Table 4-2. Summary of Undesirable Results Applicable to the Plan Area

Sustainability Indicator	Historical Period	Existing Condition	Future Conditions
Chronic Lowering of Groundwater Elevations	None	None	None
Reduction of Groundwater Storage	None	None	None
Seawater Intrusion	Not Applicable	Not Applicable	Not Applicable
Degraded Water Quality	Limited*	Limited*	Limited*
Land Subsidence	None	None	None
Depletion of Interconnected Surface Water	None	None	None

Notes:

* There are observed total dissolved solid concentrations in the Basin that exceeds the established minimum thresholds. These are localized incidents and are not indicative of basin wide water quality degradation or an increasing trend of degradation. There likely are a result of localized subsurface conditions.

4.4 Chronic Lowering of Groundwater Levels

This section described the MOs, MTs, and undesirable results for the sustainability indicator of chronic lowering of groundwater levels.

4.4.1 Undesirable Results

Chronic lowering of groundwater elevations in the Basin causes significant and unreasonable declines in available water supply required to meet all beneficial uses. The rate of basin-wide production from wells (in 2015) would decrease since declining water levels lead to dry wells. Total groundwater production leads to an undesirable result if it cannot support beneficial uses unless alternative means of obtaining sufficient water resources is achieved if technically or financially feasible. For economically distressed community members, these impacts may be more consequential as they lack the resources to adapt to the new conditions. The Domestic Well Management Program described in **Section 5.3.5** will pay special attention to the intersecting challenges these community members face.

These undesirable results for the chronic lowering of groundwater levels would cause significant and unreasonable reduction in the long-term viability of domestic, agricultural, municipal, or environmental uses over the planning and implementation horizon of this GSP.

4.4.1.1 Potential Causes

A prolonged period of extracting groundwater greater than the sustainable yield can cause chronic lowering of groundwater elevations in the Basin and could cause an undesirable result in the future.

However, undesirable results driven by local water use, while possible, are considered unlikely under projected land and water use estimates, even when the effects of climate change are considered.

4.4.1.2 Potential Effects

Potential effects of groundwater levels undesirable results could include the following:

- De-watering of a subset of the existing groundwater infrastructure, starting with the shallowest wells that are generally domestic wells;
- Drinking water supply disruptions.
- Increased costs to pump groundwater;
- Changes in irrigation practices and crops grown;
- Adverse effects to property values and the regional economy;
- Increase in costs for supplying water;
- Adverse effects on GDEs, to the extent connected with the production aquifer; or
- Harm to surface water beneficial uses including terrestrial and aquatic species.

4.4.1.3 Identification of Undesirable Results

The six RMS in Big Valley Basin were selected for the identification of undesirable results to indicate region-wide impacts to groundwater levels. Undesirable results would occur when 33 percent (two of six wells) of RMS used to monitor groundwater levels fall below their MTs for two consecutive years at the same sites. Exceedance at one RMS well may be due to localized conditions. Therefore, exceedance at two RMS is chosen as an indicator of broader basin wide trend. Note that the **Section 5**, outlines an adaptive management triggers and actions for drought conditions and when groundwater levels approach MTs at one or more RMS sites.

4.4.2 Minimum Thresholds

The GSP regulations provide that the MTs for chronic lowering of groundwater elevations shall be the groundwater level indicating a depletion of supply at a given location that may lead to undesirable results. MTs were selected to represent conditions (based on available data and information) that are just above conditions that could generate undesirable results in the Big Valley Basin. The GSP determined that maintaining groundwater levels within observed historical levels would prevent undesirable results in the Basin, which have not occurred historically.

4.4.2.1 Quantitative Metric for MTs Measurement

Groundwater levels will be measured at six RMS to gauge if MTs are being met. Groundwater level monitoring will be conducted in accordance with the monitoring plan outlined in Section 3, and it will meet the requirements of the technical and reporting standards included in the GSP regulations. As noted in **Section 3**, the current RMS for groundwater levels includes six wells.

The quantitative measurement for chronic lowering of groundwater elevations will be the annual spring (March or April) measurements taken at the RMS. Spring groundwater levels are a good indicator of long-term groundwater basin health and are less affected by the erratic measurements due to localized effects of active groundwater pumping in the summer and fall. The data obtained will be appended to existing data to generate hydrographs for the wells. These hydrographs will be analyzed for changing trends in water elevations and compared to established MTs to ensure they are not exceeded.

4.4.2.2 Description of the MTs

The development of MTs for chronic lowering of groundwater elevations included a review of historical groundwater levels and the projected water levels trends. MTs were established by analyzing historical groundwater level data, projecting water level trends in 2042, and estimating approximately how many domestic wells may be negatively impacted at different water levels. Both annual (variability from year to year) and seasonal variability were considered in the development of MTs. The MT for each RMS is defined as follows:

1. Lowest historical spring groundwater level was identified. Since groundwater conditions in the basin has been relatively stable over the past 30 years, this level has been identified as an acceptable lower limit.

2. Highest historical spring groundwater level was identified and a margin of operational flexibility corresponding to 20 percent of the range between lowest and highest spring levels was calculated.

3. The margin of operational flexibility is used to adjust down the lowest historical spring groundwater level to account for measurement uncertainties, severe extended drought periods, and effects of climate change.

4. The MT at each RMS for groundwater elevation is set as the lowest historical spring groundwater elevation, plus the operational flexibility margin.

Table 4-3 summarizes the MTs at each RMS. Groundwater level hydrographs from which the MTs were developed are shown on **Figure 4-1** through **Figure 4-6**. Information used to develop the MTs are presented in **Table 4-4**.

Table 4-3. Minimum Thresholds for the Chronic Lowering of Water Elevations

Grid Section	State Well ID	Minimum Thresholds (Elevation feet NAVD88)	Minimum Thresholds (feet bgs)
North	14N09W32G002M	1,312.6	24.8
Northwest	13N09W08M003M	1,322.3	48.5
Northeast	13N09W03R001M	1,331.8	28.3
West-Central	13N09W18J001M	1,365.5	37.3
East-Central	13N09W15J001M	1,388.3	34.6
Southwest	13N09W28J002M	1,503.3	99.9

Key:
bgs = below ground surface

4.4.2.3 Existing Local, State, or Federal Standards

No federal, other state, or local standards exist for chronic lowering of groundwater elevations.

4.4.2.4 Protection of Beneficial Uses

Exceedance of MTs would indicate undesirable results for the chronic lowering of groundwater levels resulting in significant and unreasonable impacts to beneficial uses. Of these, domestic wells are the most vulnerable because of their relative shallower depths compared to agricultural and municipal wells. Additionally, there are economically distressed communities in Big Valley that may not have the means to mitigate the impacts of a dewatered or dry well.

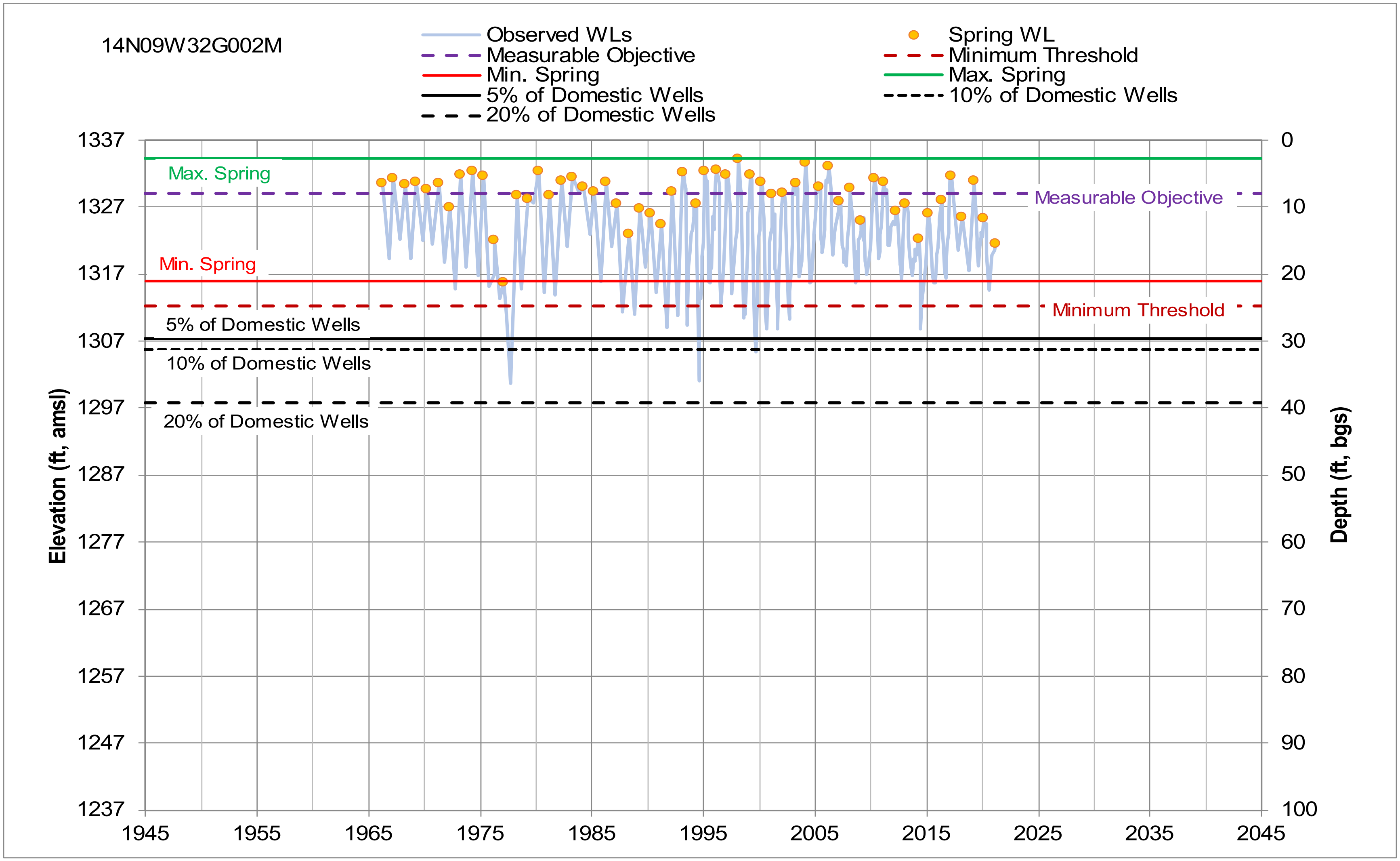
Table 4-4 and **Figure 4-1** through **Figure 4-6** highlight the number of domestic wells and the percentage of those wells that may be impacted if MTs are exceeded at each of the RMS wells. This was determined by using DWR's Online System of Well Completion Reports which includes both the number of wells and depth information. In the North, Northeast, and Southwest grid sections, all domestic wells are deeper than the MT. In the Northwest, West-Central, and East-Central grid sections, the number of domestic wells that are shallower than the MT are 13 (15%), 4 (7%), and 9 (16%), respectively.

Figure 4-7 illustrates the likelihood that the MTs for chronic lowering of groundwater would be exceeded under various levels of demands and extreme climate change conditions (2070 dry with extreme warming conditions). Under forecasted levels of water demand and climate change (Scenario C), the spring groundwater elevations would not exceed any of the MTs through the year 2042 (the GSP implementation period). Assuming water demands would increase by more than 45 percent of forecasted levels, spring groundwater levels in the Northwest RMS well would approach the MT. At 90 percent increase in water demands, spring groundwater levels in the Northwest RMS well would exceed the MT and would approach the MTs in the North and West-Central RMS wells.

Figure 4-7 demonstrates the resiliency and sustainability of the groundwater basin. Groundwater levels at all RMS sites would remain either stable or well above the MTs under project levels of demands with sever climate change conditions. Exceedances of MTs are only predicted if water demands in the Basin are significantly intensified beyond current projected land use changes.

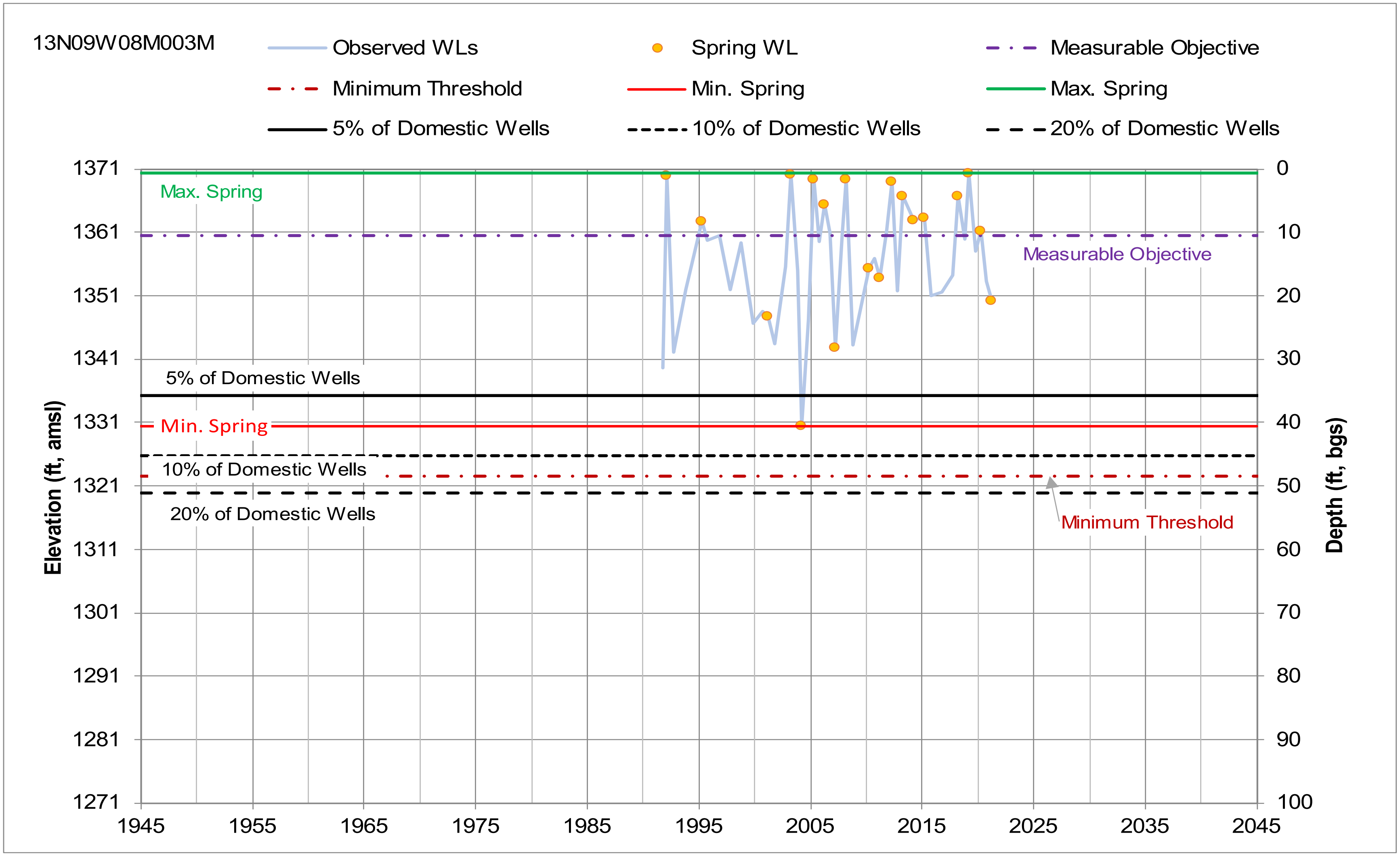
This analysis also shows that no impacts to domestic wells are anticipated under forecasted levels of demands and climate change conditions in most of the Basin. The Northwest RMS shows that, although groundwater elevation remains stable, there are a high level of fluctuations between spring and fall conditions. As discussed earlier, up to 15 percent of the domestic wells (13 out of 87) may be impacted if groundwater elevations fall below the MT at the Norwest RMS. Since the MT at this RMS is 48.5 feet below ground surface (**Table 4-3**), the potentially impacted domestic wells are fairly shallow wells. It is also not clear if all these domestic wells are active or in use. **Section 5** outlines a number of projects and management actions to address this potential impact, including (1) a domestic wells survey, (2) assistance program for domestic well owners, and (3) adaptive management triggers and actions for drought conditions and when groundwater levels approach MTs at one or more RMS wells.

Overall, the defined MTs for chronic lowering of groundwater levels, in combination with the projects and managements actions, are protective of beneficial uses in the Big Valley Basin.



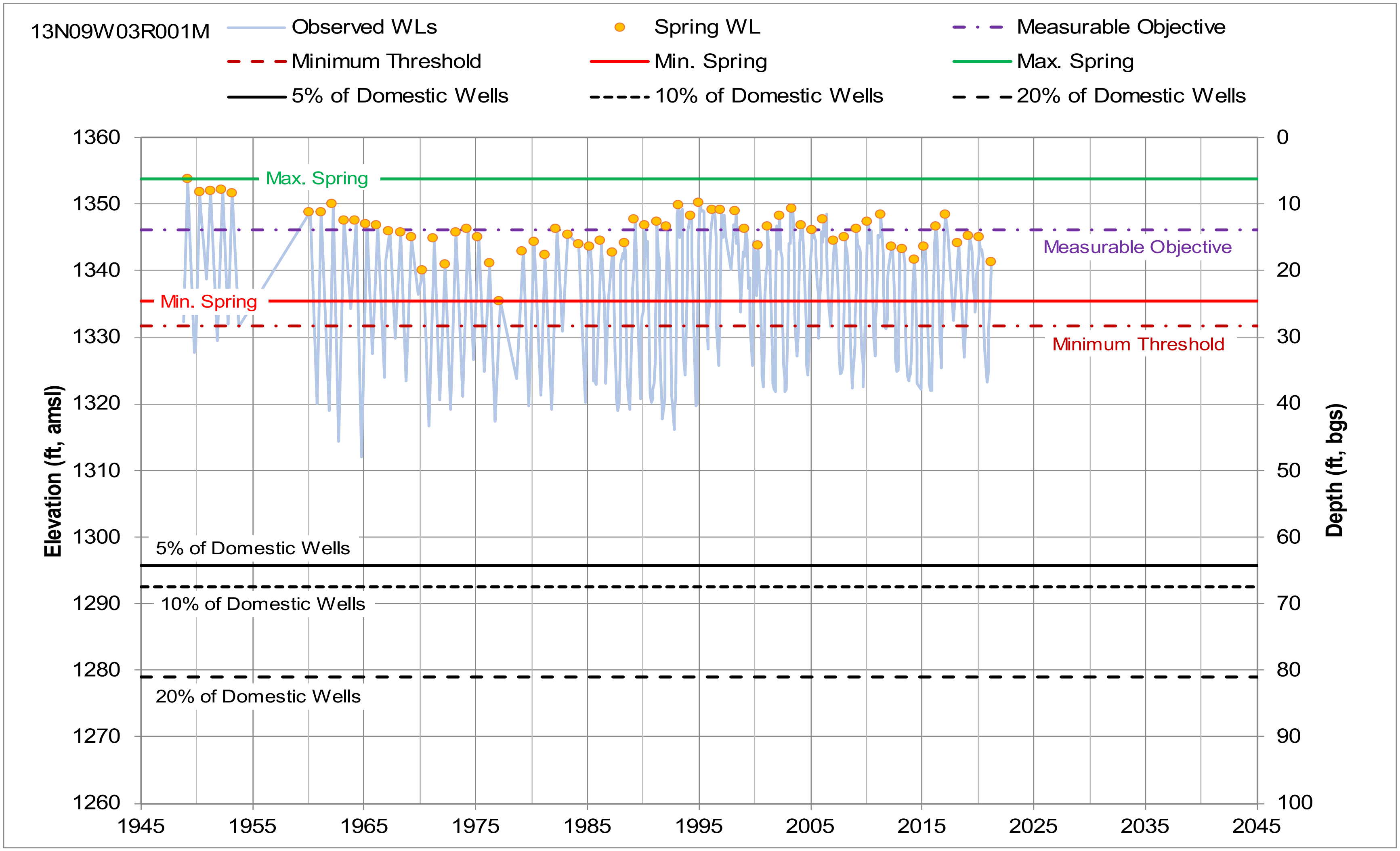
Notes: WL means water level. The domestic well percentage lines indicate the percentage of wells, within the grid section, at a certain depth. This was calculated using well location and depth information from DWR's Online System of Well Completion Reports.

