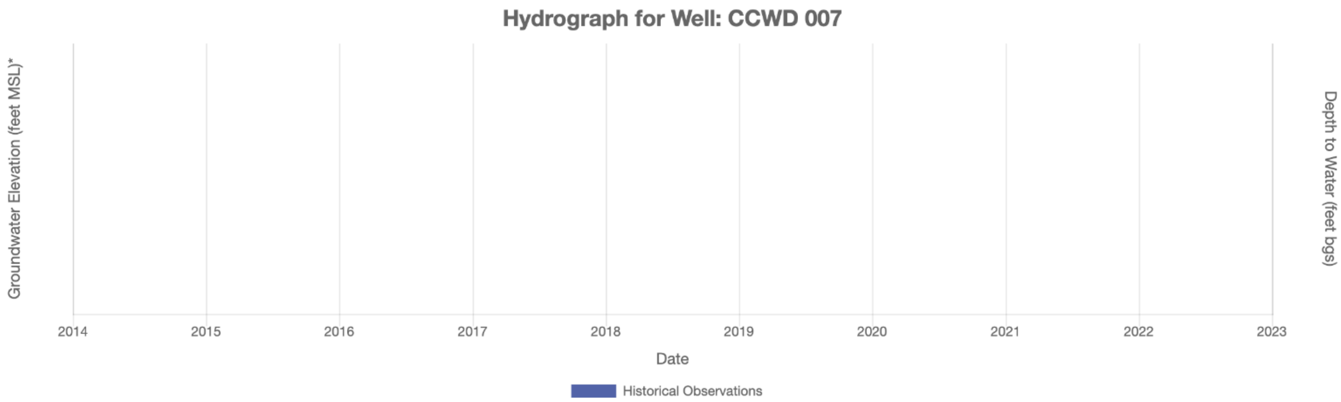
Ground Surface Elevation: 194 ft.



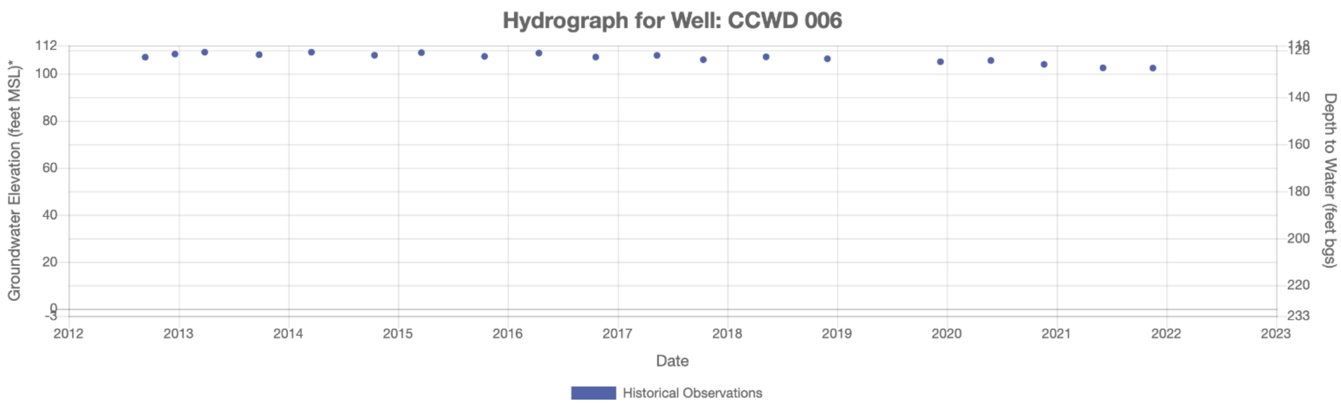
Ground Surface Elevation: 229 ft.



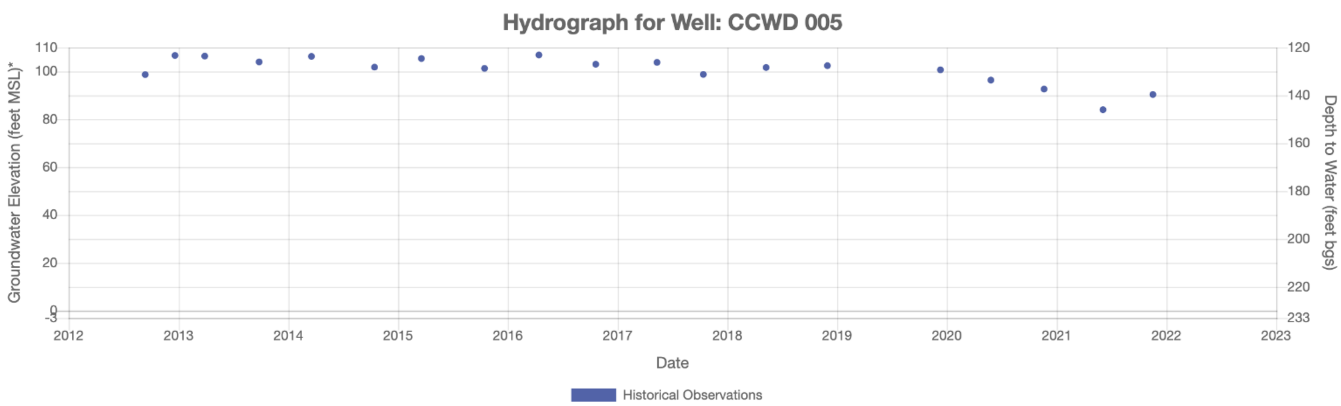
Ground Surface Elevation: 230 ft.



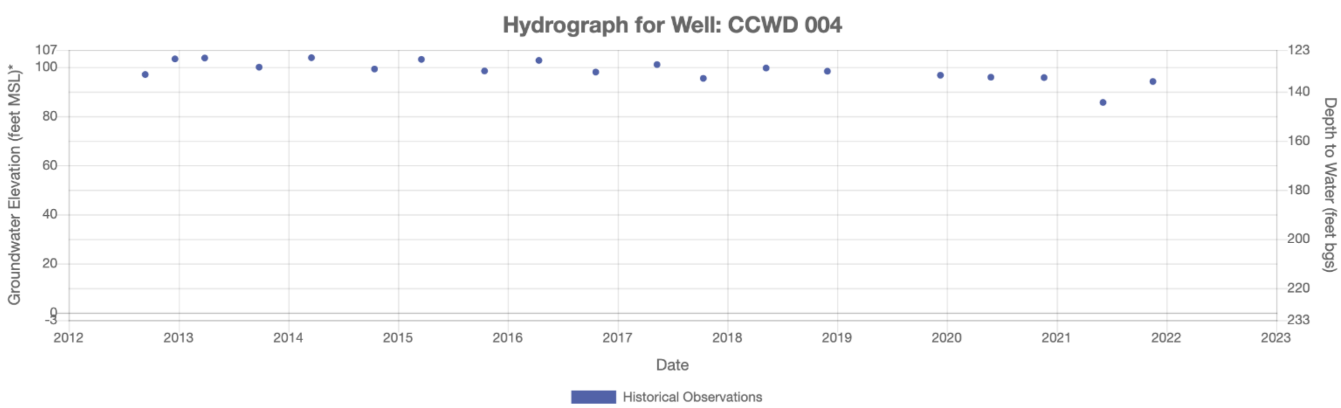
Ground Surface Elevation: 230 ft.



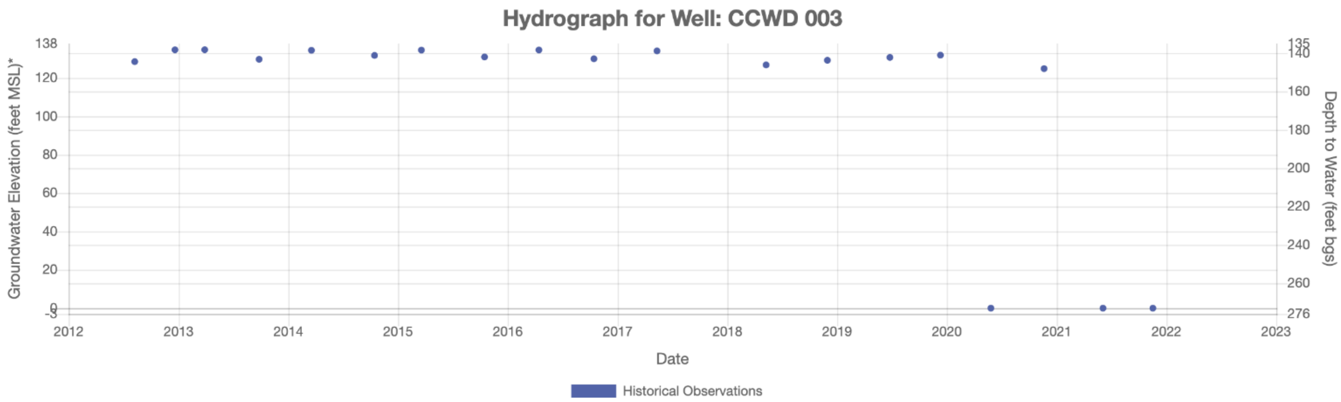
Ground Surface Elevation: 230 ft.