Figure 4-1. Spring Groundwater Elevations and Depth Exceedance for Nearby Well for Groundwater Levels Representative Monitoring Network Site 14N09W32G002M (North Grid Section)



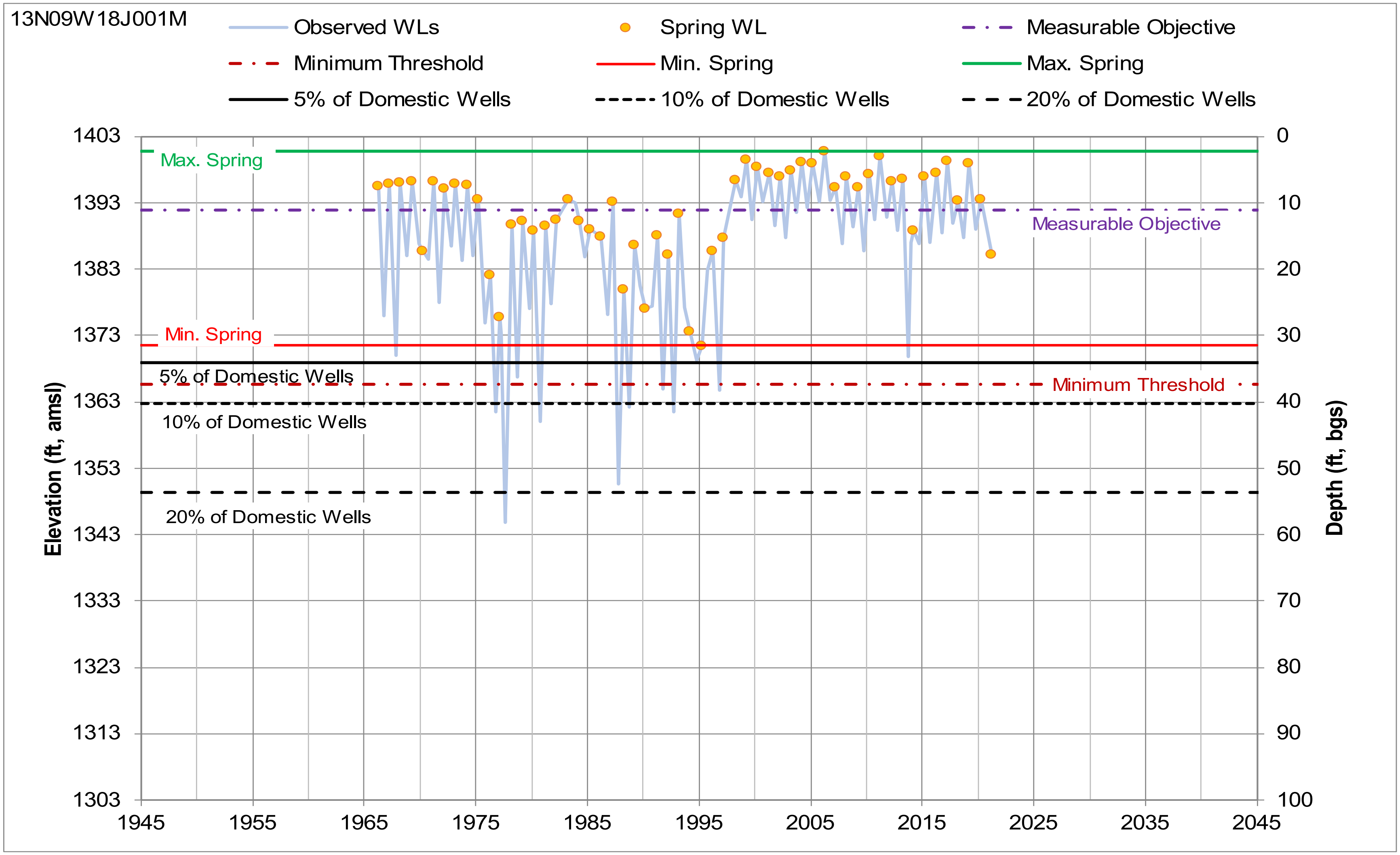
Notes: WL means water level. The domestic well percentage lines indicate the percentage of wells, within the grid section, at a certain depth. This was calculated using well location and depth information from DWR's Online System of Well Completion Reports.

Figure 4-2. Spring Groundwater Elevations and Depth Exceedance for Nearby Well for Groundwater Levels Representative Monitoring Network Site 13N09W08M003M (Northwest Grid Section)



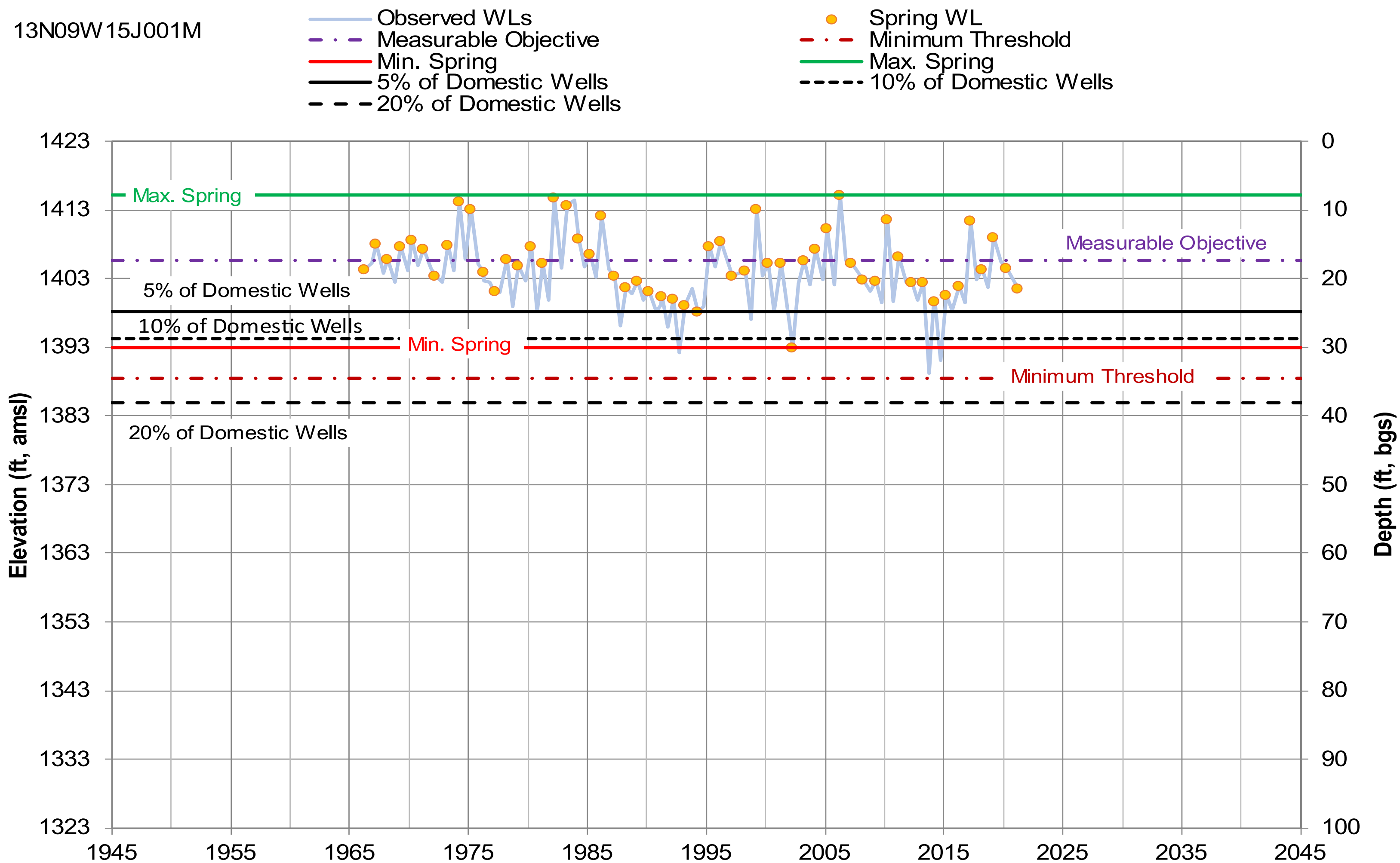
Notes: WL means water level. The domestic well percentage lines indicate the percentage of wells, within the grid section, at a certain depth. This was calculated using well location and depth information from DWR's Online System of Well Completion Reports

Figure 4-3. Spring Groundwater Elevations and Depth Exceedance for Nearby Well for Groundwater Levels Representative Monitoring Network Site 13N09W03R001M (Northeast Grid Section)



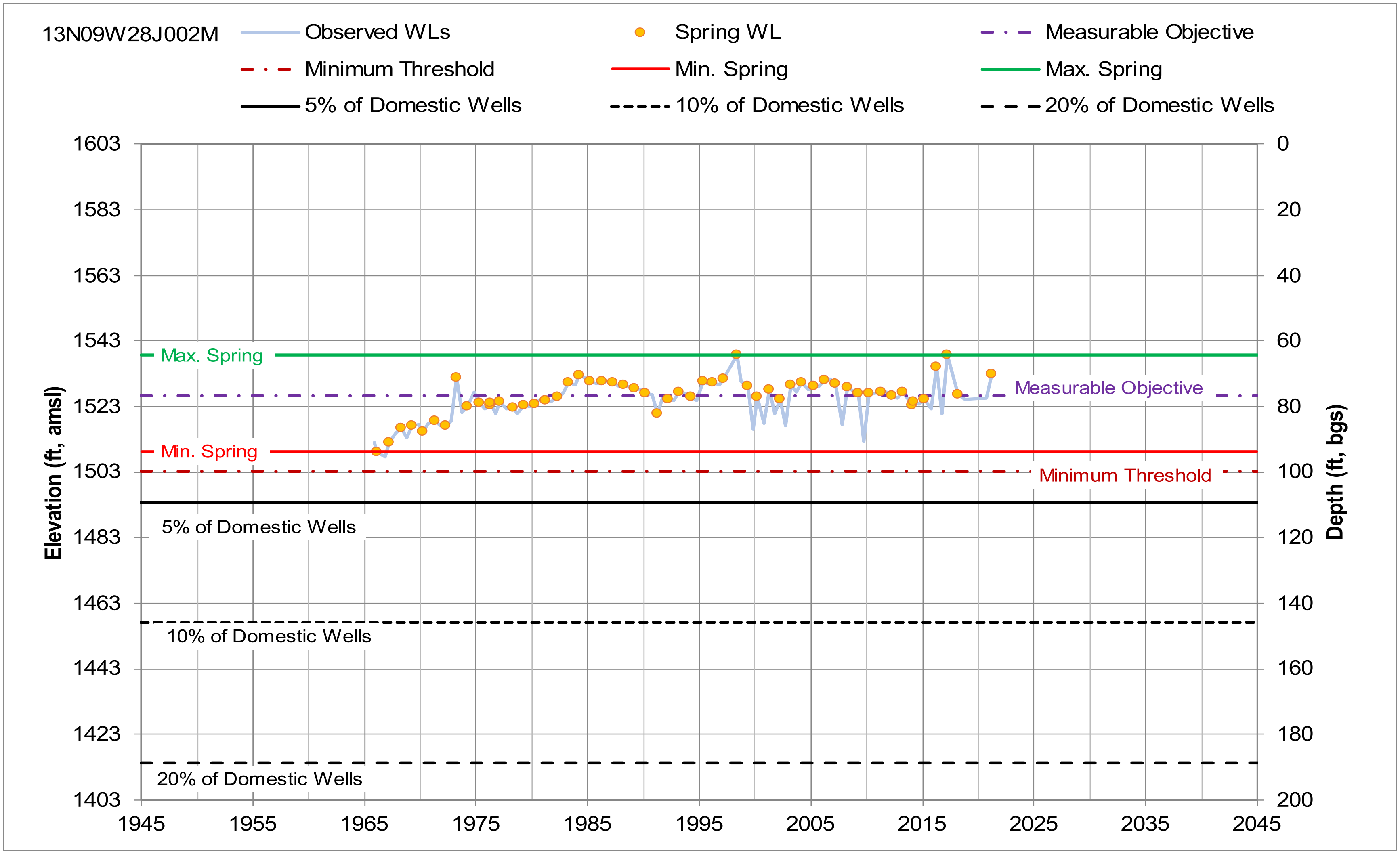
Notes: WL means water level. The domestic well percentage lines indicate the percentage of wells, within the grid section, at a certain depth. This was calculated using well location and depth information from DWR's Online System of Well Completion Reports.

Figure 4-4. Spring Groundwater Elevations and Depth Exceedance for Nearby Well for Groundwater Levels Representative Monitoring Network Site 13N09W18J001M (West-Central Grid Section)



Notes: WL means water level. The domestic well percentage lines indicate the percentage of wells, within the grid section, at a certain depth. This was calculated using well location and depth information from DWR's Online System of Well Completion Reports.

Figure 4-5. Spring Groundwater Elevations and Depth Exceedance for Nearby Well for Groundwater Levels Representative Monitoring Network Site 13N09W15J001M (East-Central Grid Section)



Notes: WL means water level. The domestic well percentage lines indicate the percentage of wells, within the grid section, at a certain depth. This was calculated using well location and depth information from DWR's Online System of Well Completion Reports.

Figure 4-6. Spring Groundwater Elevations and Depth Exceedance for Nearby Well for Groundwater Levels Representative Monitoring Network Site 13N09W28J002M (Southwest Grid Section)

Table 4-4. Information Supporting Development of Minimum Thresholds for the Chronic Lowering of Water Elevations

State Well ID	14N09W32G002M	13N09W08M003M	13N09W03R001M	13N09W18J001M	13N09W15J001M	13N09W28J002M
Grid Section	North	Northwest	Northeast	West-Central	East-Central	Southwest
Depth/ Perforations (feet)	62-118	40-245	167.0	157	200	100
Elevation (feet NAVD88)						
Reference Point	1,337.4	1,370.8	1,360.1	1,402.87	1,422.88	1,603.22
Highest Spring	1,334.6	1,370.2	1,353.8	1,400.57	1,415.08	1,538.62
Average Spring	1329.4	1360.2	1346.3	1391.9	1405.6	1526.3
Lowest Spring	1,316.3	1,330.3	1,335.5	1,371.37	1,392.78	1,509.22
Operational Flexibility Margin (feet)	3.7	8.0	3.7	5.8	4.5	5.9
Measurable Objective	1329.4	1360.2	1346.3	1391.9	1405.6	1526.3
Minimum Threshold	1,312.6	1,322.3	1,331.8	1,365.5	1,388.3	1,503.3
2015 Spring Elevation	1,326.6	1,363.1	1,343.7	1396.9	1,400.5	1,525.02
2021 Spring Elevation	1,322	1,350	1,341.4	1385.2	1,400.5	1,532.92
Level (feet below ground surface)						
Measurable Objective	8.0	10.6	13.8	11.0	17.3	76.9
Minimum Threshold	24.8	48.5	28.3	37.3	34.6	99.9
2015 Spring Level	10.8	7.7	16.4	6	22.4	78.2
2021 Spring Level	15.4	20.8	18.7	17.7	22.4	5.7
# of Wells in Grid Section	68	87	32	58	58	23
Depth > 5% of Wells	29.6	35.8*	64.3	34*	24.8*	109.3
Depth > 10% of Wells	31.2	45.2*	67.4	40.2	28.7*	145.7
Depth > 20% of Wells	39.2	51.1	81	53.6	38.1	188.6

Note: * Water level shallower than the corresponding minimum threshold.

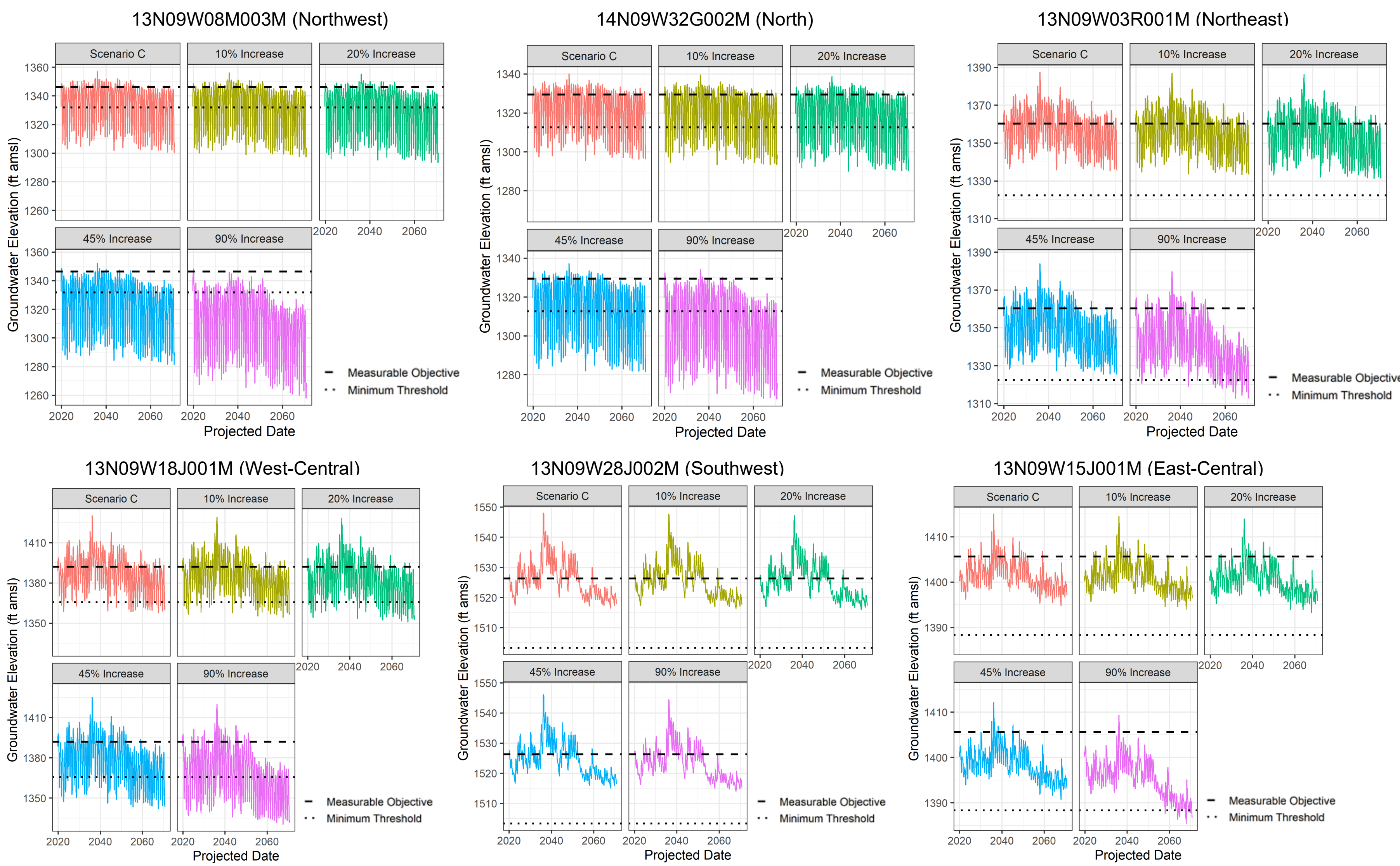


Figure 4-7. Simulated Groundwater Elevations at RMS Wells Under Climate Change and Current Level of Demand (Scenario C) and Different Levels of Demand Increase in the Big Valley Basin

4.4.3 Measurable Objectives

MOs represent the expected groundwater extraction operating conditions for the Basin. If the GSA successfully manages groundwater extraction that results in the achievement of the MOs described, the Basin will be operating sustainably.

MOs for chronic lowering of groundwater levels were established to reflect that groundwater elevations in the Basin have been stable over the available historical record. Therefore, the MOs are set as the average historical groundwater elevation at each RMS site. The defined MOs target maintenance of current conditions in the basin, while providing margin of operational flexibility for dry and wet periods.

Interim milestones are set at the same levels as the MOs.

Table 4-5 summarizes the MOs at each RMS. Information used to develop the MOs are presented in **Table 4-4**. Groundwater level hydrographs from which the MOs were developed are shown on **Figure 4-1** through **Figure 4-6**.

Table 4-5. Measurable Objectives for the Chronic Lowering of Groundwater Elevations

Grid Section	State Well ID	Measurable Objective (Elevation feet NAVD88)	Measurable Objective (feet bgs)
North	14N09W32G002M	1329.4	8.0
Northwest	13N09W08M003M	1360.2	10.6
Northeast	13N09W03R001M	1346.3	13.8
West-Central	13N09W18J001M	1391.9	11.0
East-Central	13N09W15J001M	1405.6	17.3
Southwest	13N09W28J002M	1526.3	76.9

Key:
bgs = below ground surface

4.5 Reduction of Groundwater Storage

Groundwater storage is the amount of usable water in an aquifer. Similar to surface water reservoirs, changes in the amount of storage are manifested by rising or falling water levels, for increasing or decreasing storage, respectively. As a result, changes in groundwater levels can serve as good proxy for changes in groundwater storage over time. In this GPS, the reduction of groundwater storage sustainability indicator will be incorporated into the GSP using the chronic lowering of groundwater levels indicator as a proxy.

4.5.1 Undesirable Results

A prolonged period of extracting groundwater greater than the sustainable yield can cause groundwater storage declines in the Basin and could cause an undesirable result in the future.

These reductions in storage are manifested through long-term declines in groundwater levels. Undesirable results for significant and unreasonable reduction of groundwater storage are the same as those used for chronic lowering of groundwater levels described in **Section 4.4.1**.

4.5.2 Minimum Threshold

MTs for the significant and unreasonable reduction of groundwater storage are the same as those established for chronic lowering of groundwater levels described in **Section 4.4.2**.