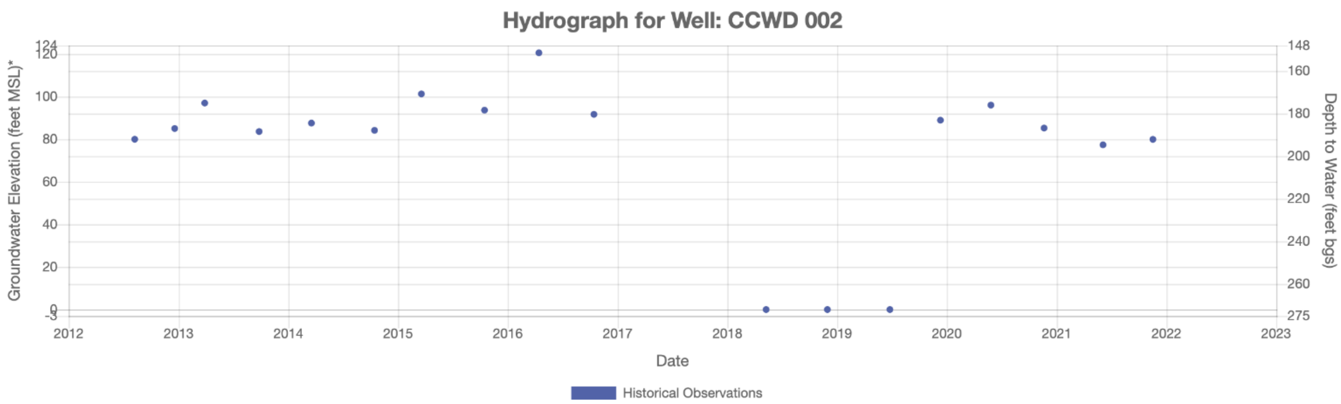
Ground Surface Elevation: 230 ft.



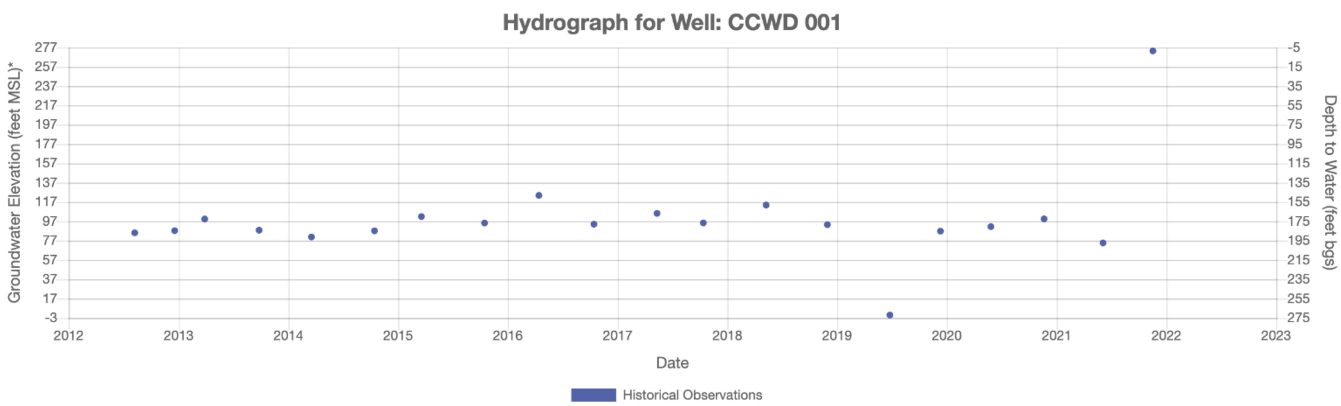
Ground Surface Elevation: 273 ft.



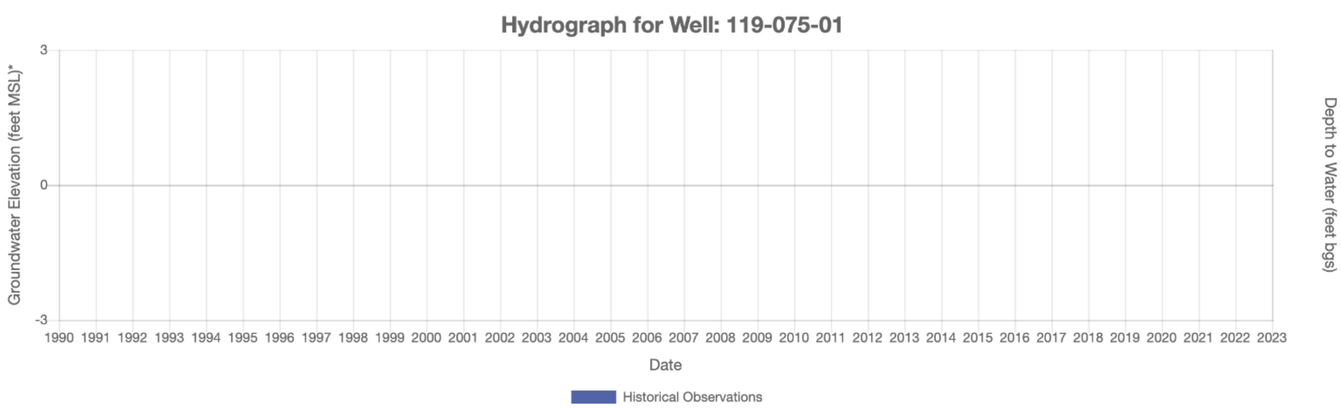
Ground Surface Elevation: 272 ft.



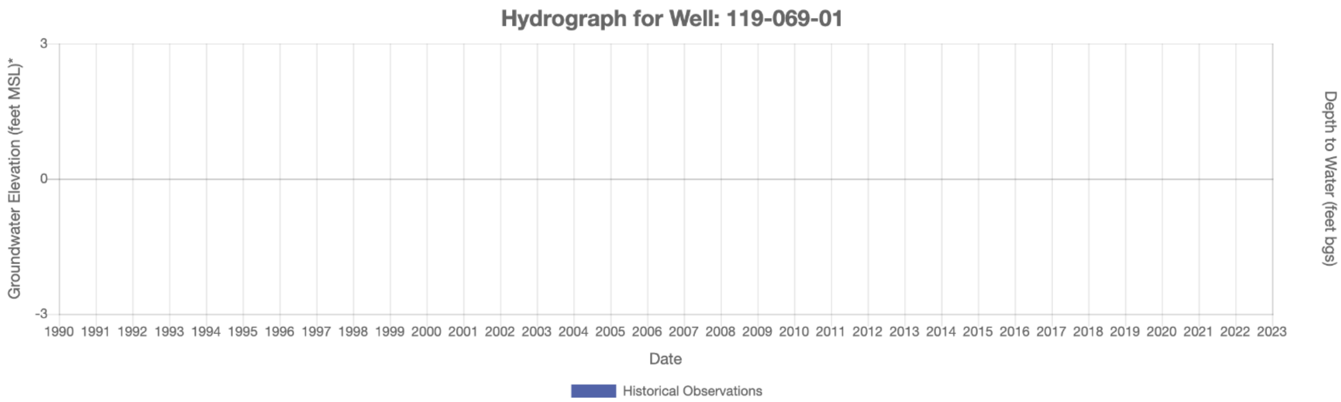
Ground Surface Elevation: 272 ft.



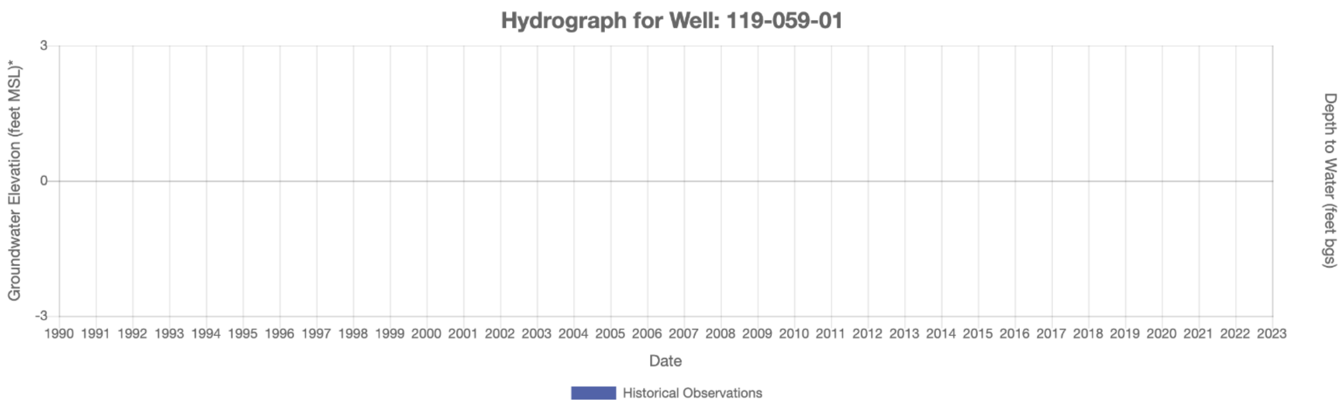
Ground Surface Elevation: 0 ft.