4.5.3 Measurable Objectives

MOs for reduction of groundwater storage are the same as those established for chronic lowering of groundwater levels described in **Section 4.4.3**.

4.6 Seawater Intrusion

Seawater intrusion is not an applicable sustainability indicator, because seawater intrusion is not present and is not likely to occur in Big Valley Basin due to the distance from the Pacific Ocean, bays, deltas, or inlets. Thus, criteria for undesirable results related to this sustainability indicator is not established in this GSP.

4.7 Degraded Groundwater Quality

This section described the MOs, MTs, and undesirable results for the sustainability indicator of degraded groundwater quality.

4.7.1 Undesirable Results

Groundwater-related activities, such as groundwater extraction or groundwater recharge, and naturally occurring groundwater constituents can cause undesirable results. Degraded groundwater quality can have a significant and unreasonable reduction in the long-term of the viability of domestic, agricultural, municipal, or environmental uses over the planning and implementation horizon of this GSP.

4.7.1.1 Potential Causes

Much of Lake County is located in the Clear Lake Volcanic Field which explains its productive geothermal power plants and numerous hot springs. Geothermal water intrusion into the groundwater aquifer can lead to water quality issues such as increase in concentrations of iron, manganese, sulphur, and nitrates. Although not specifically documented in Big Valley Basin (CDM 2006), degraded water quality could occur in the Basin as a result of over pumping of groundwater leading to undesirable results. A prolonged period of extracting groundwater greater than the sustainable yield can cause an increase in concentrations of constituents of concern to rise in the Basin and could cause an undesirable result in the future. This occurs primary through the upcoming of deep saline and geothermal water into the freshwater aquifer.

However, it should be noted that there is also a natural tendency for salt concentrations to increase over time due to agricultural and urban uses of water, which adds salts either directly or through evapotranspiration. Long-term monitoring of salinity is important to allow the GSA to assess the trends of salinity and identify the potential sources. If a causal link to groundwater pumping is established corrective measures may be taken.

There are other water quality concerns within the Big Valley Basin that are outside the purview of the GSA and are covered by other regulatory programs and are without a causal nexus to groundwater pumping, including:

- Naturally occurring constituents such as iron, manganese, boron, and arsenic.
- Constituents from land use activities (urban, agricultural, and industrial) that are not managed under SGMA. These constituents may include nitrate, salts, pesticides, and herbicides from agricultural and urban uses, which are managed by the Regional Water Quality Control Board, Irrigated Lands Regulatory Program, and Department of Pesticide Regulation.

Note that they are no known contaminated ground water plume of hazardous substances within the Big Valley Basin. These plumes of contaminated groundwater are typically caused when substances are released from a source such as an underground storage tank. If present, these plumes may be mobilized due to groundwater pumping.

4.7.1.2 Potential Effects

If groundwater quality is degraded to the point of an undesirable result, users would be negatively impacted. For drinking water users, high salinity would impact the water taste, color, and odor for both municipal and domestic wells. Domestic well users, particularly those who are economically disadvantaged, are more vulnerable as the cost for well treatment or alternative supplies may be prohibitive.

Degraded water quality would also have consequences for agricultural users. High salinity could damage crops and reduce yields, which could have associated economic impacts such as reduced agricultural acreage, reduced property value, job insecurity, and so on.

4.7.1.3 Identification of Degraded Water Quality

Seven wells were selected for identification of undesirable results to indicate region-wide impacts rather than localized conditions. Undesirable results are considered to occur during GSP implementation when 29 percent of the water quality RMS (two of seven sites) exceed the MTs for water quality for two consecutive measurements at the same sites. Exceedance at one RMS well may be due to localized conditions. Therefore, exceedance at two RMS is chosen as an indicator of broader basin wide trends. **Section 5** outlines an adaptive management triggers and actions when MTs at one or more RMS sites are approached.

4.7.2 Minimum Thresholds

The MTs for degraded water quality need to be protective of existing and potential beneficial uses and users in the Basin. The MTs focus is on constituent(s) with causal link to groundwater management rather than on the presence of naturally occurring constituents, or land use activities under the purview of other regulatory programs.

4.7.2.1 Description of Minimum Threshold

Based on the review of groundwater quality in **Section 2.2**, the constituent of concern for beneficial users in the Basin is TDS. TDS also allows for the monitoring for intrusion of deep saline and geothermal waters into the freshwater aquifers, which is major concern throughout Lake County. Therefore, TDS is being monitored as an overall indicator of groundwater quality within the Basin. The basis for establishing MTs is to minimize the additional contribution and migration of high concentrations of TDS. The MTs for TDS is 750 mg/L (**Table 4-6**).

This MT is lower than the upper secondary SMCL of 1,000 mg/L as set by SWRCB for taste and odor. Most crops grown in the Basin can tolerate water with a TDS of 750 mg/L without blending with surface water supplies. However, the GSA will continue to monitor TDS concentrations and changes in spatial or temporal trends to ensure MTs are not being exceeded and undesirable results are not being experienced by beneficial users. Available historical TDS measurements in the Basin are provided in **Appendix 2B-1**.

Table 4-6. Minimum Thresholds for Groundwater Quality

Grid Section	Well ID	Minimum Threshold (TDS mg/L)
North	14N09W32G002M	750
Northwest	13N09W08M003M	750
Northeast	13N09W03R001M	750
West-Central	13N09W18J001M	750
East-Central	13N09W15J001M	750
Southwest	13N09W29R001M	750
East-Central	1710007-007 (Well 8)	750

Key:
mg/L = milligrams per liter
TDS = total dissolved solid

4.7.2.2 Quantitative Measurement

Groundwater quality will be monitored for TDS on an annual basis at RMS (listed in **Table 4-6**). Other water quality constituents may also be collected but at a lower frequency. All measurements will comply with the data collection and quality control standard and procedures. The monitoring network and monitoring protocols are described in Section 3 (Monitoring Network and Monitoring Protocols for Data Collection).

4.7.2.3 Existing Local, State, or Federal Standards

The state upper SMCL for taste and odor is 1,000 mg/L. The recommended secondary MCL for drinking water standards is 500 mg/L[1].

[1] Secondary Drinking Water Standards (ca.gov)

4.7.3 Measurable Objectives

The MOs for minimizing the degradation of groundwater quality reflect the desired conditions and are based on maintaining groundwater quality at concentrations similar to historical observations in the Big Valley Basin.

The MOs for groundwater quality are set as the concentration of TDS of 500 mg/L (**Table 4-7**). This level represents the secondary MCL for drinking water standards, which is also protective of crop health and yields.

Interim milestones are set at the same levels as the MOs.

Table 4-7. Measurable Objectives for Groundwater Quality

Grid Section	Well ID	Measurable Objective (TDS mg/L)
North	14N09W32G002M	500
Northwest	13N09W08M003M	500
Northeast	13N09W03R001M	500
West-Central	13N09W18J001M	500
East-Central	13N09W15J001M	500
Southwest	13N09W29R001M	500
East-Central	1710007-007 (Well 8)	500

Key:
mg/L = milligrams per liter
TDS = total dissolved solid

4.8 Land Subsidence

This section described the MOs, MTs, and undesirable results for the sustainability indicator of land subsidence. Subsidence occurs when groundwater is extracted from the pore spaces in the geologic material, leading to compaction and permanent loss of storage space (i.e., inelastic land subsidence).

4.8.1 Undesirable Results

The undesirable result for land subsidence is a result due to groundwater extraction that causes a significant and unreasonable reduction in groundwater storage over the GSP planning and implementation horizon.

4.8.1.1 Potential Causes

As discussed in **Section 2.2.1.4**, there is no evidence of inelastic land subsidence in the Basin that results in permanent land compaction and loss of groundwater storage. Inelastic subsidence has not occurred for two reasons, the characteristics of the aquifer materials, and the lack of significant and prolonged groundwater extraction. Potential causes of future undesirable results for land subsidence likely would be tied to significant increases in groundwater extraction (which are not anticipated) resulting in dewatering of compressible clays in the subsurface. Clays are part of the aquifer materials; however, they do not appear to be predominant or laterally persistent, like the Corcoran Clay in San Joaquin Valley.

4.8.1.2 Potential Effects

If land subsidence conditions were to reach undesirable results, the adverse effects could potentially include a reduction in groundwater storage. Additionally, subsidence could cause damage to infrastructure, including buildings, roads, water conveyance facilities, and flood control facilities. Subsidence could have adverse effects to property values or public safety and/or could result in expenditures to mitigate these issues.

4.8.1.3 Identification of Land Subsidence

Six pixels that represent 100x100 meter squares were selected for identification of land subsidence that could lead to undesirable results. These pixels are near the six RMS for groundwater elevation. Undesirable results are considered to occur during GSP implementation when at least 50 percent (three of six) sites exceed the MTs over a five year period, and where it is demonstrated that inelastic subsidence occurred due to the lowering of groundwater elevations.

4.8.2 Minimum Thresholds

GSP regulations state that the MTs for land subsidence shall be the rate and extent of subsidence that substantially interferes with surface land uses and may lead to undesirable results. The Basin has experienced minimal levels of subsidence historically, and no dedicated subsidence monitoring network exits. Historical land surface elevation data from satellite imagery of subsidence were used to establish the land subsidence MTs. Subsidence monitoring in and adjacent to the Basin consists of InSAR satellite-based subsidence monitoring.[2] InSAR vertical displacement data is currently provided by DWR. The GSA anticipates that DWR will continue to provide this data in the future for use in GSP updates.

4.8.2.1 Description of Minimum Threshold

MTs were set at each of the six InSAR pixel locations near the RMS for groundwater levels. The MTs for subsidence are set to no more than 0.5 feet of cumulative subsidence over a five year period (beyond the measurement error), solely due to lowering of groundwater elevations. These MTs are listed in **Table 4-8**. Historical land surface elevation changes from 2015 to 2019 are shown on **Figure 4-8**.

Table 4-8. Minimum Thresholds Subsidence

InSAR Pixel	Grid Section	Associated State Well ID	Minimum Threshold (feet)
D8W3SQK	North	14N09W32G002M	-0.50
D8BV25P	Northwest	13N09W08M003M	-0.50
D8H7YN0	Northeast	13N09W03R001M	-0.50

[2] InSAR (Interferometric Synthetic Aperture Radar) is a technique for mapping ground deformation using radar images of the Earth's surface that are collected from orbiting satellites. For more information: https://pubs.usgs.gov/fs/2005/3025/2005-3025.pdf

InSAR Pixel	Grid Section	Associated State Well ID	Minimum Threshold (feet)
D82C4H5	West-Central	13N09W18J001M	-0.50
D8159A4	East-Central	13N09W15J001M	-0.50
D7I3DXN	Southwest	13N09W28J002M	-0.50

Key:
InSAR = Interferometric Synthetic Aperture Radar

Figure 4-8. InSAR Measured Vertical Displacements at the Representative Monitoring Network Site from 2015 to 2019

4.8.2.2 Quantitative Measurement

The quantitative metric for assessing compliance will be to continue to use vertical displacement data from InSAR at the individual pixels (**Table 4-8**) which will be obtained from DWR annually. This data will be appended to existing data and plotted. Both quantitative and qualitative assessments of the data will be performed to assess if any trends are apparent, and if the annual subsidence is greater than the MTs.

4.8.2.3 Existing Local, State, or Federal Standards

No federal, other state, or local standards exist for currently exist for subsidence reduction.

4.8.3 Measurable Objectives

California Natural Resources Agency's InSAR data has vertical accuracy of 18 mm (0.06 feet) at 95 percent confidence level.[3] To account for measurement error and typical elastic land subsidence, the MOs for subsidence are set to vertical displacements of no more 0.20 feet of cumulative subsidence over a five year period (beyond the measurement error), solely due to lowering of groundwater elevations. Interim milestones are set at the same levels as the MOs (**Table 4-9**).

Table 4-9. Measurable Objectives for Subsidence

InSAR Pixel	Grid Section	Associated State Well ID	Measurable Objective (feet)
D8W3SQK	North	14N09W32G002M	-0.20
D8BV25P	Northwest	13N09W08M003M	-0.20
D8H7YN0	Northeast	13N09W03R001M	-0.20
D82C4H5	West-Central	13N09W18J001M	-0.20
D8159A4	East-Central	13N09W15J001M	-0.20
D7FPNI8	Southwest	13N09W29R001M	-0.20

Key:
InSAR = Interferometric Synthetic Aperture Radar

4.9 Depletion of Interconnected Surface Water

As discussed in **Section 2.2.2.5**, there is a connection between groundwater aquifer and Kelsey and Adobe Creeks in Big Valley Basin. Both creeks are hydraulically connected during wet conditions (winter and spring), and less so during dry conditions (summer and fall). During dry conditions, Kelsey Creek downstream from Main Street bridge and all of Adobe Creek appear hydraulically disconnected. The integrated hydrologic model developed for the Big Valley Basin was used to estimate depletions at Kelsey and Adobe Creeks for the period 1985 to 2019 by comparing a baseline scenario representing current conditions with a "no pumping" scenario that removed all groundwater extraction in the Basin. The difference between the two scenarios is used to estimate the rate of surface water depletions due to groundwater extraction in the Basin.

Preliminary model results suggest that for Kelsey Creek, long-term annual depletions averaged 2.0 cfs (1,450 acre-feet/year), which represents 3.6 percent of the total Kelsey Creek flow. Kelsey Creek annual depletions fluctuates with wet and dry conditions and ranged from a high

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[3] https://data.cnra.ca.gov/dataset/tre-altamira-insar-subsidence

of 2.6 cfs (1,900 acre-feet /year) to a low of 0.7 cfs (5,000 acre-feet/year). The model estimates that most of the depletions in Kelsey Creek (72%) occurs downstream of the Main Street bridge, while 28 percent occurs upstream. These modeling results are consistent with the observed stream flow on Kelsey Creek. Average reduction in surface water flows between upstream and downstream gages Kelsey Creek is 2.2 cfs.

Preliminary model results suggest that for Adobe Creek, long-term annual depletions also averaged 2.0 cfs (14,500 acre-feet /year), which represents 5.5 percent of the total Adobe Creek flow. Adobe Creek annual depletions ranged from a high of 3.2 cfs (23,00 acre-feet /year) to a low of a 0.8 cfs (6,000 acre-feet/year).

4.9.1 Undesirable Results

The undesirable results for depletions are conditions that causes significant and unreasonable adverse effects on beneficial uses of interconnected surface water within the Big Valley Basin over the GSP planning and implementation horizon.

4.9.1.1 Potential Causes

The potential causes of undesirable results are the same as those for chronic lowering of groundwater levels (see **Section 4.4.1**).

4.9.1.2 Potential Effects

If depletions of interconnected surface water were to reach undesirable results, the adverse effects could impact the identified potential GDEs in the basin. These potential GDEs include riparian ecosystems along the surface water bodies and aquatic species, especially the State listed threatened Clear Lake hitch. They may also adversely affect other beneficial uses of surface water.

4.9.1.3 Identification of Undesirable Results

Six wells in Big Valley Basin were selected for identification of undesirable results related to depletion of interconnected surface water. Undesirable results would occur when 33 percent (two of six wells) of RMS used to monitor depletion of interconnected surface water fall below their MTs for two consecutive years at the same sites, and where it can be established that GSA's groundwater management is the cause of the exceedance.

4.9.1.4 Justification of Groundwater Levels as a Proxy

The GSP regulations state that the MT metric for depletion of interconnected surface waters shall be a rate or volume of surface water depletion. However, the regulations also allow GSAs to use groundwater elevations as a proxy metric for any (or potentially all) of the sustainability indicators when setting MTs and MOs, provided the GSP demonstrates that there is a significant correlation between groundwater levels and the other metrics. The GSP regulations state that the MT "for chronic lowering of groundwater levels shall be the groundwater level indicating a depletion of supply at a given location that may lead to undesirable results" (CCR Title 23 § 354.28[c][2]).

The use of groundwater levels as a proxy metric for this sustainability indicator is usually justified by a significant correlation between groundwater levels and depletions of interconnected surface water. It is recognized that depletions are typically correlated with shallow groundwater, rather than with deeper groundwater zones. However, currently, the monitoring of shallow groundwater in Big Valley Basin is insufficient for this purpose. Shallow groundwater monitoring is a noted data gap and projects are proposed to address this gap.

In the interim, this GSP is using groundwater levels from available monitoring wells in the proximity of surface water gages as proxy for groundwater depletions. As discussed in **Section 2.2.2**, both groundwater elevations in the Basin, as well as surface water depletions, have fluctuated with periods of wet and dry conditions, but remained fairly stable over the past 30 years. Over the same period, the long-term health of the potential GDEs along the surface water bodies has remained stable (refer to **Section 2.2.3**). The use of this interim proxy is predicated on the assumption that significant changes in groundwater elevations outside the observed historical trend may also signify a change in the pattern of surface water-groundwater connectivity. This in turn would indicate a significant change in the volume of depletions beyond those observed historically.

As discussed in Section 2.2.3.4, the timing of the Clear Lake hitch migration typically coincides with high-flow events during spring when groundwater pumping is at a low level for irrigation at this time. The relative magnitude of observed and estimated depletions (1 to 3 cfs for Kelsey and Adobe Creek) show that depletions will have limited effect on stream flows (refer to **Figure 2-65** through **Figure 2-67**).

During spring, limited and intermittent groundwater extraction occurs for frost/freeze protection between mid-February through mid-May. Frost protection pumping is typically 8 to 10 hours over night and takes place up to 10 days during spring. Modeling results show that this limited pumping has no measurable effect on depletions. In addition, when comparing the downstream to the upstream spring flows on Kelsey Creek for the period 2013 to 2020, there are no apparent differences that would indicate sudden surface water reduction indicative of the frost protection impacts (refer to **Figure 2-68**). To assess potential localized impacts on streamflow due to frost protection, if any, would require additional detailed surface water and groundwater monitoring.

Two incidents of Hitch stranding were documented in Adobe Creek on May 23, 2014, and June 9, 2014 (CDFW, 2014). Inflows to Adobe Creek during those events were 0.1 and 0 cfs per the synthetic hydrology for Adobe Creek (Flow West, 2021). It should be note that actual flows in the creek during this period is likely higher due to releases from Highland Springs and Adobe Creek Reservoirs. However, there were no flow gauges downstream from these reservoirs. No documented reports of Hitch stranding in Kelsey Creek were available.

The current evidence shows that the pattern of historical depletions has remained relatively stable over the past 30 years. However, Clear Lake Hitch population counts, as reported by USGS (2021), have been declining over the last few years. Therefore, available evidence is not sufficient to establish a clear connection between groundwater depletions and the decline in Clear Lake Hitch populations.

Similar to chronic lowering of groundwater indicator, the interim MTs and MOs for this indicator are based on spring groundwater elevations and will be compared to spring groundwater elevations in the future. Spring groundwater levels are a good indicator of long-term groundwater basin health and are less affected by the erratic measurements due to localized effects of active groundwater pumping in the summer/fall. To remove potential outliers from observed measurements, data outside two standard deviations of the mean were identified and compared to other wells at the same time period. The comparison was made to confirm the identified outliers were not a response to drought stress.

4.9.2 Minimum Thresholds

4.9.2.1 Description of Minimum Threshold

MT for each of the surface water depletions RMS is defined as follows:

1. Lowest historical spring (April or March) groundwater level was identified. Since groundwater conditions in the basin has been relatively stable, this level has been identified as an acceptable lower limit given the observed long-term health of the GDE's (as discussed in **Section 2.2.3**).

2. Highest historical spring (April or March) groundwater level was identified. A margin of operational flexibility corresponding to 20 percent of the range between lowest and highest spring levels was calculated. This margin is used to adjust down the lowest historical spring groundwater level. This adjusted low spring level is intended to account for measurement uncertainties, severe extended drought periods, and effects of climate change.

3. The adjusted low spring level is capped to not exceed a depth of 30 feet below ground surface. The 30 feet depth represent the maximum root depth for GDEs to maintain access to shallow groundwater. The resulting modified low spring level is set as the MT.

Table 4-10 summarizes the developed MTs for each of the RMS for depletion of interconnected surface waters. All MTs for RMS are less than 30 feet bgs. **Figure 4-8** through **Figure 4-13** shows the relationship between the highest and lowest historical spring groundwater levels, MTs, and MOs for each RMS.

Table 4-10. Minimum Thresholds for Depletion of Interconnected Surface Water

Location	State Well ID	Minimum Threshold (Elevation feet, NAVD88)	Minimum Threshold (feet bgs)
Adobe Creek, near Bell Hill Rd	13N09W19J001M	1395.8	17.6
Adobe Creek, near Argonaut Rd	13N09W09D005M	1337.0	24.6
Adobe Creek, near Soda Bay Rd	14N09W33K001M	1323.5	15.5
Kelsey Creek, near DWR KCK gage	13N09W02C002M	1318.5	30.0
Kelsey Creek, 1.5 mile downstream of Highway 29	13N09W03R001M	1337.0	24.3
Kelsey Creek, near Highway 29	13N09W15B002M	1352.7	26.8

Key:
bgs = below ground surface

4.9.2.2 Quantitative Measurement

The quantitative measurement will be the annual spring measurements taken April at the RMS wells. The data obtained will be appended to existing data to generate hydrographs for the wells. These hydrographs will be analyzed annually for changing trends in water elevations and compared to established MTs to ensure they are not exceeded.

4.9.2.3 Existing Local, State, or Federal Standards

No current local, other state, or federal standards currently exist for this indicator.

4.9.3 Measurable Objectives

MOs are quantitative goals that reflect the basin's desired groundwater conditions. If the GSA successfully manages groundwater extraction that results in the achievement of the MOs described, the Basin will be operating sustainably.

The MOs were established to reflect that groundwater elevations in the Basin have been stable over the available historical record. Therefore, the MOs are set as the average historical spring groundwater elevation at each RMS site. The defined MOs target maintenance of current conditions in the basin, while providing margin of operational flexibility for dry and wet periods. The MOs are listed in **Table 4-11** and illustrated on **Figure 4-9** through **Figure 4-14**.

Interim milestones are set as the same as the MOs.

Table 4-11. Measurable Objectives for Depletion of Interconnected Surface Water

Location	State Well ID	Measurable Objective (Elevation feet, NAVD88)	Measurable Objective (feet bgs)
Adobe Creek, near Bell Hill Rd	13N09W19J001M	1,405.8	7.6
Adobe Creek, near Argonaut Rd	13N09W09D005M	1,351.9	9.7
Adobe Creek, near Soda Bay Rd	14N09W33K001M	1,331.2	7.8
Kelsey Creek, near DWR KCK gage	13N09W02C002M	1,332.1	16.4
Kelsey Creek, 1.5 mile downstream of Highway 29	13N09W03R001M	1,345.4	15.9
Kelsey Creek, near Highway 29	13N09W15B002M	1,359.9	19.7

Key:
bgs = below ground surface

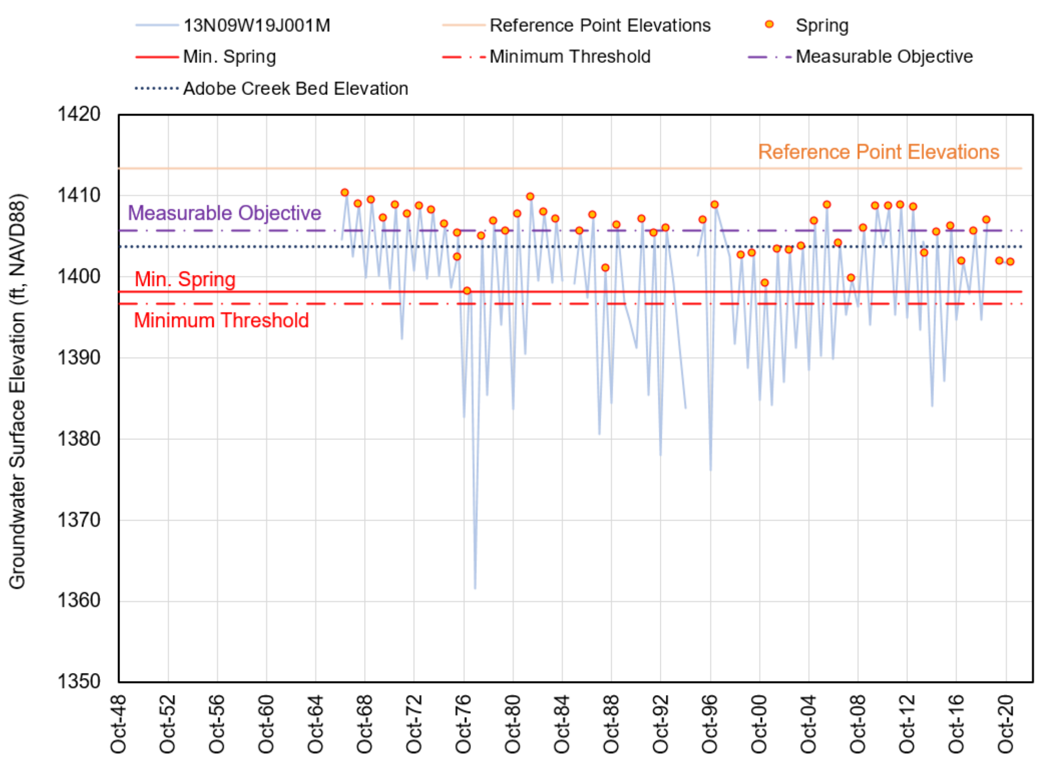

Figure 4-9. Spring Groundwater Elevations, Minimum Threshold and Measurable Objective for Representative Monitoring Network Site 13N09W19J001M

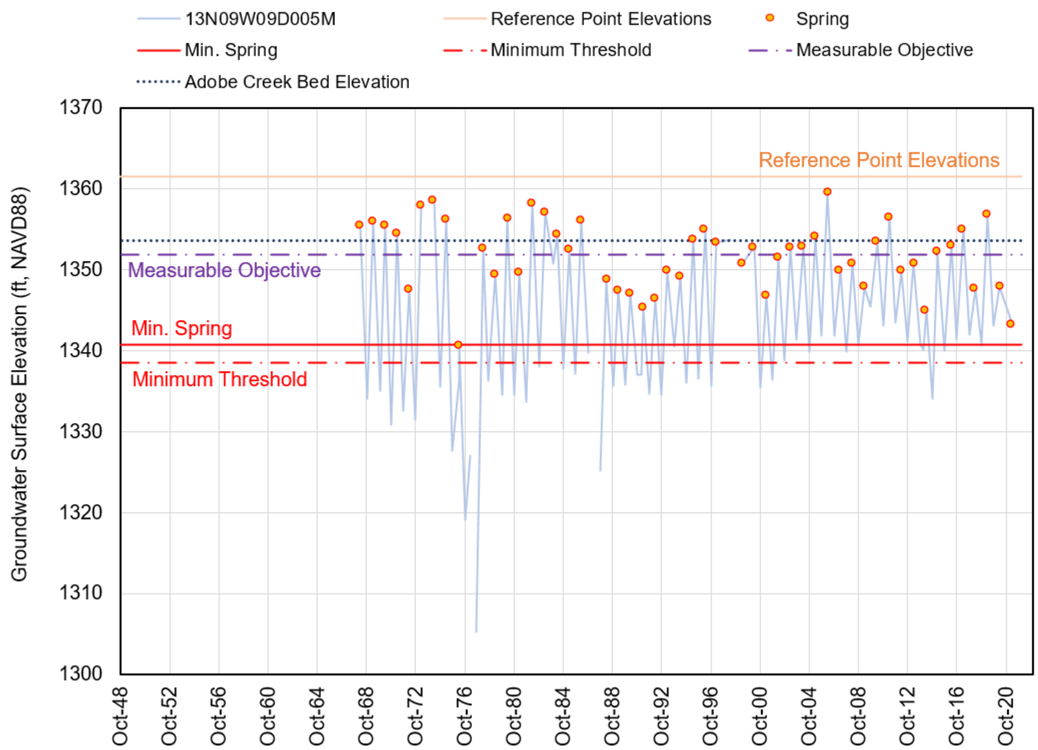

Figure 4-10. Spring Groundwater Elevations, Minimum Threshold and Measurable Objective for Representative Monitoring Network Site 13N09W09D005M

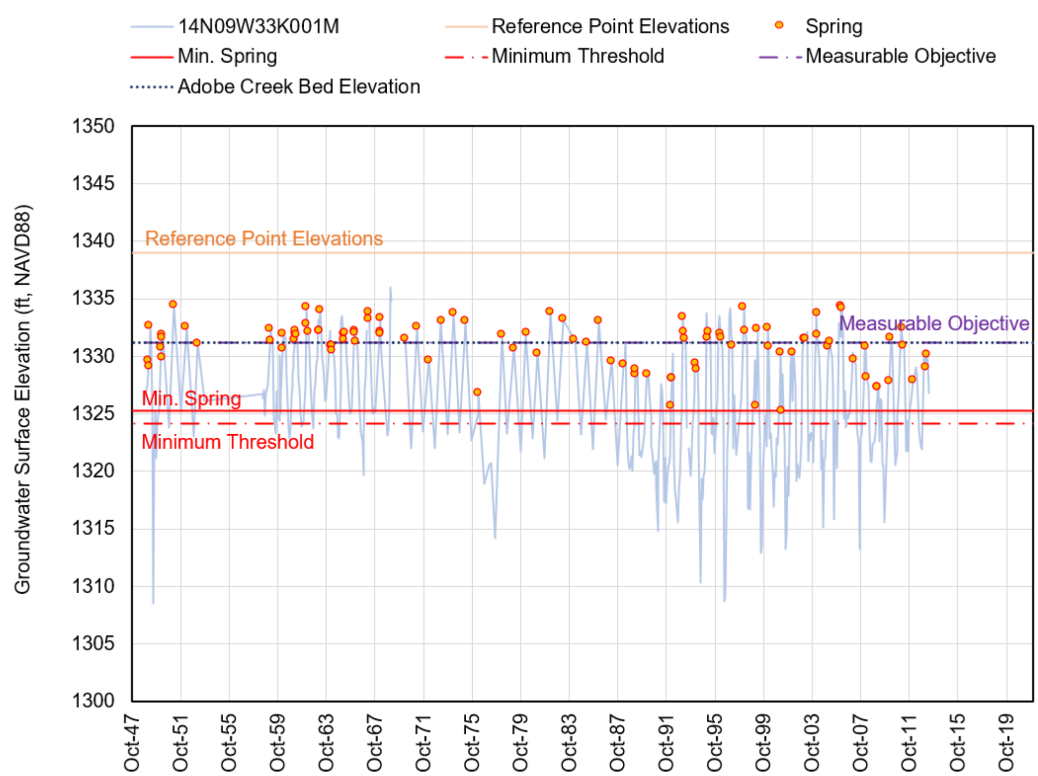

Figure 4-11. Spring Groundwater Elevations, Minimum Threshold and Measurable Objective for Representative Monitoring Network Site 14N09W33K001M

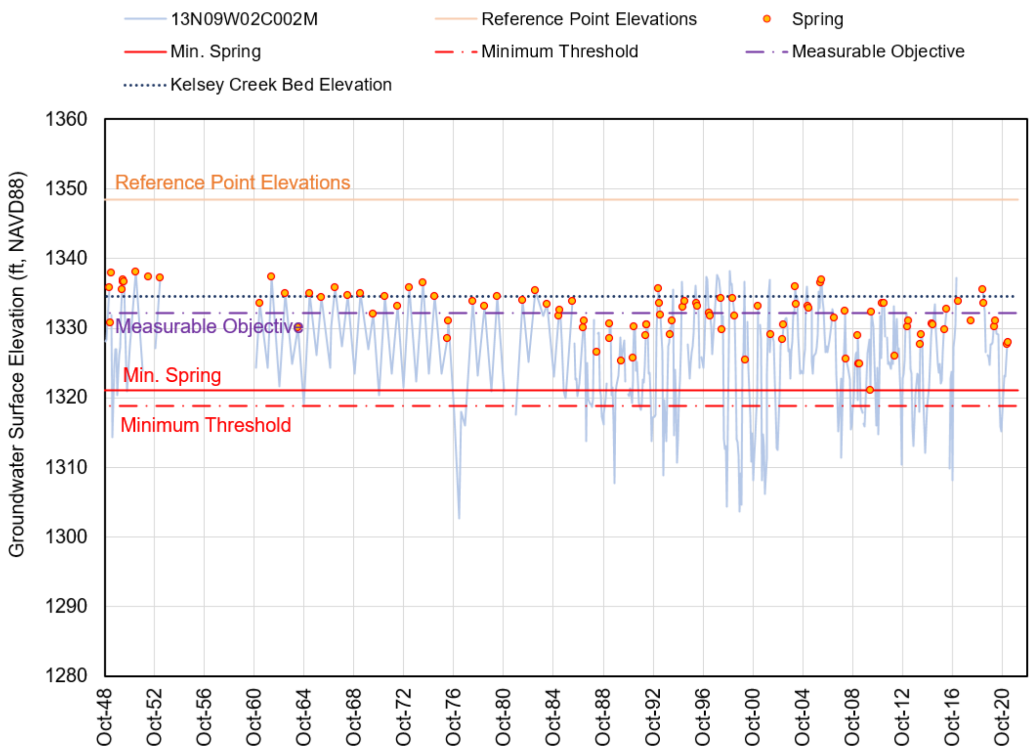

Figure 4-12. Spring Groundwater Elevations, Minimum Threshold and Measurable Objective for Representative Monitoring Network Site 13N09W02C002M

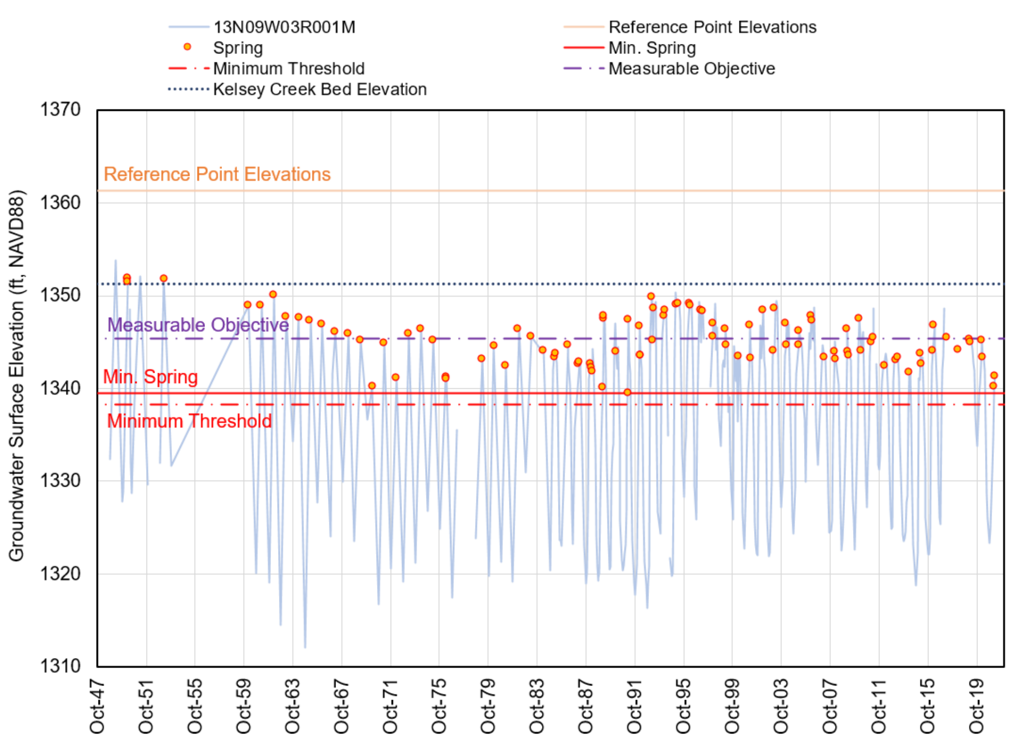

Figure 4-13. Spring Groundwater Elevations, Minimum Threshold and Measurable Objective for Representative Monitoring Network Site 13N09W03R001M

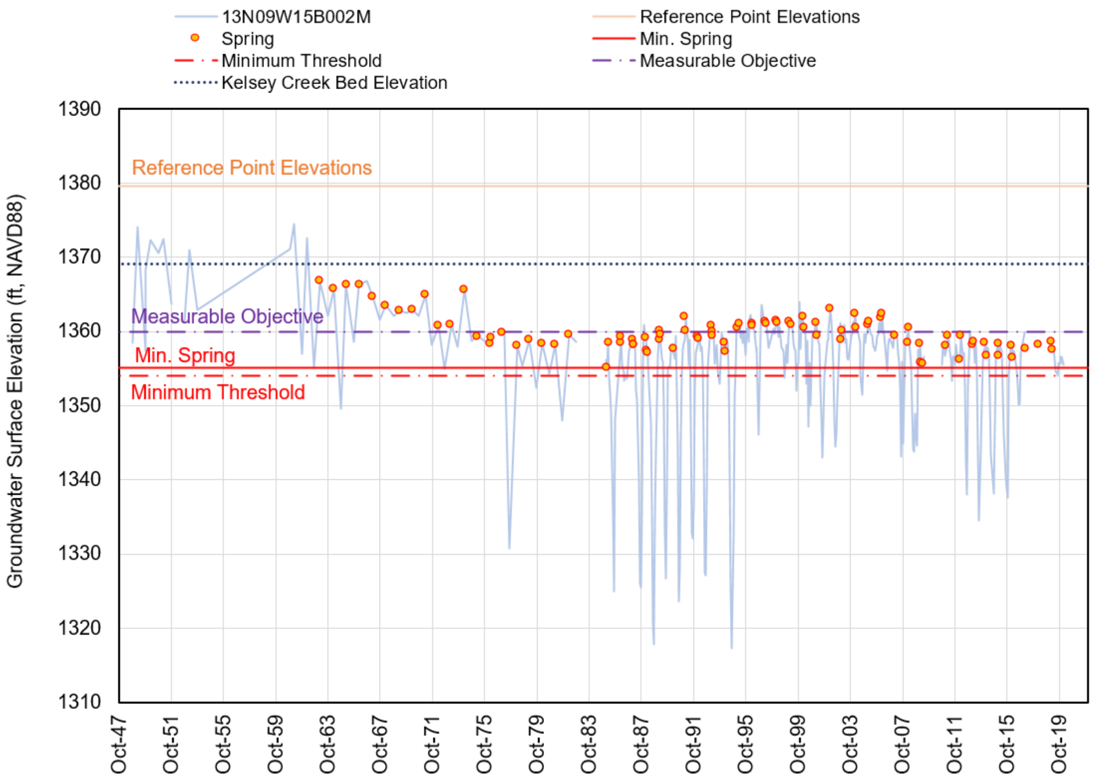

Figure 4-14. Spring Groundwater Elevations, Minimum Threshold and Measurable Objective for Representative Monitoring Network Site 13N09W15B002M

4.10 Impact to Adjacent Basins

The MTs and MOs established at the Big Valley Basin are not expected to impact the neighboring Scotts Valley Basin. The hydrogeologic model includes the neighboring Scotts Valley Basin. The predicted future conditions in the Scotts Valley Basin were accounted for when determining MTs in the Big Valley Basin. Therefore, MTs in Big Valley Basin are not likely to have adverse impacts on the neighboring Scotts Valley Basin.

4.11 Impacts on Beneficial Users

The MTs and MOs established for the sustainability indicators that are present in the Basin may have several effects on beneficial users and land use in the Basin. The Big Valley Basin has not been fully developed and its extraction potential has yet to be realized. Since MTs have been set at water levels previously experienced in the Basin, they are not anticipated to cause adverse impacts to existing uses. Historical water level trends, future water level projections, and impacts to domestic wells were all considered when establishing MTs. If MTs are exceeded for two (2) consecutive spring readings, Projects and Management Actions (PMA) will be implemented to address underlying causes and mitigate undesirable results. In addition, adaptive management actions would be triggered as MTs are being approached to proactively implement corrective actions to prevent MTs from being exceeded.

4.12 Management Areas

Management areas have not been established in the Basin.

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5. PROJECTS AND MANAGEMENT ACTIONS TO ACHIEVE SUSTAINABILITY GOAL

5.1 Introduction

This section of the GSP describes PMAs identified to support the GSP in achieving and maintaining its sustainability goal and to avoid undesirable results over the GSP planning and implementation horizon, in accordance with the GSP Regulations (Cal. Code of Regs, Title 23 § 354.44). The Big Valley Basin sustainability goal, defined in **Section 4**, is "*sustainable management of the groundwater resources of the Big Valley Basin for the long-term community, environmental, and economical benefits of existing and future residents and businesses in the Basin.*" In this GSP, the term *management actions* generally refers to activities that support groundwater sustainability without infrastructure, and projects are activities supporting groundwater sustainability that require infrastructure and associated permitting processes to implement (e.g., CEQA).

5.2 Process for Identifying and Developing Projects and Management Actions

The PMAs for Big Valley Basin were identified using a variety of sources. The GSA began the PMA development process by soliciting input from the GSP Advisory Committee (GSPAC). Several PMAs address data gaps and a need for improved basin characterization described in previous sections, and others are opportunities for water supply augmentation or demand management.

Additionally, reports such as the "Big Valley Ground Water Recharge Investigation Update" (Lake County 2003), "Adobe Creek Conjunctive Use Project Feasibility Study" (Lake County 2002), "Clear Lake Integrated Regional Water Management Plan" (Lake County 2010), and "Water Resources Climate Adaptation Plan on Adobe Creek for the Recovery of Hitch *Lavinia Exilicauda Chi* in Clear Lake" (FlowWest 2020) were taken into consideration.

The PMAs included in this section are at various stages of development. Some are relatively new ideas brought forth through the GSPAC; others are well-documented, long-standing ideas for Big Valley Basin. PMAs included in this section are based on the best available information and the best available science documented in previous sections; though, for most PMAs, many details remain to be determined before they can be implemented.