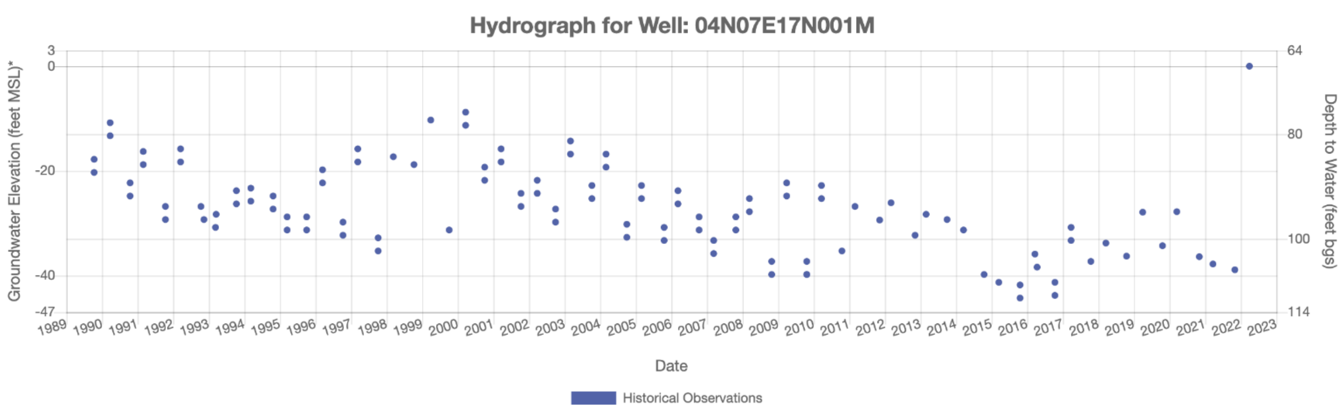
Ground Surface Elevation: 0 ft.



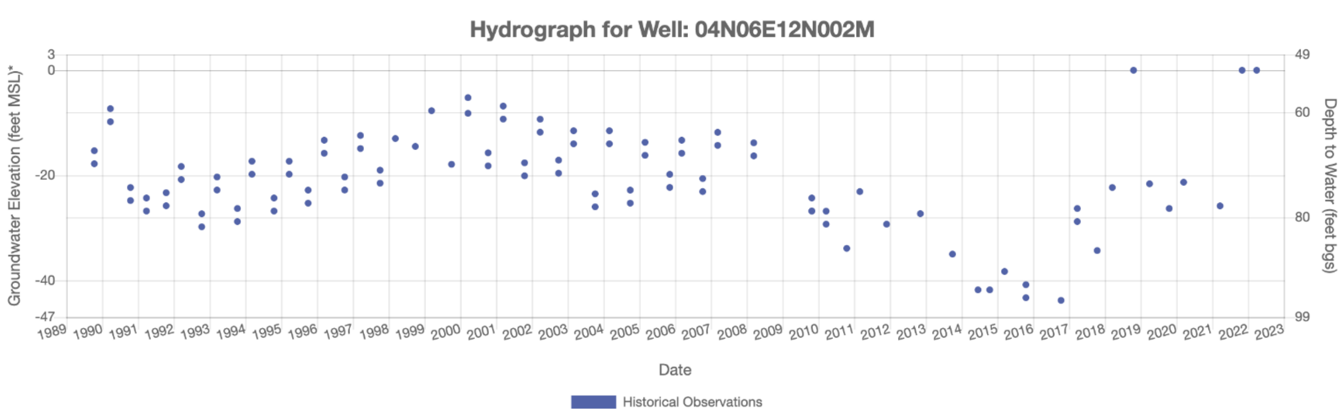
Ground Surface Elevation: 0 ft.



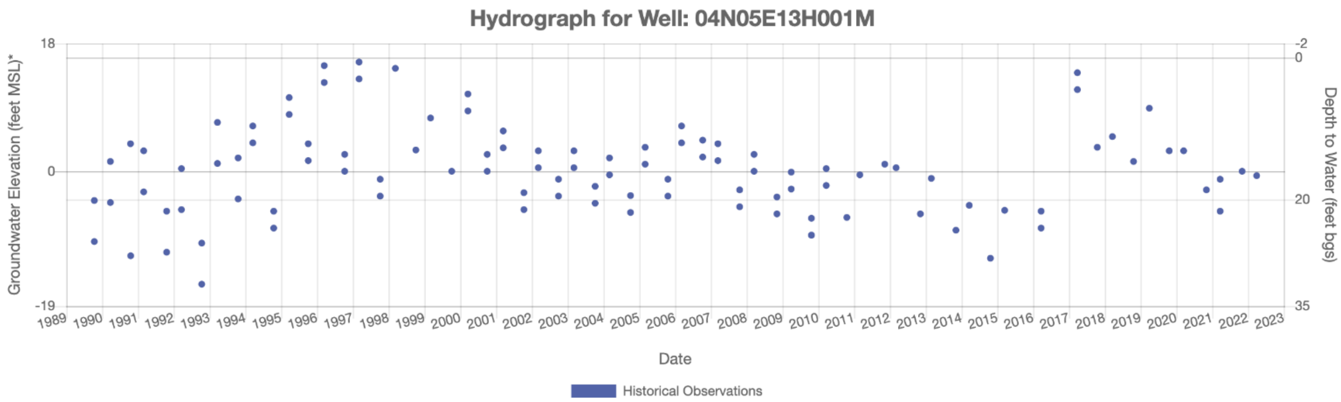
Ground Surface Elevation: 67 ft.



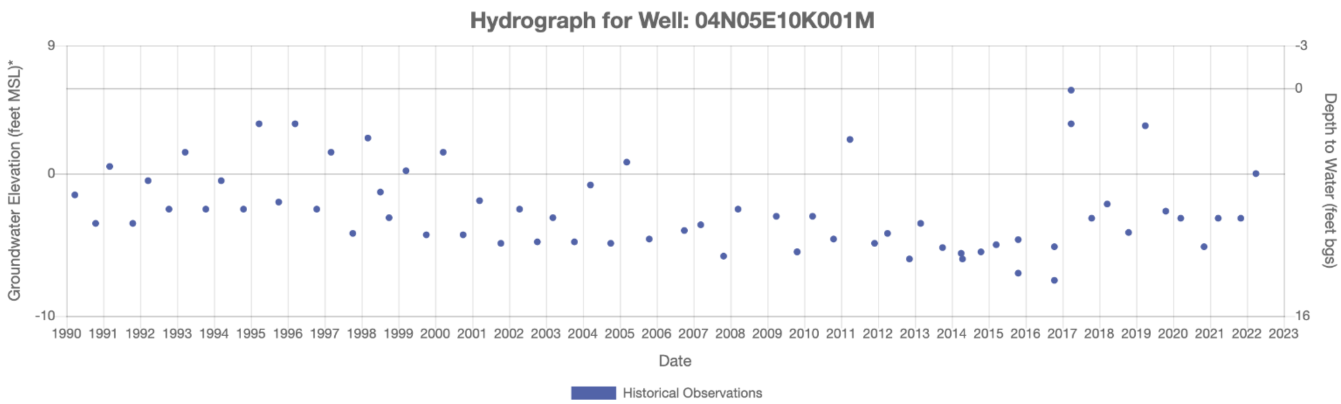
Ground Surface Elevation: 52 ft.



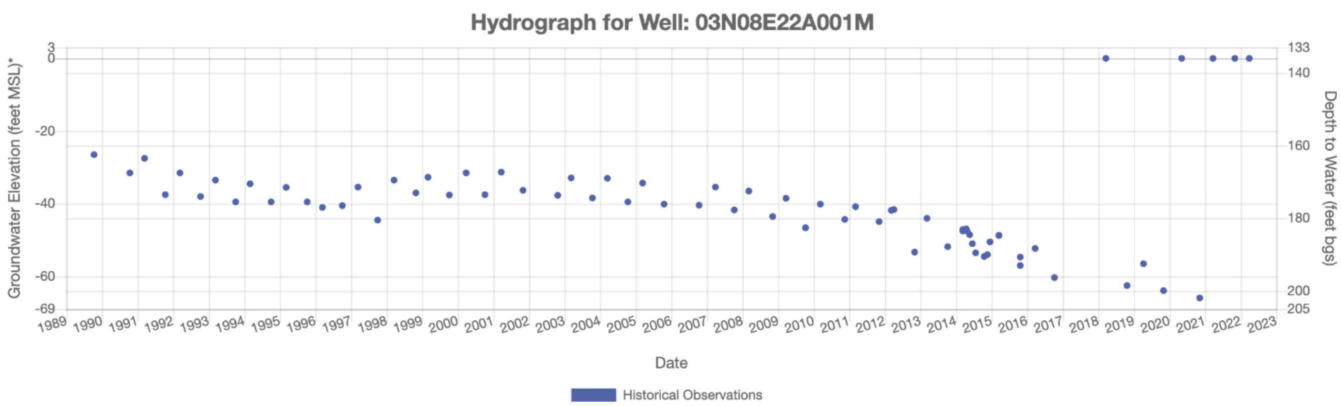
Ground Surface Elevation: 17 ft.



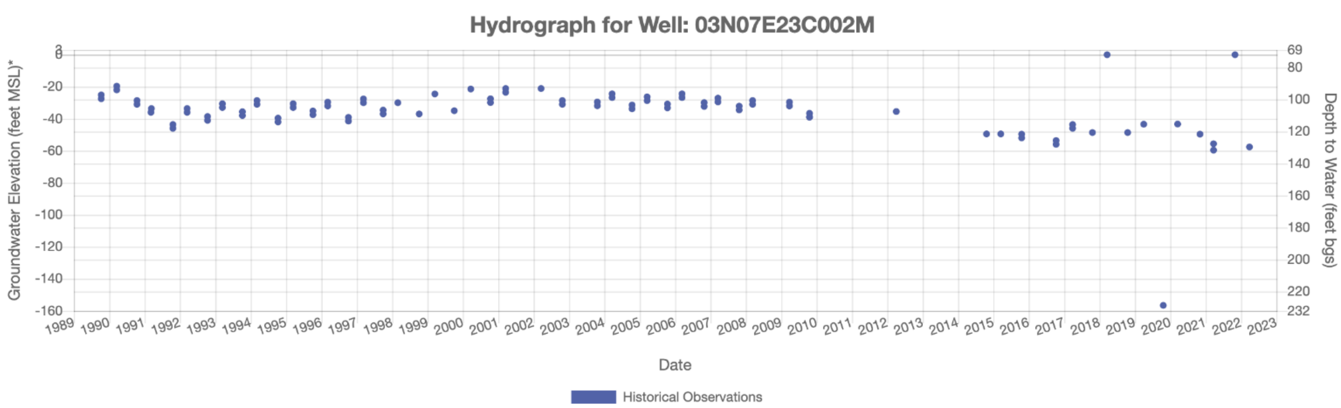
Ground Surface Elevation: 6 ft.



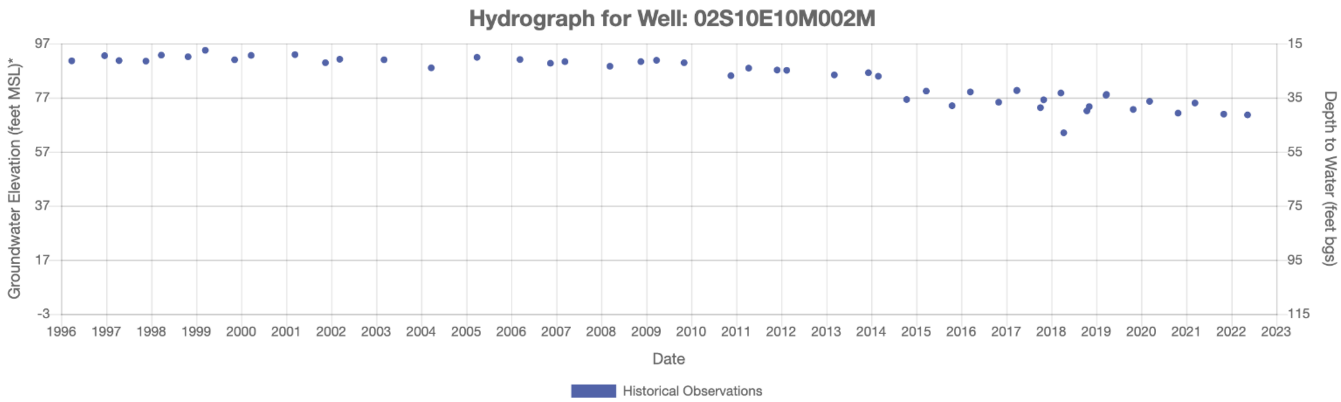
Ground Surface Elevation: 137 ft.



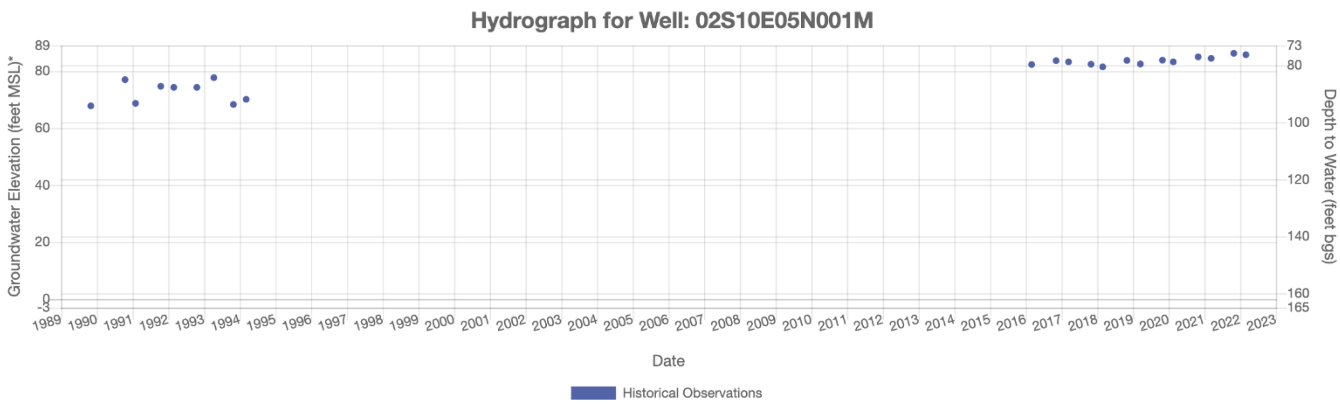
Ground Surface Elevation: 72 ft.



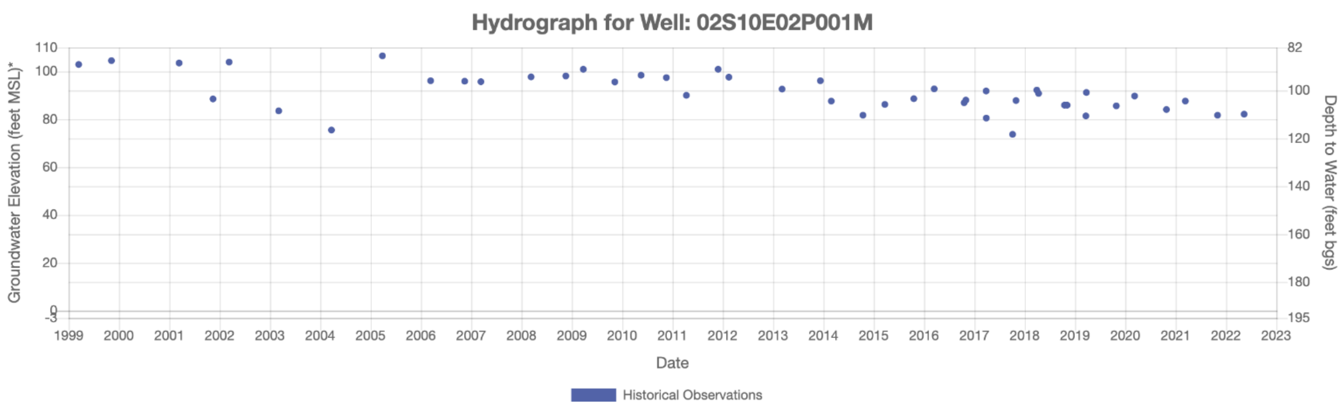
Ground Surface Elevation: 112 ft.



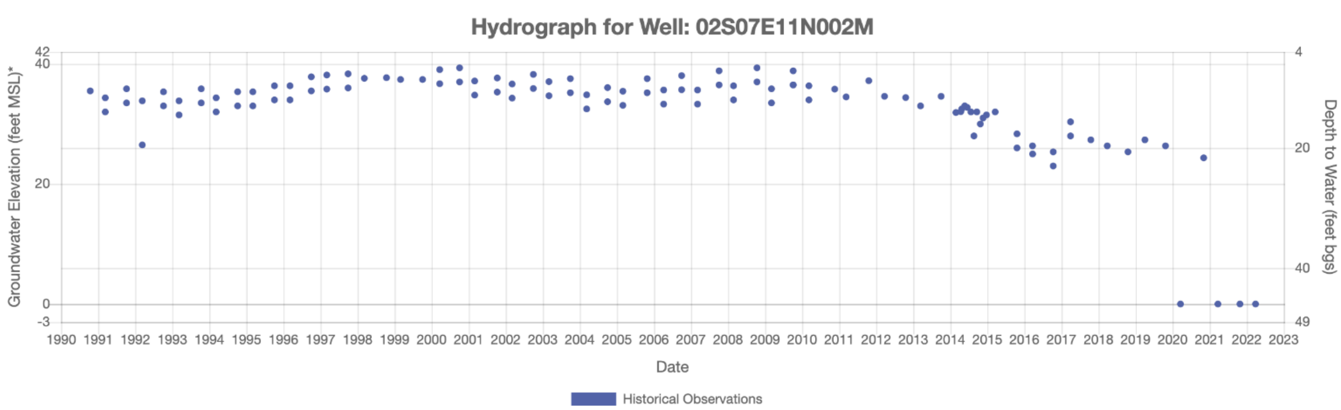
Ground Surface Elevation: 162 ft.