As demonstrated in **Sections 2** and **4**, Big Valley Basin shows no indication of historical, current, or projected overdraft, including climate change considerations. As such, there are no projects or management actions that are required to achieve sustainability. However, PMAs can assist in enhancing management capability, improving the understanding of the groundwater system, achieving measurable objectives related to relevant sustainability indicators, and allowing the GSA to respond to unexpected future changes in conditions in Big Valley Basin so that undesirable results can be prevented.

To help prioritize the PMAs, a tiered structure was established. There are three tiers and one adaptive management tier, summarized in **Table 5-1**. Each tier includes a lead entity responsible for overseeing the activity, a PMA's certainty of implementation, and its purpose.

Table 5-1. Projects and Management Actions Tiers

Tier	Lead Entity	Certainty of Implementation	Purpose
Tier 1A	GSA	Will be implemented in full	To reach sustainability
Tier 1B	GSA	Will be implemented (extent dependent on resource availability)	To otherwise comply with SGMA, fill data gaps, and support GSA operations
Tier 2	GSA or stakeholder	May be implemented (if resources are available)	To improve management, contribute to achieving measurable objectives
Tier 3	Stakeholder (GSA will coordinate with)	May be implemented	To support wider water management in the basin, for PMAs outside of the purview of the GSA
Adaptive Management Tier	GSA	Will be implemented only if triggers indicate their necessity	To be prepared if minimum thresholds are approached, or there are localized concerns

Key:
GSA = Groundwater Sustainability Agency
SGMA = Sustainable Groundwater Management Act

Tier 1 is the only tier containing PMAs that will be implemented; PMAs in other tiers may be implemented on an as-needed basis, pending funding and resource availability, or determined by GSA with guidance from the GSPAC. Tier 1 PMAs fall within the powers and authorities of a GSA under SGMA. Tier 1 PMAs are described in the most detail, including all information outlined in the GSP Regulations (CCR Title 23 § 354.44[b]). PMAs in Tier 2 and Tier 3 are generally less developed, have less available information, and are not prioritized for implementation. Additional details for those PMAs will be developed as needed.

In addition to the tiers, the PMAs were sorted into six categories:

1. Monitoring and data management
2. Education and outreach
3. Demand management
4. Water quality improvement
5. Water supply augmentation
6. Habitat restoration

These categories are provided to summarize the types of PMAs that the GSA will or may implement.

5.3 Tier 1 Projects and Management Actions

Tier 1 PMAs are those that will be GSA-led and are prioritized for implementation. Tier 1 is divided into two sub-tiers: Tier 1A, PMAs required to reach sustainability, and Tier 1B, PMAs required to comply with SGMA and support GSA operations. As **Sections 2** and **4** demonstrate, Big Valley Basin is currently managed sustainably. As such, there are no Tier 1A PMAs identified as of November 2021. However, there are several Tier 1B PMAs identified to help the GSA improve monitoring, better understand and characterize the basin, and better engage and communicate with stakeholders. Tier 1B PMAs will be implemented at least in part, and the extent to which they will be implemented will be dependent on available funding and will be a decision by the GSA with guidance from the GSPAC. See **Table 5-2** for a summary of Tier 1B projects. These PMAs are further described in the sections below.

Table 5-2. Tier 1B Projects and Management Actions

Name	Project Category	Description	Cost Estimate*
Expand Well Monitoring Network and Data Collection	Monitoring and data management	This project involves installing multi-completion wells throughout the basin and adding telemetry to the RMS Network. The purpose of this project is to improve the basin characterization, enhance data collection, and support water management.	up to $420,000
Improve understanding of relationships between surface water and groundwater elevations	Monitoring and data management	This project is intended to quantify the groundwater-surface water interaction across the basin. The project may involve installation of stream gauges, increased frequency of groundwater elevation data collection, and analyses (e.g., pump tests) to quantify surface water – groundwater interaction.	$20,000 - $70,000 per year, and $100,000 one-time cost
Conduct RMS wells baseline water quality survey	Monitoring and data management	This project involves quarterly monitoring of water quality RMS wells for two years to establish current baseline conditions. The purpose of this project is to monitor groundwater quality such that it remains usable by all beneficial users and complies with SGMA requirements.	$80,000
Update and Refine the Big Valley Integrated Hydrologic Model	Monitoring and data management	This project involves incorporating additional information from the AEM survey, groundwater level data, and streamflow data to update and improve the BVIHM. The purpose of this project is to improve basin characterization and water management.	$50,000 - $150,000

Table 5-2. Tier 1B Projects and Management Actions (contd.)

Name	Project Category	Description	Cost Estimate*
Develop Domestic Well Management Program	Improved basin characterization	This is a multi-part project that consists of a domestic well inventory, education and outreach, coordination on the dry well reporting system, and a well mitigation program. The purpose of these projects is to mitigate impacts to domestic well owners and users.	$75,000 - $100,000
Create a permanent Big Valley GSA website	Education and outreach	The GSA website would be a repository for resources related to GSP implementation, as well as GSA meetings and outreach material. The purpose of this project is to comply with SGMA and educate and inform the public.	$3,000- $5,000
Conduct public outreach consistent with the Communication and Engagement Plan	Education and outreach	The Communication and Engagement Plan identifies and describes several outreach activities. The objective of this project is to satisfy SGMA requirements, inform and educate the public, and obtain local input.	$45,000 per year

Note:

* The cost estimates are based on similar projects from other published GSPs. These costs may be further refined during GSP implementation.

Key:
AEM survey = Airborne Electromagnetic survey
BVIHM = Big Valley Integrated Hydrologic Model
GSA = Groundwater Sustainability Agency
GSP = Groundwater Sustainability Plan
RMS = representative monitoring site
SGMA= Sustainable Groundwater Management Act

5.3.1 Expand Well Monitoring Network and Data Collection

Section 2 identified several groundwater data gaps that resulted in inconclusive analyses about the connection between surface water and groundwater, impacts on the beneficial uses of groundwater, and poor definition of conditions in the east-central portion of the basin. These issues could be addressed through expanding the monitoring network and data collection.

This project proposes to expand the well monitoring network to improve the understanding of the hydraulic conditions within the Basin. The use of multiple completion wells could meet this objective and reduce the number of locations required compared to installation of traditional wells.

A multiple completion monitoring well with one or more shallow screen interval(s), or a separate shallow monitoring well, would help improve the understanding of stream-aquifer interaction and interbasin flows. Multi-completion well locations will be identified based on recommendations by a hydrogeologist with expertise in assessing surface water and groundwater interactions, with an emphasis on locations near streams. This is particularly important to be implemented adjacent to the gauge stations on Adobe Creek and Kelsey Creek.

As of November 2021, the GSA is in the process of applying for DWR TSS to install at least one multiple-completion monitoring well. The GSA, in coordination with hydrogeology experts and the GSPAC, is currently in the process of choosing the location, and the well(s) is (are) planned to be installed in 2022, pending DWR funding approval.

An additional activity that could help improve the monitoring network would be adding telemetry to the RMS monitoring system, allowing for more frequent measurements without additional labor costs. Installation of telemetry or data transmission from a remote source to a database on RMS wells would minimize the number of trips to collect high temporal resolution data.

5.3.1.1 Relevant Measurable Objectives

Implementation of this project would allow for more informed progress toward measurable objectives for the chronic lowering of groundwater, groundwater storage, and depletion of interconnected surface water.

5.3.1.2 Expected Benefits and Evaluation of Benefits

The purpose of this project is to better characterize hydrogeologic conditions in the Big Valley Basin. A thorough well monitoring program would help improve the understanding of groundwater conditions and of the relationship between the surface water depletion and groundwater elevation. An expanded well monitoring network would allow for more informed decision-making to protect beneficial uses and users of groundwater in the Big Valley Basin.

5.3.1.3 Circumstances for Implementation

This project involves installing new multi-completion well(s) and adding telemetry to groundwater level RMS wells. Data gaps will be filled based on available funding and level of need and may be filled over the full implementation period of the GSP.

5.3.1.4 Public Noticing

Information about this project will be shared with interested parties through the GSA's interested parties e-mail list, will be posted on the GSA webpage, and information will be posted at County offices. Specific coordination will be carried out to identify monitoring well locations, prioritizing County-owned land and also considering siting on a GSPAC members' land, if they are willing and interested.

5.3.1.5 Permitting and Regulatory Process

Required permitting and regulatory review will be initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include but is not limited to: Lake County (various departments), DWR, SWRCB, CDFW, RWQCB, and U.S. Fish and Wildlife Service (USFWS).

5.3.1.6 Implementation Schedule

The start and completion dates for this activity have yet to be determined and will be provided in GSP annual reports and five-year updates when known.

5.3.1.7 Legal Authority

The GSA has the authority to plan and implement studies related to groundwater management.

5.3.1.8 Estimated Cost

This activity is currently in the early planning stage and only high-level cost estimates can be provided at this time. The estimated cost per multi-completion well is approximately $100,000, though this estimate will need to be refined based on well location and subsurface geological conditions. For installation of multi-completion wells, one well per basin quadrant would substantially improve data availability and basin characterization, with specific attention to siting wells to allow for more insight into and quantification of the relationship between groundwater and surface water. Additionally, adding telemetry to groundwater-level RMS wells is estimated to cost $20,000 total for all wells.

The high-level estimate for implementing this project is up to $420,000, if four deep multi-completion wells were installed, and telemetry were added to the groundwater level RMS wells. The number of multi-completion wells installed will depend on availability of funds, either from grants and direct support (i.e., DWR TSS) or from GSP implementation fees, and decisions about number of multi-completion wells will be made by the GSA with input and guidance from the GSPAC. At the time of GSP development, the GSA is in the process of applying for TSS support to install at least one multi-completion well, which would reduce the local cost of implementing this project in full by at least $100,000.

Available grants and technical assistance will be sought to fill data gaps, to limit the local financial burden for the GSA. These grants may include the TSS, and other grant opportunities administered by DWR.

5.3.2 Improve Understanding of Interconnected Surface Water

Improving understanding of the interaction between groundwater and surface water was identified as a GSA priority. The purpose of this project action is to better understand the basin characteristics, help meet measurable objectives and avoid undesirable results related to depletions of interconnected surface water, improve overall water management, and better understand how to protect the Clear Lake hitch habitat. As discussed in **Section 2**, the Clear Lake hitch migrate and spawn in mid-February to May and occasionally into June, making even short-term depletions of interconnected surface water during this period a concern in Big Valley Basin.

This project action is intended to better quantify the groundwater-surface water interaction across the basin, with emphasis on Adobe and Kelsey Creeks as two streams of high interest for which existing streamflow data exist. The project may involve many activities, outlined below.

This project would be carried out in coordination with other related projects such as the Expand Well Monitoring Network and Data Collection and Update and Refine the BVIHM.

5.3.2.1 Expand Monitoring of Streamflow Measurements on Kelsey Creek and Adobe Creek

There are a limited number of gauges on Adobe Creek and Kelsey Creek and no gauges on the other streams in Big Valley Basin. This activity could include installing an additional gauge on

Kelsey Creek and additional gauges on Adobe Creek (particularly downstream of the reservoirs). The Big Valley Band of Pomo Indians was awarded a grant in 2021 to install two gauges—one at the Highland Springs Reservoir outlet and one at Adobe Creek Reservoir outlet. The GSA could coordinate information sharing and other responsibilities, including potential maintenance and operations costs or support, as it relates to these new gauges.

The GSPAC also discussed potentially installing one gauge on McGaugh Slough, but a GSPAC member voiced concern that a McGaugh Slough is dry most of the year, and thus, a streamflow gauge might not be a worthwhile investment.

The GSA could also work with the United States Geological Survey (USGS) and DWR to calibrate and restore the existing streamflow gauge on Adobe Creek and Highland Springs Creek upstream of the reservoirs—neither of which have not collected data since the 1970s—to allow for additional, reliable streamflow measurements and water temperature information.

5.3.2.2 Expand Frequency of Groundwater Elevation Data

The California Statewide Groundwater Elevation Monitoring (CASGEM) program currently tracks seasonal and long-term elevation trends in groundwater basins. CASGEM requires monitoring at all designated CASGEM monitoring wells to be include measurements for the yearly high and low for the basin, usually spring and fall, and also acts as a repository for additional groundwater elevation data from “Voluntary Wells” for which well construction information and other data required of CASGEM monitoring wells might not be available. FlowWest (2020) identified 17 Voluntary Wells within a half-mile of Adobe Creek and includes a recommendation to coordinate with Voluntary Well owners to increase monitoring frequency. This activity would increase monitoring frequency for Voluntary Wells near Adobe Creek and Kelsey Creek to increase temporal resolution of groundwater elevation data.

5.3.2.3 Investigate Impact of Near-Creek Pumping on Streamflow

This activity could include conducting pumping tests on wells near streams of interest to investigate and quantify potential surface water depletion, as well as analyses of the additional data that will be made available by implementation of other PMAs. Pumping tests would be conducted outside of the hitch migration period.

5.3.2.4 Relevant Measurable Objectives

Implementation of this project would allow for more informed progress toward measurable objectives for depletion of interconnected surface water, such that surface water remains usable by all beneficial users.

5.3.2.5 Expected Benefits and Evaluation of Benefits

The purpose of this project is to better characterize potential interconnectedness of groundwater and surface water in the Big Valley Basin and in particular at Adobe and Kelsey Creeks. Specifically, obtaining high temporal resolution groundwater elevation data alongside frequent streamflow measurements could yield more detailed insight about short-term fluctuations in the groundwater elevation and streamflow, including potential impacts of groundwater pumping for frost protection on streamflow, especially during the migration and spawning season of the Clear Lake hitch. Gathering these data can help to inform decision-making to avoid depletion of interconnected surface waters and can benefit environmental users of surface water.

5.3.2.6 Circumstances for Implementation
This overall project is already underway, with the compilation of existing streamflow and groundwater elevation data for the BVIHM and for the definition of groundwater conditions. The GSA, in coordination with the GSPAC, will decide whether to implement specific activities described above if there is active support from relevant parties (e.g., landowners, well owners, USGS, DWR) and funding.

5.3.2.7 Public Noticing
Information about this project will be shared with interested parties through the GSA's interested parties e-mail list, posted on the GSA webpage, and posted at County offices.

Coordination with owners of adjacent land will be carried out to explore opportunities for streamflow gauge installation in specific locations. Coordination with well owners will be carried out to arrange timing for groundwater level measurement events, and to share results.

5.3.2.8 Permitting and Regulatory Process
Required permitting and regulatory review will be initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include, but is not limited to: Lake County (various departments), DWR, SWRCB, CDFW, RWQCB, and USFWS.

5.3.2.9 Implementation Schedule
Some of the activities outline above are already underway. For example, the Big Valley Rancheria Band of Pomo Indians is currently working towards the installation of the reservoir outlet gauges. The implementation of other activities, however, is funding dependent and thus do not have an estimated schedule at the time of this GSP development.

5.3.2.10 Legal Authority
Data management, improvements to the BVIHM, and some monitoring improvements would be led by the GSA, while the Big Valley Band of Pomo Indians and FlowWest may implement more monitoring improvements. The GSA has the authority to plan and implement monitoring and data collection efforts.

5.3.2.11 Estimated Cost
Cost would be determined based on specific activities that the GSA proceeds with. Installation and operation of a stream gauge station would cost approximately $15,000 per year. Carrying out more frequent monitoring would cost approximately $1,000 per year per well for labor to measure groundwater level. A high-level range of costs to augment the available data and better understand interaction between groundwater and surface water is $20,000–$70,000 per year. Additionally, conducting pumping tests and analyzing resulting data is estimated to have a one-time cost of approximately $100,000.

Available grants and technical assistance will be sought to fill data gaps to limit the local financial burden to the GSA. These grants may include TSS and grant opportunities administered by DWR.

5.3.3 Conduct RMS Wells Baseline Water Quality Survey

Lack of recent data to form a comprehensive baseline for groundwater quality is a data gap for the monitoring program, as described in **Section 3**. Several water quality parameters, including nitrate and TDS, have been identified by stakeholders and the GSA as needing expanded monitoring to improve characterization of the Big Valley Basin. Nitrate is an important water quality indicator for human health, while TDS is generally regarded as an aesthetic concern for drinking water.

This project involves quarterly monitoring of the seven groundwater quality RMS wells for a period of two years to establish current baseline conditions in the Big Valley Basin. Once baseline monitoring is complete, annual groundwater quality monitoring will occur during the October water level monitoring event. EC, arsenic, nitrate, boron, and TDS will be included in water quality analysis for baseline and continued annual monitoring; however, only EC is managed under this GSP.

5.3.3.1 Relevant Measurable Objectives

Implementation of this project would allow for more informed progress toward measurable objectives for groundwater quality, such that groundwater remains usable by all beneficial users.

5.3.3.2 Expected Benefits and Evaluation of Benefits

The purpose of this project is to better characterize groundwater quality of the Big Valley Basin. More comprehensive baseline groundwater quality monitoring will help characterize seasonal and long-term water quality trends. A groundwater quality baseline would allow for more informed decision-making to protect beneficial uses and users of groundwater, especially drinking water users, in the Big Valley Basin.

5.3.3.3 Circumstances for Implementation

This project will be implemented as soon as funding is available to implement.

5.3.3.4 Public Noticing

Information about this project will be shared with interested parties through the GSA's interested parties e-mail list, will be posted on the GSA webpage, and information will be posted at County offices.

Specific coordination with groundwater quality RMS well owners will be carried out to arrange timing for sampling events, and to share results.

5.3.3.5 Permitting and Regulatory Process

No permitting or regulatory requirements are anticipated to implement this management action.

5.3.3.6 Implementation Schedule

Quarterly monitoring of the seven groundwater quality RMS wells will be carried out for a period of two years, starting when funding is available.

5.3.3.7 Legal Authority

This effort would be led by the GSA. The GSA has the authority to plan and implement monitoring and data collection efforts.

5.3.3.8 Estimated Cost

Estimated overall cost for this project is approximately $80,000. This estimate assumes that each quarterly sampling event will cost approximately $10,000 for laboratory analytical fees, field labor to collect samples, labor to coordinate with well owners, and labor to process results received from the laboratory for all seven groundwater quality RMS wells.

The GSA will explore funding opportunities for this project, including grants and technical support services from DWR, but it is possible that this project will need to be carried out using GSP implementation fees. The estimated cost for this project is thus included in the estimate of GSP implementation costs provided in **Section 6**.

5.3.4 Update and Refine the Big Valley Basin Integrated Hydrologic Model

As part of initial GSP development, the GSA developed the BVHIM. Through the GSP implementation process, the model will be updated and refined with newly collected data to both fill data gaps and update existing datasets. Updates to the model are required to maintain the BVIHM as a useful water resources management tool.

Specifically, additional data are needed to characterize groundwater-surface water interaction. This data collection effort is another PMA, described above in **Section 5.2.2**. Information from that project would then be integrated into the BVIHM.

In addition to data related to groundwater-surface water interaction, the BVIHM will be updated with AEM survey data collected by DWR. The AEM flights occurred in November 2021 and the data will be ready for integration into the BVIHM in mid-2022. The AEM data will help refine the hydrogeologic understanding of the basin. This can then be used to help determine potential recharge areas, as well as help define basin boundaries with Scotts Valley Basin and with Clear Lake.

5.3.4.1 Relevant Measurable Objectives

The model is used to develop the water budget and sustainable yield, which all SMCs are tied to. Updates and refinements to the BVIHM would help understand progress toward all measurable objectives, especially the measurable objective for depletion of interconnected surface water.

5.3.4.2 Expected Benefits and Evaluation of Benefits

The purpose of this project is to enhance the model that is used as the basis for the water budget and sustainable yield. Through updates and refinements, the model's accuracy will improve. This can help inform improved groundwater management, which may positively impact beneficial users of groundwater, particularly environmental users.

5.3.4.3 Circumstances for Implementation

The GSA will implement updates and refinements to the BVIHM every five years as a part of GSP implementation (see **Section 6**). However, part of the data collection process, the AEM survey, is already underway. New data will be incorporated into the BVIHM every five years or more frequently if funding is available.

5.3.4.4 Public Noticing

The data used to update the model will be incorporated into the County's data portal with an accompanying notice. The model results will be included in the five-year GSP update that has an established set of public notice procedures.

5.3.4.5 Permitting and Regulatory Process

There are no known permitting or regulatory processes necessary to update the BVIHM.

5.3.4.6 Implementation Schedule

The GSA will update the BVIHM annually and make interim updates as information becomes available. The GSA will present the updated model in the GSP five-year update.

5.3.4.7 Legal Authority

The GSA has the authority to carry out updates and refinements to the BVIHM. The GSA would lead this effort, with support from DWR.

5.3.4.8 Estimated Cost

The BVIHM update would cost an estimated $50,000 to $150,000 each time it is revised for the five-year GSP update, though level of effort may decrease after larger model improvements are made for early GSP updates. Estimated level of effort and cost for upcoming model updates will be included in each five-year GSP update. The source of this funding could be GSP implementation fees or a grant.

5.3.5 Develop Domestic Well Management Program

In 2021, some households reliant on domestic wells reported dry wells in Big Valley Basin. It is important to identify the reason why these wells have gone dry. Development of a domestic well management program is aimed at better understanding domestic well issues in Big Valley Basin and protecting drinking water well users from potential impacts to changing groundwater levels or quality. Activities that could be part of this program include a domestic well inventory, coordination with DWR'S Household Water Supply Shortage Reporting System, outreach and engagement, and a domestic well mitigation program, described below.

These activities would be developed in accordance with, and guided by, the state's Groundwater Management Principles & Strategies to Monitor, Analyze, & Minimize Impacts to Drinking Water Wells Framework. In particular, this domestic well management program is based on Strategy 1.5 to "Ensure long-term groundwater sustainability planning and implementation, including projects and actions supporting drinking water well users, can minimize the impacts of future droughts, through the implementation of SGMA" (DWR and SWRCB 2021). The activities described below are meant to position the GSA to be knowledgeable of potential domestic well impacts and ready to help support short-term and long-term solutions to protect drinking water users in the face of drought.

5.3.5.1 Domestic Well Inventory

Recognizing that some domestic wells are shallower than the MT, the compilation of additional data into a Domestic Well Inventory is essential. The inventory is meant to better characterize domestic wells and will include information on well location, construction, and use. The GSA will compile publicly available data from DWR's Online System for Well Completion Report Database, County Well Permit Database, County Assessor parcel data, and census data.

While DWR's Online System for Well Completion Report Database and the County's Well Permit Database have data on well presence, location, and some construction information, these databases are generally known to be incomplete, and locations given are not precise. As such, the County Assessor parcel data and census data can be used to infer the presence of domestic wells based on use/dwelling code of a parcel, or from comparing number of homes in a census block to available community water system location and population served data. The GSA will also coordinate with Lake County Division of Environmental Health to require that all new wells comply with DWR regulations.

This analysis of parcel data and census data has already been done on a statewide level, including Lake County, by the Community Water Center, and the results of their analysis are included in their Drinking Water Tool as a "Likely Domestic Well Communities" layer at the PLSS section level. The State Water Resources Control Board 2021 Aquifer Risk Map and Needs Analysis GAMA Tool is also useful in identifying domestic well communities and relevant groundwater quality information. The GSA aims to build upon existing data and refine for the Big Valley Basin, with specific attention to compile well construction information to better understand which domestic wells may be vulnerable to fluctuations in or long-term lowering of groundwater levels. Additionally, knowing whether domestic wells are currently in use is essential in directing support to households reliant on groundwater.

5.3.5.2 Coordination with DWR's Household Water Supply Shortage Reporting System

DWR's Household Water Supply Shortage Reporting System (HWSSRS) is a website for Californians to report problems they experience with their private (self-managed) household water supply and to find resources to address household water shortage. The information compiled in the HWSSRS is also intended to inform state and local agencies' actions to address drought impacts on household water supplies. Improved coordination with DWR's HWSSRS, and outreach within the Big Valley Basin to encourage use of this reporting system for wells that have gone dry, would help the GSA to understand and be prepared to help mitigate impacts to domestic wells.

The GSA will develop a page on the new GSP website (described further in **Section 5.3.6**) that connects with DWR's HWSSRS and provides information about additional local resources to help homeowners and renters address household water shortage. The GSA will publicize the HWSSRS and encourage its use at all public meetings and workshops.

The GSA will coordinate with the County Division of Environmental Health and County Office of Emergency Services (OES) to help encourage use and review of the DWR HWSSRS and coordinate response. Regular review of HWSSRS data can help identify reported household water shortages to focus engagement and mitigation efforts. Frequent review of the HWSSRS data alongside groundwater elevation and basin geologic data will allow for better understanding of how groundwater conditions are impacting households that have already reported shortages, as well as how conditions may also impact neighbors also reliant on domestic wells.

5.3.5.3 Outreach and Engagement

By developing a more complete inventory of domestic wells and reviewing the HWSSRS, the GSA can engage with well owners and users that are more likely to be impacted by lowering of groundwater levels or degraded groundwater quality and help to identify options for improving the reliability of their water source, including deepening or replacing their wells, or considering alternative sources like consolidating with a nearby water system. The GSAs will also provide information and resources to domestic and small agricultural well owners and users, including funding for well testing, inspection, and replacement. These resources will be targeted to well owners and users in locations where wells have gone dry.

It is important to note that the two household water shortages reported in DWR's HWSSRS as of October 15, 2021, are renter-occupied households. Outreach and engagement conducted about household water shortages should be focused on reaching well owners as well as renters of homes with domestic wells and should be sensitive to the uncertainty that renters face in engaging with landlords about property improvements and habitable living conditions.

5.3.5.4 Domestic Well Mitigation Program

A domestic well mitigation program can be established to address impacted wells. The mitigation program is intended to protect human health and people's access to water.

The GSA can take action to mitigate impacts to domestic well users regardless of undesirable results. **Section 5.6** describes the GSA's approach to adaptive management which considers drought conditions and negative groundwater trends. When active domestic wells are impacted by low groundwater levels, the GSA will prioritize finding short-term and long-term solutions for water supply. Short-term actions can include emergency bottled water or hauled water programs. Specific long-term actions that could be implemented by this mitigation program include well deepening, well replacement, or connection to existing community water systems.

While the GSA does not have the financial resources to fund all potential domestic well mitigation actions, the GSA will collaborate with County OES and state and federal agencies to connect impacted well owners and users with available resources for emergency supplies and long-term solutions. This includes, but is not limited, programs such as through the DWR Small Community Drought Relief Funding, State Water Resources Control Board Safe and Affordable Funding for Equity and Resilience Drinking Water Program, and the United States Department of Agriculture Decentralized Water System Grant Program.

Securing funding from these sources is a GSA priority with special attention to economically distressed households unlikely to be able to personally finance solutions. Additionally, coordination with organizations such as Rural Community Assistance Corporation and Clean Water Action may help identify additional funds to mitigate household water shortage and foster relationships between the GSA and local well owners and users. For wider regional changes in groundwater conditions, the GSA may consider larger corrective actions to better understand and mitigate impacts.

5.3.5.5 Relevant Measurable Objectives

Implementation of this management action would help to identify significant and unreasonable impacts from the lowering of groundwater levels, reduction in groundwater storage, and degradation of groundwater quality. Mitigation and avoidance of domestic and municipal wells going dry will improve sustainability goals in Big Valley Basin.

5.3.5.6 Expected Benefits and Evaluation of Benefits

The primary benefit of implementing a domestic well management program is to mitigate impacts of changing groundwater conditions on households that depend on domestic wells. Using a more complete inventory of wells and identifying the wells more likely to be impacted by lowering of groundwater levels, the GSA can engage with domestic well owners and users to find resources for short-term and long-term solutions. Improved coordination with DWR's HWSSRS would facilitate this targeted engagement, and the domestic well mitigation program would help identify solutions to mitigate impacts to households that depend on domestic wells.

5.3.5.7 Circumstances for Implementation

Since some domestic wells in Big Valley Basin have recently been reported to have gone dry, this program will be implemented immediately upon adoption of the GSP. The domestic well mitigation program will rely on the cooperation of well owners to share their information with the GSA, or through DWR's HWSSRS.

5.3.5.8 Public Noticing

Information about this program will be shared with stakeholders through the GSA's e-mail list, will be posted on the GSP website, and information will be posted at GSA and County offices. In addition, water districts, and other local agencies will help spread the word to domestic well owners and users.

5.3.5.9 Permitting and Regulatory Process

The GSA and individual proponents have the authority to plan and implement monitoring and data collection efforts. Any required permitting and regulatory review will be initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include but is not limited to: Lake County (various departments), DWR, SWRCB, CDFW, Regional Water Boards, USFWS, and California Air Resources Board.

5.3.5.10 Implementation Schedule

A general schedule to implement the domestic well management program is outlined below in **Table 5-3**. It should take approximately two years to update the domestic well inventory. Both the inventory and mitigation program will be refined on an as-need basis. However, outreach and engagement, coordination with DWR's HWSSRS, and development and implementation of the domestic well mitigation program are ongoing activities.

Table 5-3. Domestic Well Management Implementation Schedule

Task Description	2022	2023	2024
Domestic Well Inventory			
Perform Outreach and Engagement	Ongoing		
Coordinate with DWR on HWSSRS	Ongoing		
Develop and Implement Well Mitigation Program	Ongoing		

Key:
DWR= Department of Water Resources
HRSSRS = Household Water Supply Shortage Reporting System

5.3.5.11 Legal Authority

The GSA has the authority to plan and implement monitoring and data collection efforts.

5.3.5.12 Estimated Cost

Developing the domestic well inventory is a $75,000 to $100,000 one-time cost, and ongoing outreach and engagement, coordination with DWR's HWSSRS, and development and implementation of the domestic well mitigation program is estimated to cost $10,000 annually.

Specific domestic well mitigation actions may range substantially in cost, and the GSA aims to work with households experiencing water shortages to identify short-term and long-term water shortage options and funding sources.

5.3.6 Create a Permanent Big Valley GSA Website

As called out in the Big Valley Basin Communication and Engagement Plan (C&E Plan) (**Section 7**), the GSA website is a tool to support communication and engagement activities. As of November 2021, the GSA has a number of website landing pages, hosted within the Lake County Water Resources Department's website, that provide information about SGMA, local SGMA-related efforts, archived meeting recordings and materials, along with outreach material: http://www.lakecountyca.gov/Government/Directory/WaterResources/Programs___Projects/Big_Valley_GSP/Big_Valley_GSA.htm.

Pending funding availability, a Big Valley GSA website would be developed, operated, and maintained by the GSA. It would serve as a public repository for the Big Valley Basin GSP and other reports (the annual reports and five-year updates and supporting information), as well as house GSA meeting information and outreach material, including information to help homeowners and renters address household water shortages as described in **Section 5.3.5**. The GSA would be responsible for regularly updating the website.

5.3.6.1 Relevant Measurable Objectives

While this management action would not directly impact measurable objectives, improved communication and information sharing with interested parties will help the GSA better collaboratively manage groundwater. The website will also offer the community a single location for finding information and resources related to groundwater in Big Valley Basin.

5.3.6.2 Expected Benefits and Evaluation of Benefits
The purpose of this project is to comply with SGMA, educate and inform the public and provide opportunities for feedback and engagement from interested parties. All Big Valley Basin beneficial users would benefit from the development of a new Big Valley GSA website.

5.3.6.3 Circumstances for Implementation
The GSA would create a new, permanent website as soon as funds are available. In the meantime, the GSA will continue to use and update the existing webpages hosted under the Lake County Water Resources Department's website landing pages.

5.3.6.4 Public Noticing
News of the GSA website will be shared with interested parties through the existing interested parties e-mail list, during public meetings, GSPAC meetings, and on all documents and reports shared and distributed by the GSA.

5.3.6.5 Permitting and Regulatory Process
There are no permitting or regulatory requirements necessary to create a new GSA website.

5.3.6.6 Implementation Schedule
It would likely take one to two months to create a website and transfer the existing GSA content to the new website.

5.3.6.7 Legal Authority
The GSA has the legal authority to create a GSA-specific website.

5.3.6.8 Estimated Cost
A one-time cost of $3,000 to $5,000 is needed to create a new GSA website. Regular site maintenance and posting would fall under GSA administration fees, described in **Section 6**.

5.3.7 Conduct Public Outreach Consistent with the Communication and Engagement Plan

The C&E Plan provides the approach and activities to engaging with interested parties in Big Valley Basin (**Section 7**). The potential outreach activities identified in the C&E Plan seek to build and expand public awareness of the GSA, groundwater in Big Valley Basin, and local compliance with SGMA, and to actively engage interested parties to coordinate and collaborate on issues important for GSP development and implementation. These activities will be led by the GSA but will involve coordination and partnership with local community organizations.

5.3.7.1 Relevant Measurable Objectives
While this management action would not directly impact measurable objectives, improved communication and engagement with interested parties will help the GSA better collaboratively manage groundwater.

5.3.7.2 Expected Benefits and Evaluation of Benefits
The objective of this management action is to satisfy SGMA requirements, inform and educate the public, and obtain local input. All Big Valley Basin beneficial users may benefit from inclusive and transparent public outreach.

5.3.7.3 Circumstances for Implementation
Activities laid out in the C&E Plan will be implemented to satisfy SGMA requirements.

5.3.7.4 Public Noticing
The C&E Plan was posted on the Lake County GSA webpage for public comment from September 30, 2021, until October 15, 2021.

5.3.7.5 Permitting and Regulatory Process
There are no permitting or regular requirements involved in conducing outreach consistent with the C&E Plan.

5.3.7.6 Implementation Schedule
Public outreach will be an ongoing management action throughout the duration of GSP implementation.

5.3.7.7 Legal Authority
The GSA has the authority, and a legal obligation, to perform outreach.

5.3.7.8 Estimated Cost
The projected cost for this project is thus included in the estimate of GSP implementation costs provided in **Section 6**. Outreach and related activities are estimated at $45,000 per year. The GSA may seek additional funding support from the DWR Facilitation Support Services grant to perform outreach-related activities.

5.4 Tier 2 Projects and Management Actions

Tier 2 PMAs are those that **may** be implemented by either the GSA or stakeholders in order to improvement water management and contribute to achieving measurable objectives in the Big Valley Basin (see **Table 5-4**). Tier 2 PMAs have been developed to different levels of detail, and information remaining to be developed (if the PMA progresses) are noted at the end of each project description.

Table 5-4. Tier 2 Projects and Management Actions

Name	Project Category	Description	Cost Estimate*
Implement Adobe Creek Conjunctive Use Project	Water supply augmentation	The proposed project involves modifications to the Highland Springs Reservoir and its operations, including consideration of multi-benefit features. The objective of this project is to increase groundwater recharge in Big Valley Basin.	$0.8M (2002 cost estimate)
Rehabilitate Kelsey Creek Detention Structure	Water supply augmentation	This project involves rehabilitating the middle gate engine base at the Kelsey Creek Detention Structure. The purpose of the project is to ensure the continued use of Kelsey Creek Detention Structure for groundwater recharge.	$9,000 - $10,500
Improve Water Demand Estimates	Monitoring and data management	This project would refine these water demand estimates with additional data. The purpose is to improve the water budget and water management and support potential demand management policies.	$40,000 - $70,000
Investigate recharge locations and benefits	Water supply augmentation	This project would investigate the feasibility of recharge locations in the Basin. From the initial investigation, it is possible that the GSA may elect to carry out groundwater recharge implementation. The objective of this project is to improve water supply reliability and water management.	$10,000 - $35,000
Investigate stormwater capture for in lieu use	Water supply augmentation	This project involves investigating stormwater capture to augment water supply. The objective of the proposed project is to reduce groundwater demand and minimize surface water depletion.	$15,000 - $25,000
Conduct video survey of RMS wells	Monitoring and data management	This project would involve video surveys of select wells to confirm well construction information, including screening depth. The purpose of this project is to improve the Big Valley Basin RMS Network.	$10,000

Notes:

* The cost estimates are based on similar projects from other published GSPs. These costs may be further refined during GSP implementation.

Key:

GSA = Groundwater Sustainability Agency

RMS Network = Representative Monitoring Site Network

5.4.1 Implement Adobe Creek Conjunctive Use Project

The Adobe Creek Conjunctive Use (ACCU) Project has been recognized as an opportunity to increase groundwater recharge in the Big Valley Basin for decades. The project as included in this GSP is revisiting and building upon the ACCU project identified in the Big Valley Groundwater Management Plan adopted by the District on May 18, 1999, and further documented in the Adobe Creek Conjunctive Use Project Feasibility Study (Lake County, 1999; Christensen Associates, Inc., 2002).

The potential project involves:

1. Improving control of water storage in Highland Springs Reservoir by retrofitting seven hydraulically operated sluice gates to the existing Principal Spillway;

2. Modifying reservoir operations to provide for storage of a small portion of winter inflow that is normally spilled to Clear Lake;

3. Increasing groundwater recharge by natural percolation of releases from the reservoir into the streambeds of lower Highland and Adobe Creeks;

4. Relocating the existing water intake in Highland Springs Reservoir to accommodate lower reservoir water levels in fall; and

5. Improving regulation of flow in Adobe Creek during spring to enhance spawning habitat for fish (particularly the Clear Lake hitch).

Limited information is available in previously developed plans about how the ACCU project would impact nearby domestic and municipal wells; initial work to update the existing plans would include analysis of these impacts such as potential groundwater quality changes.

Previously developed plans showed some incorporation of multi-benefit features, mostly a focus on enhancing the habitat of the Clear Lake hitch. Furthermore, multi-benefit features could be incorporated to realize not only water supply benefits, but also restore ecosystems, enhance access to green space and recreation for the surrounding community, and more. Initial work to update the existing ACCU project plans would include consideration of additional multi-benefit features that could be included, increasing the potential positive impacts on communities in the Big Valley Basin and making the project eligible for additional sources of funding.

Several permitting considerations are relevant for this project. Planning previously completed for the ACCU Project determined Mitigated Negative Declaration under the California Environmental Quality Act, with mitigation measures proposed to protect Valley Oak trees on the banks of the reservoir. Dam safety permits will need to be secured, as any significant modification to the structure or operation of Highland Springs Reservoir and Dam for conjunctive use is subject to approval of DWR's Division of Safety of Dams. Since the proposed modification to reservoir operations will result in storage of water for more than 30 days, an application for a water right permit should be prepared.

The objective of this project is to increase groundwater recharge in Big Valley to mitigate against potential future overdraft, contributing toward progress on all measurable objectives in Big Valley Basin. All Big Valley Basin beneficial users may benefit from increased recharge due to implementation of the ACCU project.

Cost estimates were last made for this project in the 2002 the feasibility study, and the study notes that the effective base data for the cost estimate is October 31, 2000. The feasibility study estimated that adding control gates to the Principal Spillway at Highland Springs Dam is $800,000, with operations and maintenance costs of $6,000 per year. These cost estimates would need to be updated to reflect inflation and current costs of materials and labor, as well as to reflect design progression beyond the feasibility study phase.

This project would be implemented if funding is available. Potential funding sources include DWR grants, specifically Sustainable Groundwater Management grants for GSP planning and implementation projects.

To move this project forward, additional information on updated cost, funding sources, and schedule would need to be determined.

5.4.2 Rehabilitate Kelsey Creek Detention Structure

The Kelsey Creek Detention Structure is a key piece of groundwater management infrastructure. The purpose of the project is to ensure the continued use of Kelsey Creek Detention Structure for groundwater recharge. All Big Valley Basin beneficial users may benefit from increased recharge due to the rehabilitation of the Kelsey Creek detention structure.

The structure is comprised of three radial gates, each with an engine that is manually operated by Lake County staff. In March 2021, Lake County staff discovered an issue with the middle gate engine base; the mounting bolt connection to the structure's concrete base failed and the engine's plate lifts every time the engine is operated.

To repair this gate, the gate and engine would be taken apart, the base would be rehabilitated or demolished and repoured, and the engine and gate would be reinstalled. The County has received three cost estimates to repair the engine base, ranging from $9,000 to $10,500. However, due to financial constraints, the engine base has not been repaired as of November 2021. To move this project forward, the GSA would need to obtain funding and permits.

5.4.3 Improve Water Demand Estimates

As part of the initial GSP effort, the GSA developed a water budget with the best available data. The water budget includes estimates of water demand from agricultural, municipal, and domestic users; however, these estimates vary widely in accuracy. This project would refine these estimates with additional data.

This is a multi-faceted project that could be completed by completing a variety of activities with different timelines. Some activities that could be carried out include:

- Quantification and timing of the volume of water pumped for irrigation, grape processing, frost protection, and domestic uses – This would involve coordination with interested stakeholders in the Basin and applicable land use and other authorities. The cost estimate for this project is $10,000 to $40,000.

- Validate land use spatial data and evapotranspiration estimates – This would involve remote sensing and ground truthing. This effort would further refine agricultural water use and agricultural water pumping. The cost estimate for this project is $30,000.

For either activity, the extent of data collection would be dependent on the amount of information needed to have a reasonable certainty in the estimated values. The GSA would take lead on this project, with possible assistance from the County Agricultural Commissioner, County Farm Bureau, and/or DWR.

This project would benefit beneficial users of groundwater, as refined water demand information will enhance water management and support progress toward the groundwater levels, groundwater storage, and depleted surface water measurable objectives. To move this project forward, additional information on funding sources, schedule, and permitting would need to be determined.

5.4.4 Investigate Recharge Locations and Benefits

Recharge projects can offer multiple benefits such as increase groundwater supplies, provide habitat to wildlife, and add recreation space. This project would investigate the feasibility of recharge locations in Big Valley Basin, with a goal to improve water supply reliability and water management. Feasibility includes analyzing the physical basin characteristics, potential impacts to nearby domestic and municipal wells, developing cost estimates, and identifying benefits. The project would place an emphasis on protecting and benefiting domestic and municipal wells. The objective of this project is to improve water supply reliability and water management. All Big Valley Basin beneficial users of groundwater may benefit from increased recharge, and specific location-dependent benefits would be investigated as a part of this project.