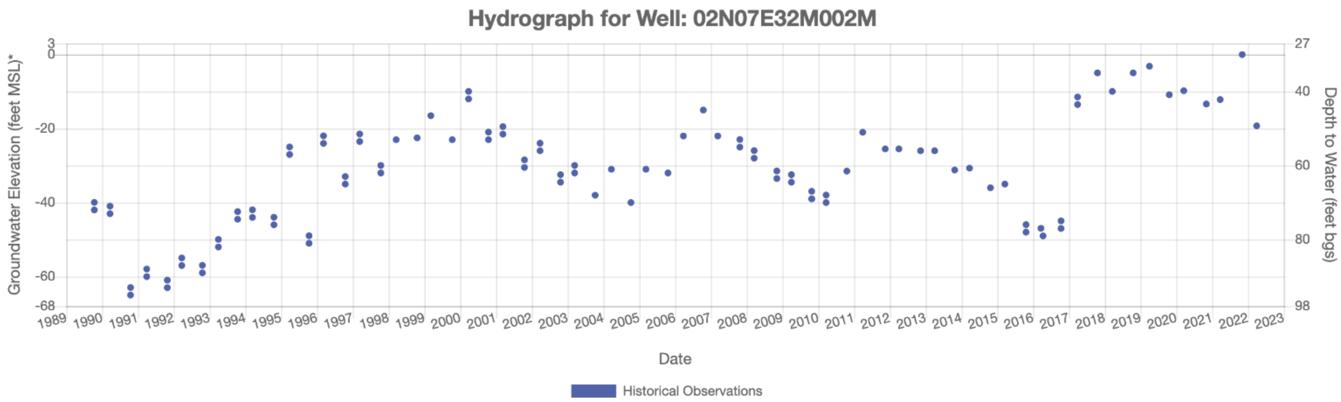
Ground Surface Elevation: 193 ft.



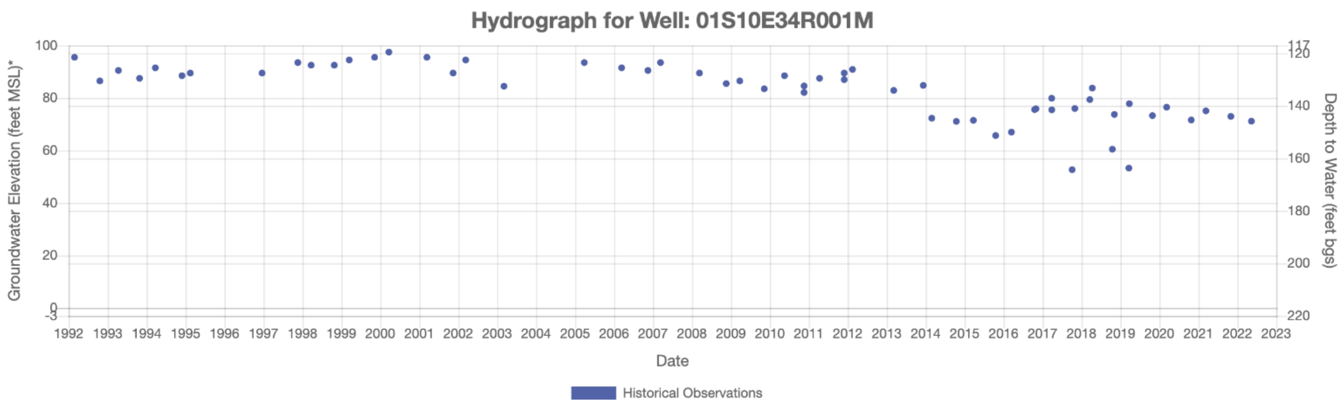
Ground Surface Elevation: 46 ft.



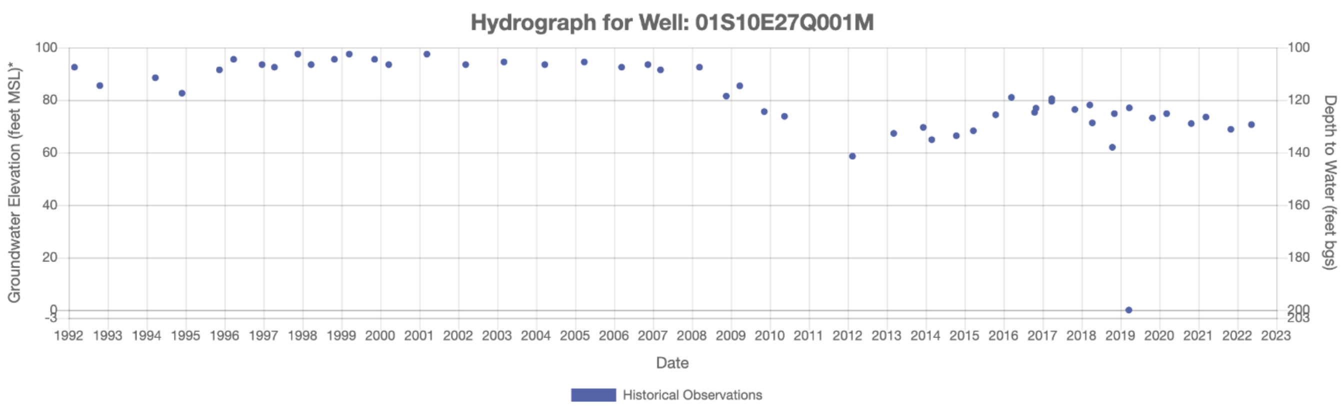
Ground Surface Elevation: 30 ft.



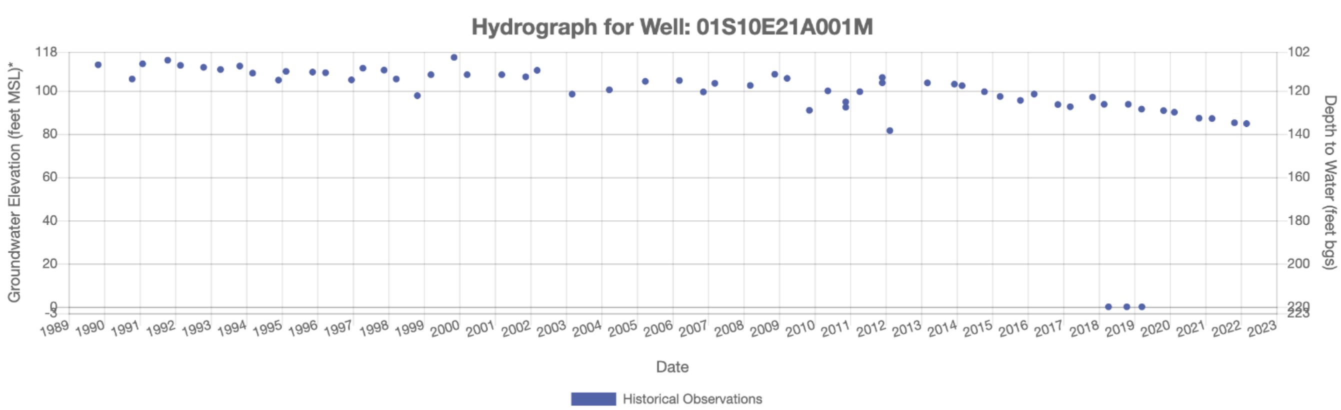
Ground Surface Elevation: 217 ft.



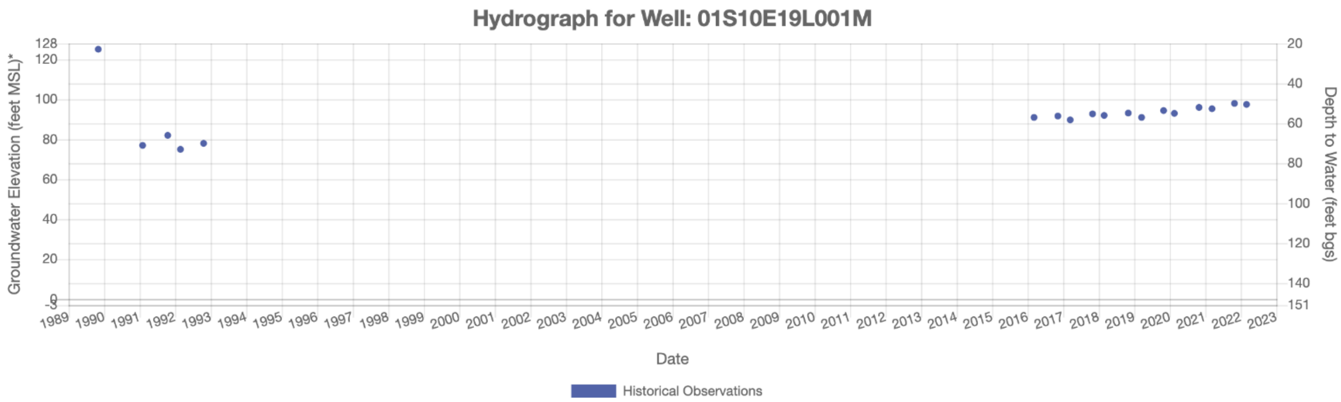
Ground Surface Elevation: 200 ft.



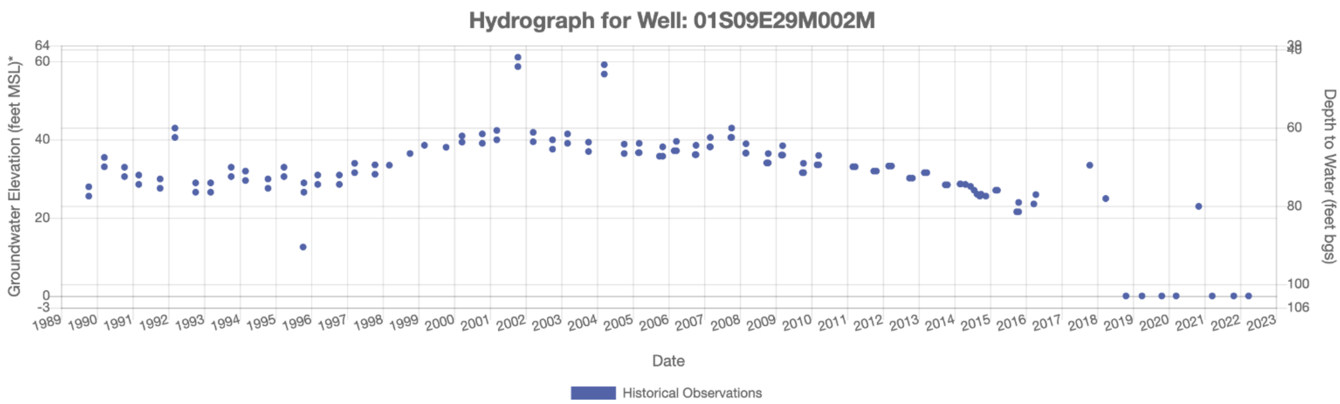
Ground Surface Elevation: 220 ft.



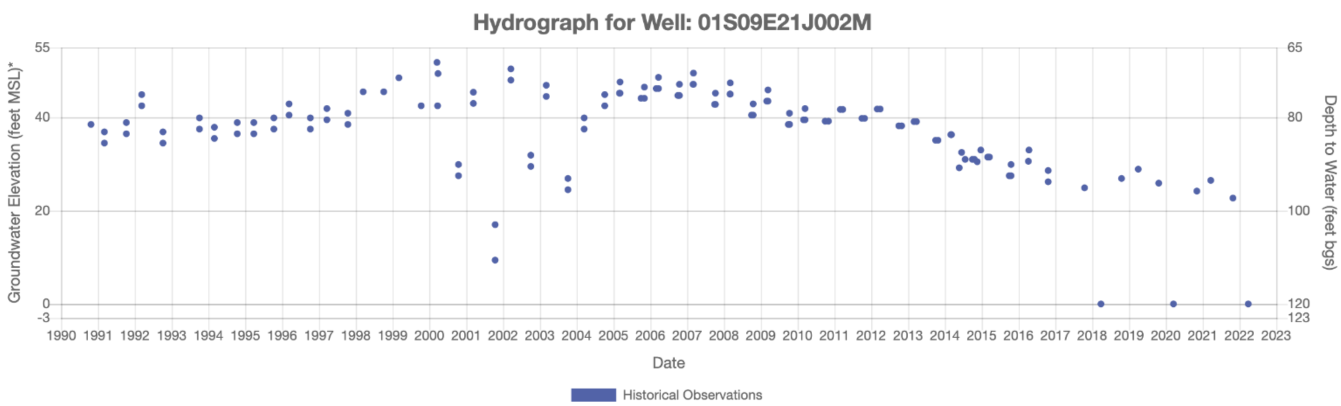
Ground Surface Elevation: 149 ft.



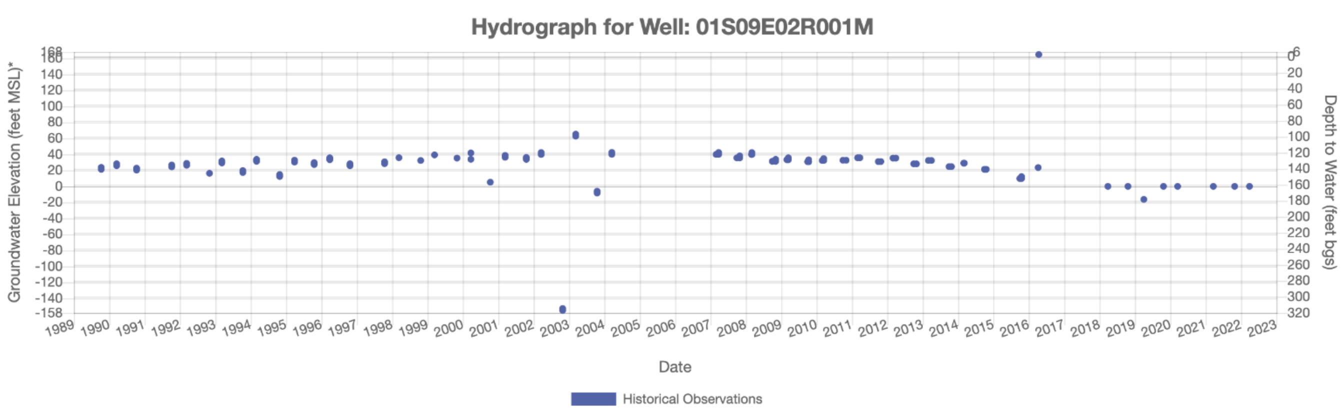
Ground Surface Elevation: 103 ft.



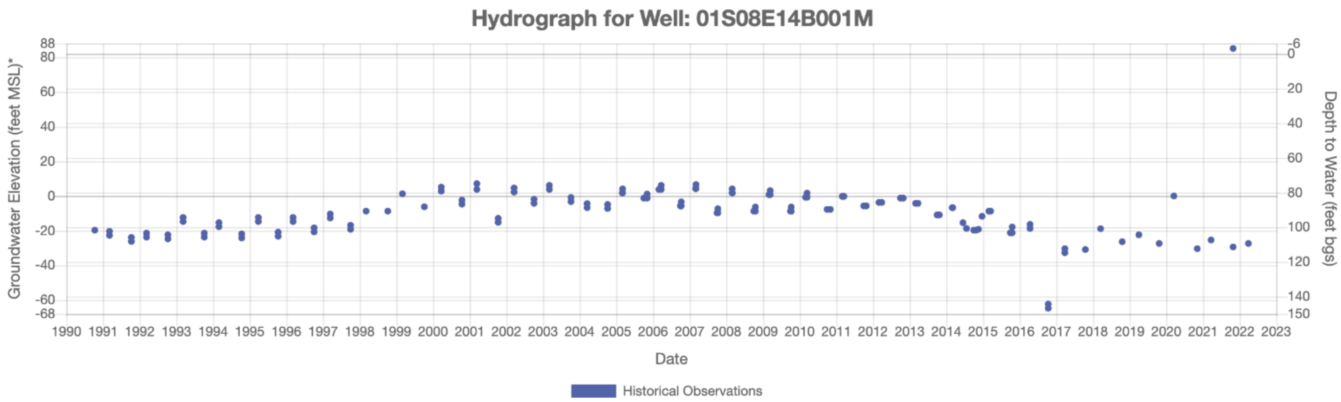
Ground Surface Elevation: 120 ft.



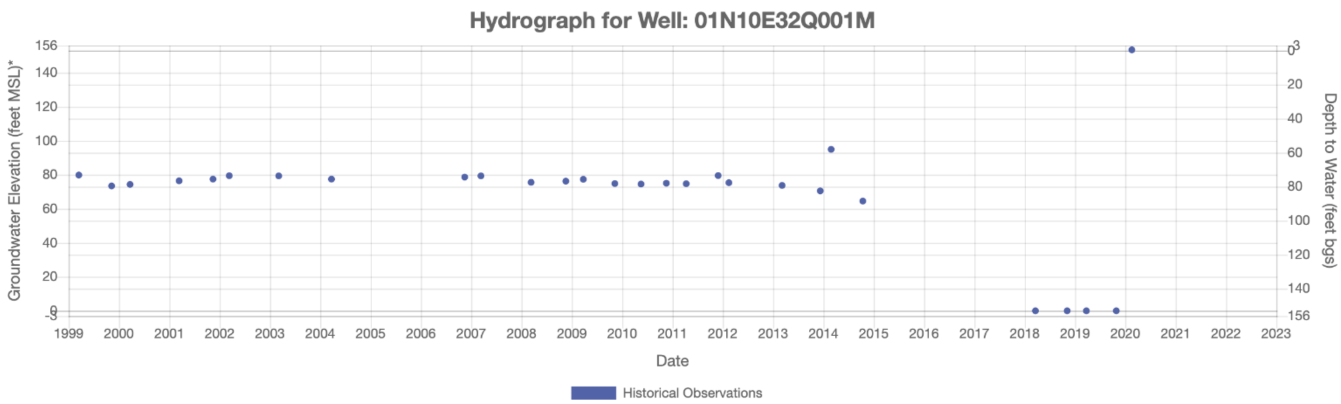
Ground Surface Elevation: 162 ft.