This project could include two phases: 1) The Soil Agricultural Groundwater Banking Index database review and potential impacts analysis; and 2) site-specific infiltration tests. The GSA would lead this investigation, with support from other agencies as needed. The investigation could include analysis of the physical basin characteristics; analysis of potential impacts to nearby domestic and municipal wells; and identification of multi-benefit features to consider. The project would place an emphasis on protecting and benefiting domestic and municipal wells, and would include analysis of potential groundwater quality impacts of recharge.

The cost to carry out the first phase is estimated to be $10,000 to $15,000 total. The cost to carry out the second phase is estimated to be $10,000 to $20,000 per site included. The potential cost of this project would range from $10,000 to $35,000, depending on the extent to which it is implemented. To move the study forward, additional information on funding sources would need to be determined.

Depending upon the results of the investigation, it is possible that the GSA or Big Valley Basin stakeholders would decide to pursue groundwater recharge projects. Specific recharge locations would be based on the results of the feasibility study, and potential recharge projects identified may include development of upstream storage on Kelsey Creek; creation of spreading basins at existing gravel pits; restoration of erosion damage to watershed hillsides from fire and off-highway vehicle use; banking groundwater; Flood-Managed Aquifer Recharge; and using recycled water for groundwater recharge. Several potential recharge project ideas have a focus on multiple benefits. Specifically, besides groundwater recharge, Flood-Managed Aquifer Recharge can also provide benefits to flood risk reduction, ecosystem enhancement, water quality improvement, climate change adaptation, and recreation. The viability of such projects, including analysis of water rights and permitting, would need to be considered on an individual basis after the initial investigation has been concluded.

5.4.5 Investigate Stormwater Capture for In-Lieu Use

This project involves assessing the feasibility of and carrying out stormwater capture for in-lieu use. Captured stormwater can serve as an alternative water supply, thereby reducing groundwater demand and benefiting interconnected surface water. The captured stormwater could be used for irrigation, frost protection, and so on. The investigation would likely cost $15,000 - $25,000.

The objective of the project is to reduce groundwater demand. This would relate to measurable objectives for groundwater elevation and depletion of interconnected surface water for Big Valley Basin. All Big Valley Basin beneficial users of groundwater may benefit from in-lieu use of stormwater. To move this project forward, additional information on funding sources would need to be determined.

5.4.6 Conduct Video Survey of RMS Wells

This project would involve downhole video surveys of select wells to confirm well construction information, including screening depth. The screen depth is a critical piece of data as it helps determined which aquifer the water is pulled from.

As discussed in **Section 3**, the groundwater quality monitoring network uses wells with known depths, but the screen interval(s) for four of seven RMS wells for groundwater quality are not known. Without screen depth information, depth discrete comparison of water quality data is difficult. A video survey of wells lacking well construction information could confirm construction attributes.

Conducting video surveys for private wells would be challenging, as the well pump would need to be temporarily removed to allow the survey to be completed. The GSA would need to coordinate with well owners to carry out video surveys of their wells.

Estimated overall cost for this project to conduct video surveys of four RMS wells is approximately $10,000. This estimate assumes that video surveys for each well will cost approximately $2,500, including video survey contractor fees, report generation, and coordination with well owners to pull the well pump.

The purpose of this project is to improve the groundwater quality RMS network. Completing this project would help data from RMS wells more meaningfully characterize groundwater quality and groundwater level in Big Valley Basin, to better document progress toward all measurable objectives and inform decision-making to protect beneficial users of groundwater, especially drinking water users. To move this project forward, additional information on funding sources would need to be determined.

5.5 Tier 3 Projects and Management Action

Tier 3 PMAs are those that **may** be implemented by stakeholders in coordination with the GSA, in order to support wider water management in Big Valley Basin. Tier 3 PMAs are generally outside of the authority or purview of the GSA. Tier 3 PMAs have also generally been developed in less detail than Tier 1 and Tier 2 PMAs. Cost estimates are not provided for Tier 3 PMAs, as their scopes need to be further developed to generate reasonable estimates of costs. Information provided is meant to document these project ideas, which are adjacent to, but not directly under, the purview of GSA operations, in case a stakeholder decides to further them.

The GSA recognizes the value of these PMAs and would coordinate with entities implementing them as feasible. Coordination could include public outreach partnership, advertisement in GSA websites and listservs, and providing relevant data. While the GSA is not responsible for funding these PMAs, the GSA in coordination with the GSPAC could decide to contribute funds, if available.

Table 5-5. Tier 3 Projects and Management Actions

Name	Project Category	Description
Re-establish wetlands and riparian habitats	Habitat Restoration	This project would restore and rehabilitate wetlands and riparian habitat around Clear Lake and its tributaries. There are several entities involved or interested in this effort that the GSA may coordinate with. The purpose of the project is to provide habitat for wildlife and migratory birds, while improving groundwater recharge to the wells across the basin.
Keep hitch passage and spawning data updated	Monitoring and data management	The proposed project involves coordination with the Big Valley Band of Pomo Indians and CDFW to incorporate updated data and understanding of hitch passage and spawning into GSP updates and share groundwater level and streamflow data as useful. The objective of this project is to support hitch management strategies in the Basin.
Conduct study on hitch migratory habitat restoration	Habitat Restoration	The objective of the project is to better understand how streamflow conditions impact hitch spawning and migration and protect hitch habitat. This project could include investigation reservoir reoperation and creek flow augmentation.
Implement non-point source discharge control	Water quality improvement	The proposed project involves methods and implementation approaches to control non-point discharges from urban and agricultural uses. The objective of the project is to control pollution discharge to the groundwater, and help achieving groundwater quality measurable objective.

Key:
CDFW = California Department of Fish and Wildlife
GSA = Groundwater Sustainability Agency
GSP = Groundwater Sustainability Plan

5.5.1 Re-establish Wetlands and Riparian Habitats

Big Valley Basin contains some of the largest remaining wetland along Clear Lake and its tributaries. Since a majority of this land is privately held, organizations such as Lake County Land Trust, TNC, The Chi Council, and the Big Valley Rancheria Band of Pomo Indians are interested in working with landowners to restore and preserve these lands. Lake County Land Trust's work involves fee title purchase or conservation easements with the purpose of conserving and improving this vital habitat and water resource for the wildlife and environmental, scenic, cultural, and historic values of the area.

TNC is interested in partnering with growers for on-farm, multi benefit groundwater recharge program that provides critical wetland habitat for migratory birds. The proposed program would use surface water supplies to flood and maintain shallow ponds on fallow or dormant fields using existing diversion, conveyance, and on-farm infrastructure. The flooded fields would provide migratory habitat as well as groundwater recharge benefits. This project would benefit environmental water users and provide benefits to all beneficial uses and users of groundwater through recharge.

Reestablishment of wetlands and riparian habitats is of interest to the GSA, given its relationship to interconnected surface water, groundwater levels, and groundwater dependent ecosystems. Where possible, both legally and financially, the GSA may choose to support and/or coordinate on these activities.

5.5.2 Keep Hitch Passage and Spawning Data Updated

The proposed project involves coordination with the Big Valley Band of Pomo Indians, FlowWest, and CDFW to incorporate updated data and understanding of the timing and location of hitch passage and spawning into GSP updates and to share groundwater level and streamflow data generated through progress on other PMAs. As it was discussed in **Section 2.2.3.3,** there are concerns about the adverse impacts of different activities on various hitch life cycles which cannot be determined due to lack of high spatial and temporal resolution data.

The objective of this project is to support hitch management strategies in the Basin. This project, in connection with other projects focused on improving data availability and characterization of groundwater-surface water interaction, would benefit environmental users of surface water.

5.5.3 Conduct Study on Hitch Migratory Habitat Restoration

The Clear Lake hitch migrate and spawn in Adobe and Kelsey Creek in mid-February through May, occasionally into June, each year. Substantial discussion of potential impacts to stream conditions, and thus also hitch migratory and spawning habitat, has occurred throughout GSP development. The objective of the project is to better understand how streamflow conditions impact hitch spawning and migration and protect hitch habitat. This project, in connection with other projects focused on improving data availability and characterization of groundwater-surface water interaction, would benefit environmental users of surface water.

Two potential activities that could improve understanding of impacts to hitch habitat are described below. Note, this project ties into Tier 1B (i.e., Improve Understanding of Interconnected Surface Water).

5.5.3.1 Improve Reservoir Operations to Increase Streamflow During Key Periods

Streamflow on Adobe Creek is regulated by Highland Springs and Adobe Creek Reservoirs. The new gauges on the reservoir outlets, discussed above in **Section 5.3.2**, paired with hitch passage and spawning data could help create new operating guidelines for these reservoirs. These guidelines could include strategic releases to support hitch migration and spawning. In addition to supporting the hitch, this effort could enhance groundwater recharge and support GDEs.

5.5.3.2 Investigate Creek Flow Augmentation to Reduce Hitch Entrapment

As noted in FlowWest (2020) there is a lack of guidance regarding hitch passage and spawning flows. This investigation would first monitor hitch passage and spawning to improve criteria for depth, velocity, and step height. This data could then be used to ascertain the additional amount of water needed to transport juvenile hitch downstream to Clear Lake that would otherwise be trapped due diminished stream flow. The next phase of this investigation could then examine ways to augment streamflow such as groundwater pumped directly into the streams.

5.5.4 Implement Non-Point Source Discharge Control

Non-point source pollution, caused by runoff from agricultural and urban lands, is a concern in Big Valley Basin. Pollution can be harmful to all beneficial users of groundwater but can be addressed through policies and management. As described in **Section 2.1**, there are several entities who monitor and have authority over non-point source pollution such as the Central Valley RWQCB. Although the GSA does not have authority in controlling non-point source pollution, there are connections to items under GSA purview such as groundwater quality and groundwater dependent ecosystems. When appropriate, the GSA would coordinate with other regulating entities on non-point source pollution controls.

5.6 Adaptive Management

During GSP implementation, the GSA will use adaptive management to take actions in response to events that may affect long-term Big Valley Basin sustainability or cause a short-term undesirable condition. Trigger events for implementation for the adaptive management allow for a variety of actions, ranging from coordination and monitoring to management of groundwater extractions and recharge. Two types of trigger events are defined:

- Long-term basin sustainability triggers
- Short-term acute drought triggers

This adaptive management strategy is meant to allow the GSA to be responsive to unforeseen changes in groundwater conditions, especially those associated with climate change.

5.6.1 Long-Term Basin Sustainability Triggers

These triggers occur when (1) a negative trend causes a sustainability indicator to approach an MT, or (2) an MT is exceeded. When a long-term sustainability trigger occurs, the following actions would take place:

- The GSA will inform the GSPAC.
- The GSA will initiate an investigation of the negative trend (or the MT exceedance) to determine if it is a localized change in conditions, or representative of a long-term, regional change in conditions. This will include analysis of potential impacts to beneficial uses and users of groundwater, including those reliant on groundwater for their drinking water source.
- Based on the results of the investigation, the GSPAC will advise the GSA on a recommended course of action that may include:
  - Increased monitoring frequency
  - Coordination and information sharing with overlying landowners, land use authorities, and applicable regulatory agencies.
  - Management modifications in the area represented by the monitoring site (e.g., halting, reducing, or altering the timing/pattern of groundwater extraction).
  - Implementing one or more of the identified projects and managements actions
  - Additional study to recommend other mitigation actions

The GSA actions would be deemed successful in returning Big Valley Basin to sustainable conditions, once (1) the observed negative trend is halted or reversed, (2) the MT exceedance is corrected, and/or (3) it was established that the identified issue was a result of localized conditions and not risk to long-term Big Valley Basin sustainability.

5.6.2 Short-Term Acute Drought Triggers

These triggers occur (1) during extended drought period, or (2) when a drought emergency is declared. When an acute drought trigger occurs, the following actions would take place:

- The GSA will inform the GSPAC.
- The GSA will initiate coordination and share information with OES.
- The GSA will publicize the resource webpage with links to relevant information and available programs to assist drought-affected well owners and users, already developed as described in **Section 5.3.5**.

- The GSA will periodically review the list of drought-affected wells in the Basin to determine if these are isolated incidents due to well construction/age, or these represent wider regional changes in groundwater conditions.

- For isolated incidents of impacted wells, the GSA may assist in coordination with County OES and other state and federal agencies to connect impacted well owners and users with available resources for emergency water supplies and well rehabilitation.

- For wider regional changes in groundwater conditions, the GSA, in coordination with the GSPAC, may consider corrective actions to better understand or mitigate the drought impacts, including:

  - Increased monitoring frequency

  - Coordination and information sharing with groundwater users to encourage conservation

  - Management modifications in the Basin or in areas mostly affected (e.g., halting, reducing, or altering the timing/pattern of groundwater extraction)

  - Implement one or more of the identified projects and managements actions

Several of these actions relate to the domestic well management program described under **Section 5.3.5**. Prioritizing implementation of the domestic well management program will allow for the GSA to be well-positioned to act in response to long-term basin sustainability triggers and short-term acute drought triggers.

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6. PLAN IMPLEMENTATION

This chapter describes the activities and associated costs to implement the Big Valley Basin GSP. It outlines the first five years and discusses how the GSA plans to meet these costs in accordance with SGMA regulations on GSP implementation.

6.1 GSP Implementation Activities

The implementation plan includes GSA-required activities (e.g., administration and monitoring), and consideration of PMAs included in **Section 5**.

6.1.1 GSA Administration

The GSA administrative tasks include, but not limited to, operation and maintenance, project management and coordination, administrative and finance staff, engineering and consulting, and legal expenses.

Big Valley Basin GSA receives in-kind legal services from Lake County on an as-needed basis. If legal services are needed on issues requiring specific expertise in groundwater, SGMA compliance, or other specialized matters, the GSA may engage outside counsel.

It is anticipated that administrative and management needs will be monitored and updated accordingly throughout GSP implementation, as they may be subject to change based on the implementation schedule and potential unforeseen needs.

6.1.2 Monitoring Program

The GSA will implement the monitoring program described in **Section 3.** Note these monitoring activities are the day-to-day activities that are required under SGMA and does not include new monitoring programs as detailed in **Section 5**. Monitoring activities will include data review and analysis, installation and maintenance of monitoring wells and equipment, and data management. These monitoring activities will support evaluation of Basin conditions relative to established sustainable management criteria. The GSA will work to ensure all data are collected and evaluated using best management practices and applicable quality assurance and quality control guidelines.

6.1.3 GSP Updates

GSP updates include the required Annual Reports and Five-Year Update Reports, described further in **Section 6.2** and **Section 6.3,** below. Preparation of these reports involve several activities such as updating to the Big Valley Integrated Hydrologic Model, the PMAs, and performing public outreach.

6.1.4 Stakeholder Outreach and Engagement

As described in **Section 1** and **Section 5**, the GSA has and will continue to perform outreach and engagement activities. These activities include facilitation and management of the GSP

Advisory Committee, outreach consistent with the C&E Plan, and development and maintenance of a GSA website.

6.1.5 Implementation of Projects and Management Actions

Due to the sustainable condition of Big Valley Basin, implementation of PMAs will occur on an as-needed basis, as outlined in in **Section 5**:

- Tier 1A PMAs are to help reach sustainability. None have been identified due to the sustainable conditions of the Basin.
- Tier 1B PMAs are to comply with other SGMA requirements, fill data gaps, and support GSA operations. Seven (7) PMAs were identified that will be implemented by the GSA, depending on resource availability.
- Tier 2 PMAs are to improve management and contribute to achieving measurable objectives. Six (6) PMAs were identified that may be implemented by the GSA or stakeholders if resources available.
- Tier 3 PMAs are to support wider water management in the basin, including activities outside the purview of the GSA. Five (5) PMAs were identified that may be implemented by interested stakeholders, with GSA coordination.
- Adaptive management actions will be implemented by the GSA if triggers triggering events occur, as described in **Section 5.6**.

6.2 Annual Reporting

Annual reports will be completed in compliance with CCR Title 23 § 356.2 and submitted to DWR by April 1 of each year following GSP adoption, except years when five-year or periodic assessments are submitted.

Annual reports will present data over the prior water year (October 1 through September 30). The first annual report covering water year 2021 (October 1, 2020, to September 30, 2021) will be submitted to DWR by April 1, 2022. Prior to the first five-year update report to this GSP, which is to be submitted to DWR in January 2027, four annual reports for the Big Valley Basin will be submitted to DWR between 2022 and 2026.

6.2.1 GSP Annual Report Module

All parts of the GSP Annual Report are uploaded through the SGMA Portal consisting of the following parts:

- Part A. Groundwater Extractions excel file: volume extracted by water use sector (e.g., urban, industrial, agricultural, managed wetlands, managed recharge, native vegetation, and other).

- Part B. Groundwater Extraction Methods excel file: volume extracted by methods (e.g., meters, electrical records, land use, groundwater model, or other).
- Part C. Surface Water Supply excel file: water supply volume by water source type (e.g., Central Valley Project, State Water Project, Colorado River Project, local supplies, local imported supplies, recycled water, desalination, and other).
- Part D. Total Water Use excel file: total water use volume by water use sector and by water source type.
- Part E. Change in Storage.
- Part F. Monitoring Network Module: information updated as needed.
- Part G. GSP Annual Report PDF and GSP Annual Report Elements Guide Template: upload the GSP Annual Report pdf and populate the Elements Guide template.
- Part H. GSP Annual Report Submittal.

Annual reports will include sections on general information, basin conditions, and plan implementation progress for the reporting period. The following subsections provide a general outline of the information that will be provided.

6.2.2 General Information

General information will include an executive summary that highlights the key content of the annual report. As part of the executive summary, this section will include a map of the Big Valley Basin, description of the sustainability goal, a description of GSP projects and their progress, and an annual update to the GSP implementation schedule. Key required components include:

- Executive Summary
- Map of the Subbasins

6.2.3 Basin Conditions

Basin conditions will describe the current groundwater conditions and monitoring results. This section will include an evaluation of how conditions have changed over the previous year and will compare groundwater data for the water year to historical groundwater data. Pumping data, effects of project implementation (if applicable), surface water flows, total water use, and groundwater storage will be included. Key required components include:

- Groundwater level data from the monitoring network, including seasonal high and seasonal low contour maps
- Hydrographs of groundwater elevations at representative monitoring locations
- Groundwater extraction data

- Surface water supply data by sector and source
- Total water use data
- Change in groundwater storage, including maps of the aquifer
- Subsidence rates and survey data

6.2.4 Plan Implementation Progress

Progress toward successful GSP implementation will be included in the annual report. This section of the annual report will describe the progress made toward achieving interim milestones as well as implementation of projects and management actions. Key required components include:

- GSP implementation progress, including proposed changes to the GSP
- Progress toward maintaining the Big Valley Basin's sustainability goal

6.3 Five-Year Evaluation Report

The GSA will conduct an evaluation every five years to summarize GSP implementation, whether the GSP is meeting the sustainability goal, and summarize implementation of projects and management actions. An evaluation will also be made whenever the GSP is amended (at least once every five years). DWR will use this evaluation to review the GSA's progress toward meeting the Big Valley Basin sustainability goal. A description of the information that will be included in this report, as required by CCR Title 23 § 356.4, is provided in the below.

6.3.1 Sustainability Evaluation

The sustainability evaluation will summarize current groundwater conditions for each sustainability indicator and describe overall progress in maintaining sustainability. An overview of interim milestones and measurable objectives will also be included, along with an evaluation of status relative to minimum thresholds. Implementation of all projects and management actions will be documented. If any of the adaptive management triggers are found to be met during this evaluation, a plan for implementing adaptive management described in the **Section 5** would be included.

6.3.2 Monitoring Network Description

A description of the monitoring network will be provided in the five-year evaluation report. An assessment of the monitoring network's function will also be provided, along with an analysis of data collected to date. If additional data gaps are identified, the GSP will be revised to include a program for addressing these data gaps, along with an implementation schedule.

6.3.3 New Information

The five-year evaluation report will describe and evaluate new information on groundwater conditions, PMAs, and so on. The GSA will apply an adaptive management approach to review and incorporate all new information into the GSP. The periodic evaluations will indicate whether new information warrants changes to any aspect of the GSP such as basin setting, undesirable results, minimum thresholds, and measurable objectives.

6.3.4 GSA Action

The five-year evaluation report will include a summary of the regulations or ordinances, related to the GSP, that have been implemented by DWR, the GSA, or others since the previous report. Note it is within the GSA's authority to evaluate and adopt new regulations or ordinances that help achieve the sustainability goal. The summary will also address how the ordinances may require updates to the GSP.

6.3.5 Plan Amendments, Coordination, and Other Information

The five-year evaluation report will describe any completed or proposed GSP amendments. This includes changes to the basin setting, measurable objectives, minimum thresholds, and undesirable results.

The five-year evaluation report will also describe coordination between the GSA, tribes, land use agencies, Scotts Valley Basin, and others. This will include meetings, joint projects, or data collection efforts. The GSA will summarize any other information deemed appropriate to support the GSP and will provide associated required information to DWR.