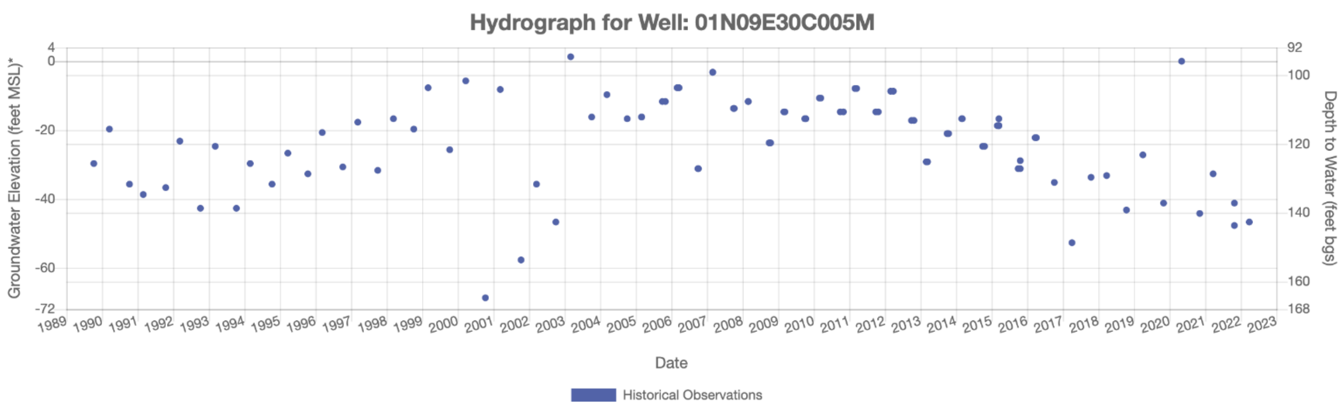
Ground Surface Elevation: 83 ft.



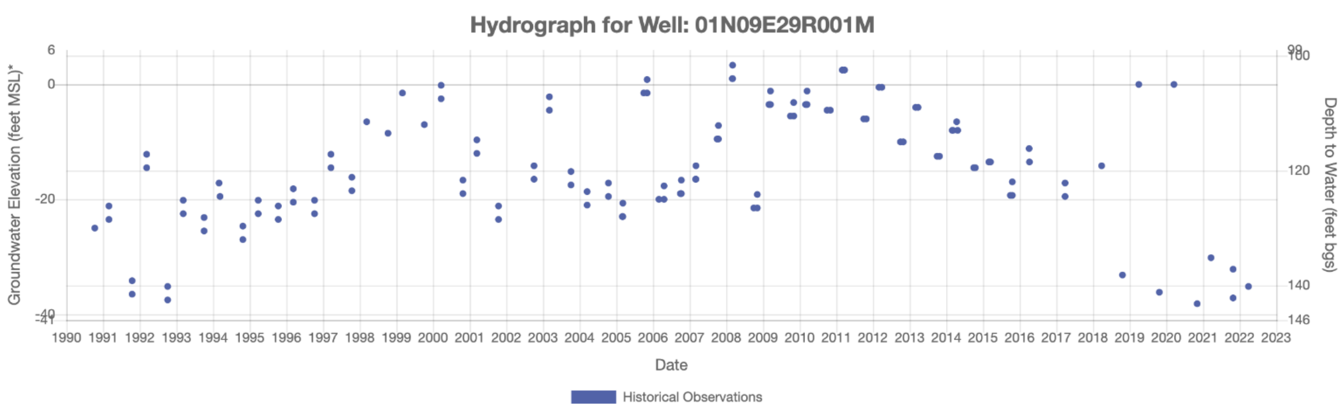
Ground Surface Elevation: 153 ft.



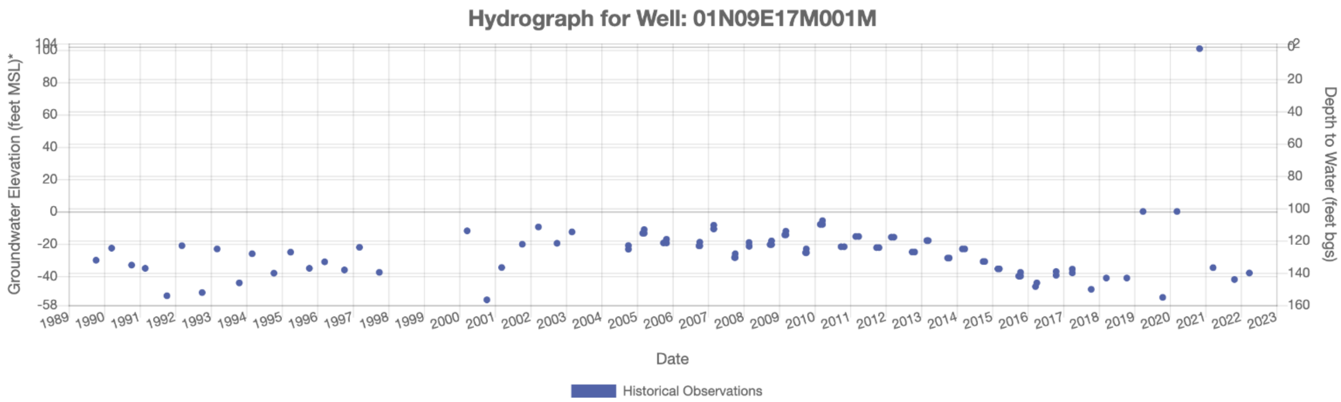
Ground Surface Elevation: 96 ft.



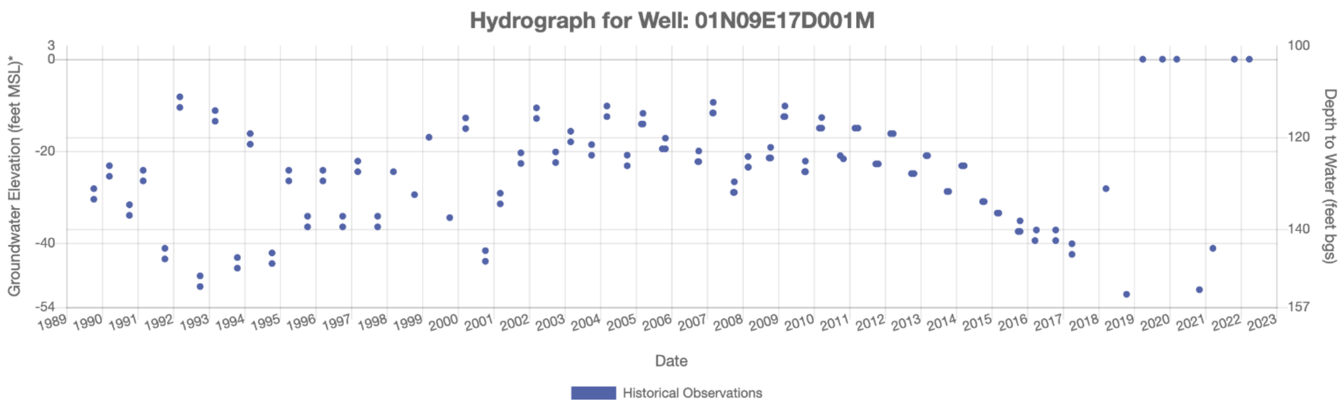
Ground Surface Elevation: 105 ft.



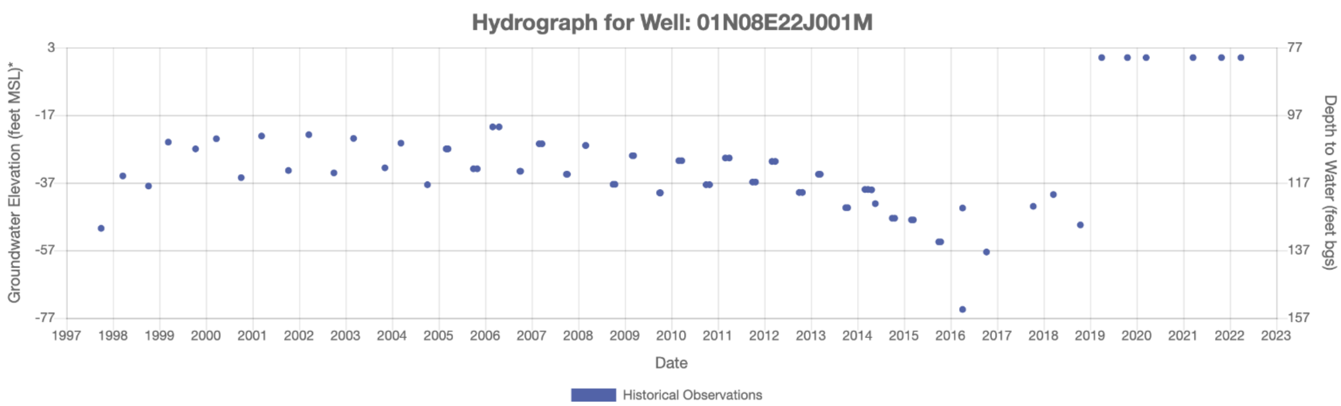
Ground Surface Elevation: 102 ft.



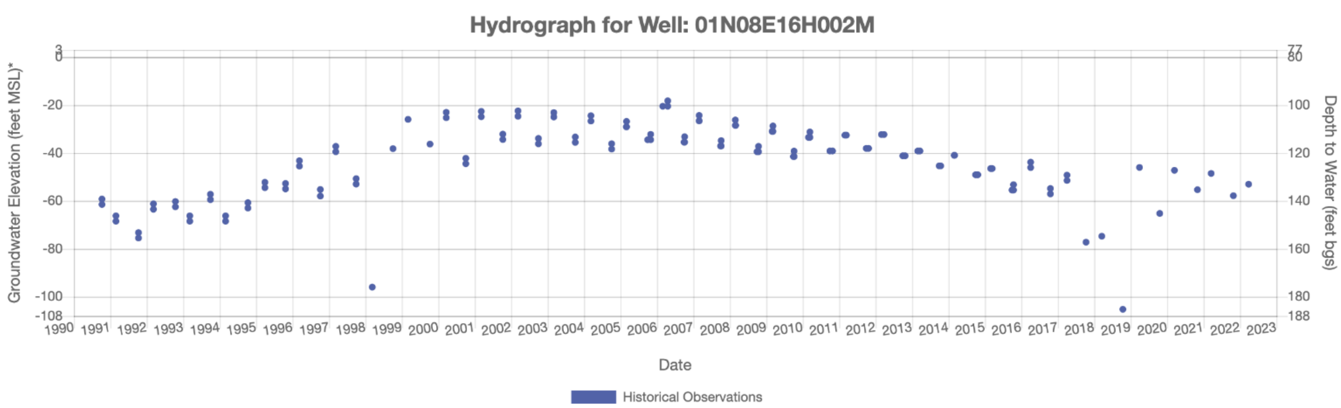
Ground Surface Elevation: 103 ft.



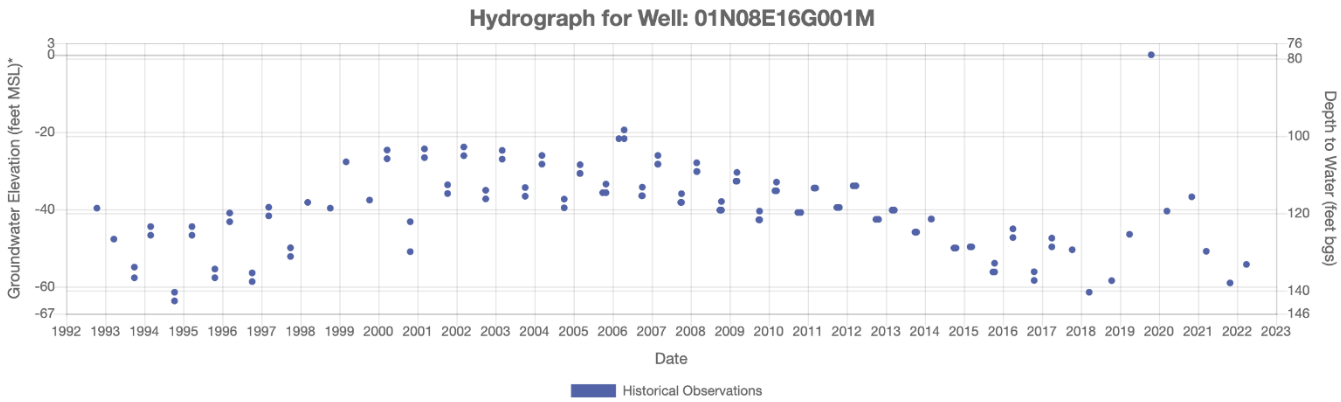
Ground Surface Elevation: 80 ft.



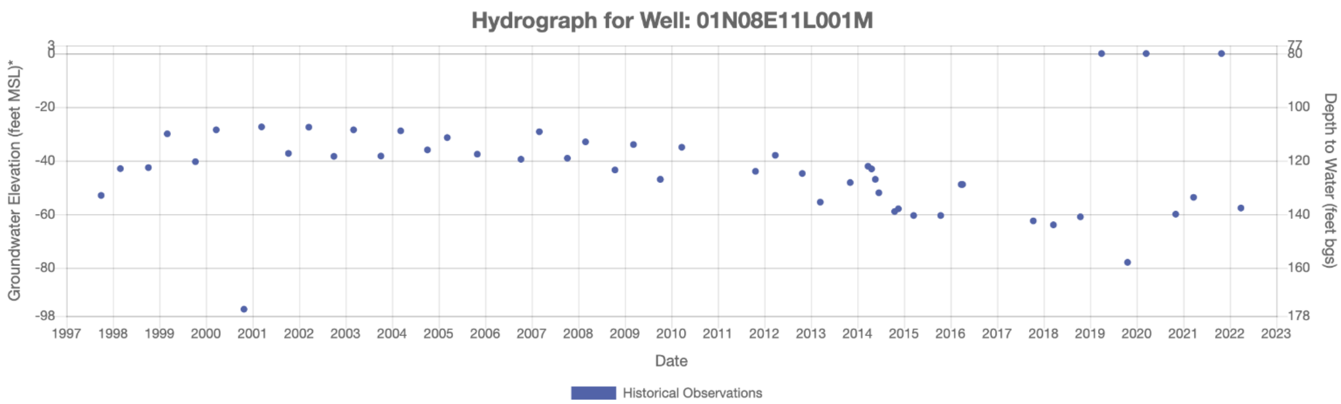
Ground Surface Elevation: 80 ft.



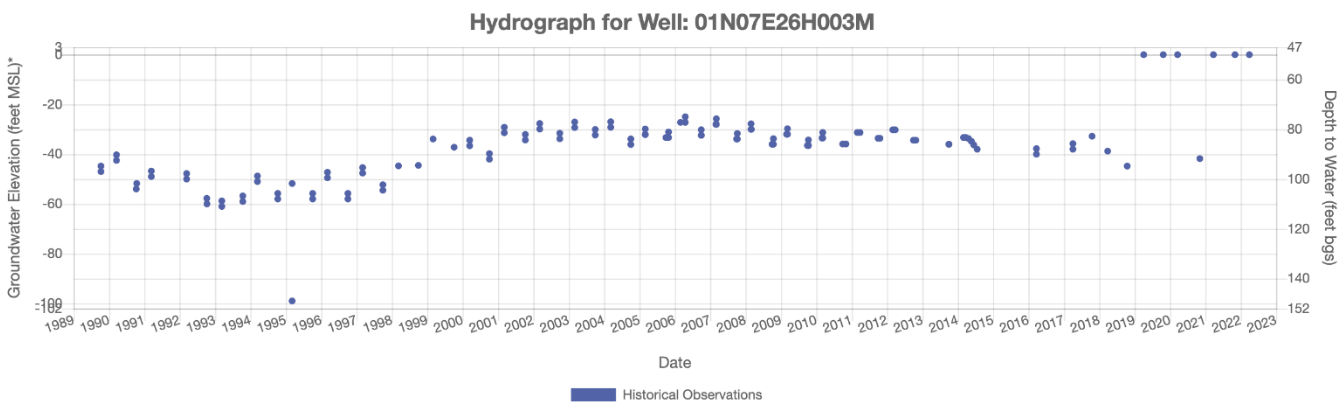
Ground Surface Elevation: 80 ft.



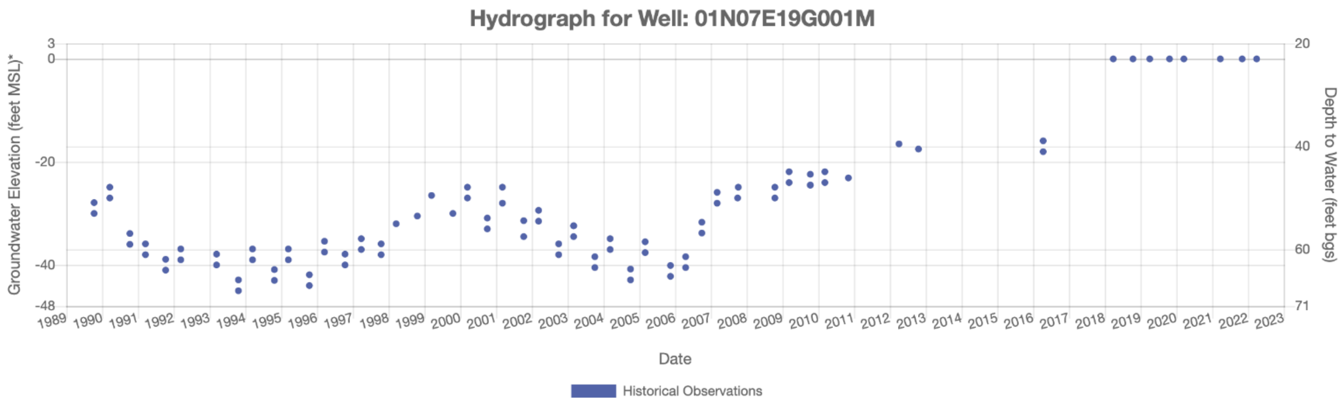
Ground Surface Elevation: 80 ft.



Ground Surface Elevation: 50 ft.



Ground Surface Elevation: 24 ft.



Ground Surface Elevation: 50 ft.