6.4 Data Management System

Through the development of this GSP, the GSA created a data management system (DMS). The DMS was created to manage data related to monitoring, analysis, and reporting on groundwater conditions and related information and meet the requirements of the GSP Regulations, including CCR Title 23 § 352.4, § 352.6, and § 354.4.

The DMS has four key attributes:

1. Flexibility for importing data from various software platforms and systems,
2. Sufficient capacity to store existing historical data and additional future data,
3. Ability to export data to numerous software formats (i.e., ESRI, Tableau), and
4. Capability to grow and evolve in the future.

This DMS consists of a Microsoft Access database that incorporates data storage and an interface to manipulate, query, and manage data. Microsoft Access also has the capability to sync with web components to allow for online viewing of data in the form of maps and graphs. The DMS also has functionality to enable importing/exporting data to other commercially available software programs.

As described in **Section 5**, the goal is for the data management system to be incorporated into the GSA website. For more information on the DMS, see **Appendix 6A**.

6.5 Estimate of GSP Implementation Costs

Tables 6-1 and **6-2** presents GSP implementation costs based on typical costs from similar GSPs. **Table 6-1** presents the annual costs outside the five-year update whereas **Table 6-2** includes the costs associated with the five-year update such as updates to the BVIHM. These costs include GSA administration and implementation all other GSP aspects. Note that these costs may be subject to change, as they are projections based on the time of development of this report (November 2021).

Table 6-1. Typical Groundwater Sustainability Plan Implementation Costs Outside the Five-Year Update

Description	Annual Costs Outside the Five-Year Update
GSA Administration	
Operation and Maintenance	$20,000 - $45,000
Project Management and Coordination	$20,000 - $50,000
Administrative Personnel	$70,000 - $140,000
Engineering and Consulting	$10,000 - $20,000
Legal Expenses	$10,000 - $20,000
Subtotal	**$130,000 - $275,000**
Monitoring Program	
Water Level Monitoring	$10,000 - $20,000
Water Quality Monitoring	$10,000 - $20,000
Land Subsidence Monitoring	$5,000 - $15,000
Subtotal	**$25,000 - $55,000**
GSP Updates	
Annual Report	$20,000 - $50,000
Updates to Integrated Hydrologic Model [1]	N/A
Updates to PMAs [1]	N/A
5-Year Periodic Updates [1]	N/A
Subtotal	**$20,000 - $50,000**
Outreach and Engagement	**$5,000 - $10,000**

Table 6-1. Typical Groundwater Sustainability Plan Implementation Costs Outside the Five-Year Update (contd.)

Description	Annual Costs Outside the Five-Year Update
Projects and Management Actions *(refer to **Section 5**)*	
Tier 1A PMAs	N/A
Tier 1B PMAs	Extent of implementation depends on funding availability
Tier 2 PMAs	Implementation depends on funding availability
Tier 3 PMAs	N/A
Adaptative Management Actions	Variable [2]
Subtotal	Depends on funding availability
TOTAL *(not including PMAs)*	**$180,000 - $390,000**

Notes:

[1] These line items do not have an associated cost outside of the five-year update. SGMA requires these activities be complete as part of the five-year update. See Table 6-2 for those costs.

[2] This refers to adaptive management actions costs including increased coordination activities and other actions associated with the specific triggers.

Key:
GSA = Groundwater Sustainability Agency
GSP = Groundwater Sustainability Plan
N/A = Not Applicable
PMA = Projects and Management Action
SGMA = Sustainable Groundwater Management Act

Table 6-2. Typical Groundwater Sustainability Plan Implementation Costs During the Five-Year Update

Description	Annual Costs During the Five-Year Update
GSA Administration [1]	**$130,000 - $275,000**
Monitoring Program [1]	**$25,000 - $55,000**
GSP Updates	
Annual Report	N/A
Updates to Integrated Hydrologic Model	$50,000 - $150,000
Updates to PMAs	$10,000 - $20,000
5-Year Periodic Updates	$100,000 - $250,000
Subtotal	**$190,000 - $440,000**
Outreach and Engagement	**$10,000 - $30,000**
Projects and Management Actions [1]	Depends on funding availability
TOTAL *(not including PMAs)*	**$355,000 - $800,000**

Note: [1] Refer to Table 6-1 for details

Key:
GSA = Groundwater Sustainability Agency
N/A = Not Applicable
PMA = Projects and Management Action

6.5.1 Funding of GSA Activities

The GSA has the powers and authority to impose fees and assessments and may pursue other financing sources for capital projects and funding sources for repayment of debt, operations, and other ongoing expenses (CWC § 10730 and § 10730.2). **Table 6-3** summarizes potential financing and funding sources that may be used for GSP implementation.

The GSA has been successful in pursuing past grant funding (e.g., Sustainable Groundwater Planning Grant programs). The GSA will continue to pursue grant opportunities to fund GSP implementation and local infrastructure projects.

GSA annual budgets will be reviewed, revised if needed, and approved by the County Board of Supervisors based on interpreted basin conditions, past actual expenditures, and the immediate needs. The budget will be adjusted over time as the GSP implementation costs are better understood through sustainable management activities and guidance from DWR on the submitted GSP and subsequent reporting.

Table 6-3. Potential Funding and Financing Sources for GSP Implementation

Capital Financing	Considerations
State (DWR) Grants (Prop. 68 and future bonds)	Solicitations are typically targeted to general types of projects and specific benefits that are in the State's interest
US Department of the Interior, Bureau of Reclamation WaterSmart Grants	Project-specific funding that can support planning studies (e.g., water market strategy grants)
Other targeted potential grant programs (e.g., AB 252)	Potential for multi-benefit projects
Local bond issuance	Local borrowing based on agency authority
Private borrowing	Current low interest rate environment may make these options attractive
State or Federal low interest loans	This could include future bond funded loan programs
Funding Sources	**Considerations**
Fee – General	General options for legal authority pre- and post-GSP development: Prop. 26, Prop. 218, CWC § 10730, CWC § 10730.2
Regulatory Fee	Typically, pre-GSP fee that is related to regulatory cost. Prop. 26 and CWC § 10730
Service Fee	Related to cost of service. Prop 218 and CWC § 10730.2. Subject to majority protest vote
Special Tax	Subject to 2/3 majority approval vote
Special Benefit	Special benefit assessment subject to majority protest vote

Key:
AB = Assembly Bill
CWC = California Water Code
DWR = California Department of Water Resources
GSP = Groundwater Sustainability Plan

6.6 Schedule for Implementation

The GSP implementation schedule allows time for the GSA to develop and implement PMAs and meet all sustainability objectives by 2042. While some sustainability projects began immediately after SGMA became law and are already contributing to Basin goals, the GSAs will begin implementing all other planned GSP activities by 2022. Many PMAs will be implemented adaptively on an as-needed basis as explained in **Section 5**.

A general implementation schedule showing the major tasks and estimated timeline during the 20 years of GSP implementation is provided in **Table 6-4**. This includes key implementation tasks, projects that are either completed or currently under construction, and required reporting. Projects in the planning phase and management actions detailed in **Section 5** are not included because these are going to be implemented on as needed basis.

The comprehensive implementation schedule will be updated every five years as part of the GSP five-year update process. However, the schedule may be modified periodically as agreed to by the GSA to reflect changes in progress, monitoring, funding opportunities, and other factors that could affect overall implementation efforts. For instance, the schedule may be updated to accommodate the near-term availability of significant funding opportunities or options (e.g., passage of a new State Proposition that includes planning and/or implementation funding for GSAs/GSPs that is not currently available).

Table 6-4. 20-Year GSP Implementation Schedule

TASK NAME	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
Plan Implementation																					
GSP Submittal to DWR	u																				
Outreach and Communication																					
Monitoring and DMS																					
GSP Reporting																					
Annual Reports	u	u	u	u	u		u	u	u	u		u	u	u	u		u	u	u	u	
5-year GSP Evaluation Reports						u					u					u					u

u Indicates a submittal.
Indicates ongoing activity.

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7. NOTICES AND COMMUNICATION

From the day the Big Valley Groundwater Sustainability Agency (BVGSA) was established, via a formal resolution by the Lake County Board of Supervisors, through the Big Valley GSP formal adoption on January 11, 2022, all phases of the GSA and GSP processes have been conducted in compliance with SGMA and GSP regulations.

The BVGSA developed the Big Valley Basin GSP in an intentionally open and public process. The agency conducted GSP development activities with an intent to engage beneficial users of groundwater, to consistently include interested parties, and to continually solicit and welcome input from the community.

This chapter describes the coordinated tools, activities, and methods the BVGSA used to inform and engage stakeholders in development of the Big Valley Basin GSP, and the agency's intent for future communication activities during GSP implementation.

7.1 BVGSA Decision-Making Process

The BVGSA has been tasked with overseeing development of a GSP for the Big Valley Basin, and it serves as the administrative body for public outreach and all phases of the GSP under SGMA. The five members of the Lake County Board of Supervisors serve as the Board of Directors for the Lake County Watershed Protection District, and they thereby act as the BVGSA. Big Valley Basin includes territory under the Lake County Board of Supervisors District 4 and District 5 regions.

Through a chartered process, the BVGSA Board of Directors created the Big Valley Basin GSPAC, a group of stakeholder representatives that reflect local beneficial uses and users of groundwater. The eleven-member GSPAC is coordinating on all basin-wide outreach and implementation efforts and activities. The GSPAC members and the entities they represent are also consulting and coordinating, both individually and collectively as a group, with community organizations and nonprofits to support and implement outreach efforts and activities.

Pursuant to SGMA regulation §354.10 (d), the Big Valley Basin GSP identifies this decision-making process, and includes this overview of its governance structure. Consistent with the GSPAC charter, administrative and plan-development activities of BVGSA has been delegated to GSPAC members by the BVGSA Board of Directors. GSPAC representatives, through a series of monthly standing meetings and additional technical subcommittee meetings, have been instrumental in developing, reviewing, and finalizing the GSP. Every part of the GSP was reviewed by GSPAC members and then updated, using GSPAC members' comments and feedback to refine plan elements before being presented and discussed during publicly held GSPAC meetings.

As the GSP moves toward implementation, the GSPAC will remain a vital part of the process, offering guidance to the BVGSA on plan activities and management. In February 2022, the GSPAC will be rechartered, to define the committee's role in GSP implementation. In addition, GSPAC members will help guide public outreach activities, assist with groundwater education efforts, and work with the GSA to review data and new information that will be useful for groundwater management in the Big Valley Basin.

7.2 Big Valley Basin Beneficial Users and Uses of Groundwater

Under SGMA, a GSP needs to identify beneficial users and uses of groundwater within a basin. The BVGSA identified and engaged with many interest-based categories described in SGMA and codified in California Water Code Section 10723.2.

As part of its initial GSA formation notification, the BVGSA provided a preliminary list of beneficial users within Big Valley Basin. The initial list of beneficial users and uses centered around leveraging existing relationships with stakeholders in the basin and connecting with participants who had knowledge of water-related issues in the region. Stakeholders identified in the initial GSA formation resolution included:

- Agricultural water users, including small individual landowners that rely on groundwater for agriculture
- California Native American Tribes
- Disadvantaged communities
- Domestic well owners
- Environmental uses and users
- Improvement districts and other special districts that own or maintain water infrastructure
- Land-use planning agencies or organizations

The Big Valley Basin C&E Plan, that can be found in Appendix 7A, provides additional detail on outreach and engagement with the beneficial users identified for Big Valley Basin. Further, the C&E Plan identifies proposed tools and activities to engage and consult with each of these beneficial users in development of the GSP for the Big Valley Basin, and then provides a foundation for continued engagement through GSP implementation.

The BVGSA intends to regularly review and update the list of beneficial users of groundwater within the basin. As SGMA and GSP-related groundwater activities progress in the future, there will be a need to identify new beneficial uses of groundwater, or to create outreach programs that specifically seek to engage particular beneficial users. As greater awareness of groundwater develops in Big Valley, the hope is to engage new groups and individual community members in ways that are meaningful for them. The BVGSA plans to constantly evaluate beneficial users and uses of groundwater, and to look for ongoing ways to engage diverse voices for better representation of all beneficial users in the basin.

7.3 Public Outreach and Engagement

The BVGSA utilized a variety of outreach tools and engagement activities to encourage the active involvement of diverse social, cultural, and economic elements of the population within the basin. These activities were guided by the Big Valley Basin C&E Plan, which is provided in **Appendix 7A**. The activities identified in the C&E Plan were adapted in accordance with state and local social distancing requirements resulting from the COVID-19 pandemic. To support execution of the activities identified in the plan, and to ensure a collaborative and inclusive GSP development process, the BVGSA utilized DWR's Facilitation Support Services program. Facilitation and outreach support was provided by Stantec Consulting Services, Inc.

7.3.1 Outreach Tools

The tools used for outreach made use of existing channels of communication and established new ones in compliance with SGMA and GSP requirements. These tools are further described in the **Appendix 7A** C&E Plan. The BVGSA intends to continue the use of these tools after GSP adoption; enhancing them to create communication that is easy to access, navigate, and that is inclusive of more diverse and underrepresented audiences. These tools include:

- The BVGSA website
- An Interested Parties Database
- A repository of Lake County groundwater and BVGSA documents
- An archive of all GSP-related meetings and resources
- Social media posts

7.3.2 Outreach and Engagement Activities

The BVGSA conducted a variety of outreach activities to provide opportunities for interested parties and stakeholders to be updated and to engage in the development of the Big Valley Basin GSP. These activities sought to build public awareness of the BVGSA and SGMA, to educate the community on groundwater issues, and to actively engage key stakeholder groups to coordinate and collaborate on technical issues important for GSP development. Outreach and engagement activities included:

- Lake County Board of Supervisors updates
- GSPAC meetings
- Technical subcommittee meetings on a variety of GSP elements
- Public meetings and educational open houses

From the beginning, the BVGSA established that all meetings undertaken to develop the GSP would be open to the public, and they would also include opportunities for anyone to ask questions or to make public comments. The public-centered approach for these meetings offered a variety of ways for the public to engage—from basic groundwater education presentations to sitting in on technical working groups. The result has been an ongoing chance for the public to learn about the Big Valley Basin, its groundwater and associated activities, and to engage in every part of the GSP development process.

Table 7-1 provides a listing of all of the publicly held meetings for Big Valley GSP development.

Table 7-1. List of Public Meetings for GSP Development in Big Valley Basin

Date	Meeting Type	Topic/Focus	Location
10/06/20	BOS update	• Introduction of SGMA and GSP process • Overview of stakeholder identification and advisory committee planning	Virtual
03/9/21	BOS update	• Status of GSP development grant • Overview of process to select a GSP technical team • GSP development timeline	Virtual
03/10/21	Public meeting	• Introduction to SGMA • Big Valley Basin overview • GSP Development process	Virtual
03/11/21	Public meeting	• Introduction to SGMA • Big Valley Basin overview • GSP Development Process	Virtual
04/27/21	BOS update	• Presentation of selected technical team • Status of GSP development process	Virtual
05/11/21	GSPAC meeting	• Introduction of GSPAC, Charter, and meeting schedule • GSP technical team introductions • GSP development schedule	Virtual
05/28/21	GSPAC meeting	• Overview of GSP elements • GSP section review process and timeline	Virtual
06/25/21	GSPAC meeting	• Introduction to groundwater modeling and groundwater budget • Section 1 review	Virtual
07/13/21	BOS update	• Local SGMA activity recap • Status of GSP development and GSPAC activities	Virtual
07/23/21	GSPAC meeting	• Review of Sections 1 and 2 • Subcommittee needs and timeline	Virtual

Table 7-1. List of Public Meetings for GSP Development in Big Valley Basin (contd.)

Date	Meeting Type	Topic/Focus	Location
08/12/21	SMC subcommittee meeting	• Introduction to SMCs • Proposed representative monitoring sites	Virtual
08/19/21	SMC subcommittee meeting	• Groundwater quality • Subsidence	Virtual
08/19/21	Public meeting	• Update on GSP development • Domestic wells in Big Valley Basin • Communication and outreach planning	Virtual
08/19/21	GDE subcommittee meeting	• Identification of GDEs • Groundwater management's potential effects on GDEs	Virtual
08/24/21	SMC subcommittee meeting	• Groundwater levels and change in storage	Virtual
08/27/21	GSPAC meeting	• Communication and engagement planning • HCM, RMS, GDE, and SMC overview and discussion	Virtual
08/27/21	SMC/GDE joint subcommittee meeting	• Surface water depletion (Part 1 of 2)	Virtual
09/02/21	SMC/GDE joint subcommittee meeting	• Surface water depletion (Part 2 of 2)	Virtual
09/02/21	GDE subcommittee meeting	• Monitoring and management actions for GDEs	Virtual
09/24/21	GSPAC meeting	• Draft Communication and Engagement Plan • GSP section updates for RMS, GDE, SMC, and PMA • Model development and preliminary results	Virtual
10/05/21	BOS update	• GSP development status and schedule • Status of draft GSP sections going through preliminary GSPAC and public review • Call for public input on the Draft Communications and Engagement Plan	Virtual
10/08/21	GSPAC meeting	• Section updates for Sections 1-5 • Proposed SMCs, discussion, and guidance process for recommendations	Virtual

Table 7-1. List of Public Meetings for GSP Development in Big Valley Basin (contd.)

Date	Meeting Type	Topic/Focus	Location
10/22/21	GSPAC meeting	• Update on Draft Communications and Engagement Plan • Status of model development • SMC discussion and agreements	Virtual
11/02/21	BOS update	• Status of GSP development activity • Presentation of proposed SMCs	Virtual
11/18/21	Public meeting	• Draft GSP and public comment process	Virtual
11/19/21	GSPAC meeting	• Review of final chapter contents • Public comment period and adoption process	Virtual
12/16/21	Public meeting	• Public Draft GSP comments and update • Adoption process for Big Valley Basin GSP	Virtual
12/17/21	GSPAC meeting	• Final review of contents before GSP adoption	Virtual
01/11/22	BOS meeting	• Public hearing and adoption of Big Valley Basin GSP	Virtual
01/28/21	GSPAC meeting	• Review and analysis of GSPAC activities • Discussion on GSPAC rechartering process and priorities	Virtual
02/XX/22 Date TBD	BOS meeting	• GSP implementation • SGMA long-range timeline, annual reporting, and Five-Year Updates	Virtual
02/XX/22 Date TBD	GSPAC meeting	• Rechartered organization and proposed GSPAC members • Schedule of meetings • Guidance for BVGSA under GSP implementation	Virtual

Key:

BOS = Lake County Board of Supervisors, the sitting Board of Directors for the Big Valley Groundwater Sustainability Agency

BVGSA = Big Valley Groundwater Sustainability Agency

GDE = Groundwater Dependent Ecosystems

GSP = Groundwater Sustainability Plan

GSPAC = Groundwater Sustainability Plan Advisory Committee

HCM = Hydrogeologic Conceptual Model

PMA = Project and Management Actions

RMS = Representative Monitoring Sites

SGMA = Sustainable Groundwater Management Act of 2014

SMC = Sustainable Management Criteria

All of the publicly held meetings listed were recorded during the videoconferences, to facilitate on-demand viewing by community members who were unable to attend any of the scheduled meetings. The archive of meeting agendas, presentation materials, and the individual meeting recordings are available on the BVGSA webpages and in the archives of the Lake County Board of Supervisors meetings.

7.4 Big Valley Basin Communication and Engagement Plan

The Big Valley Basin C&E Plan was developed for the BVGSA by Stantec, with funding provided by DWR's SGMA Facilitation Support Services program. The C&E Plan provides a structure for potential communication and engagement activities that will support the development, adoption, and implementation of a GSP for Big Valley Basin. The purpose of the Plan is to provide options that may aid the BVGSA and technical teams as they work to: (1) meet the regulatory requirements of SGMA, (2) support the GSP development processes (technical, policy, and others, as applicable), and (3) accomplish the communication and engagement objectives specific to the members of the BVGSA.

Every section of the C&E Plan begins with the California Water Code or California Code of Regulations section(s) identifying the applicable requirements for public outreach and engagement under SGMA. Introduction of these requirements serve as a reminder of the applicable regulatory and statutory requirements of SGMA.

7.5 GSP Content Review and Feedback Processes

In an effort to encourage early and ongoing feedback, several opportunities for stakeholder and general public input were offered during GSP development. These stages of development and input included:

> *<u>Step 1: Draft section review by GSPAC</u>*
> *GSP content was drafted in sections and reviewed by the GSPAC, with each member offering direct feedback to the technical team.*
>
> *<u>Step 2: Draft section review by the public</u>*
> *The updated content was then publicly posted and discussed at regularly scheduled and noticed GSPAC meetings, all of which included a designated public comment period on the agenda.*
>
> *<u>Step 3: Draft chapter review by GSPAC and the public</u>*
> *Some sections were then combined and rereleased for public input as full chapters. This content was publicly posted on the BVGSA webpages, promoted on social media, and feedback was requested either via email to the Interested Parties Database or through public comment at any of the GSP-related meetings.*
>
> *<u>Step 4: Draft GSP review and public comment period</u>*
> *The updated chapters and content from previous review periods was compiled into a Draft GSP. The Draft GSP was posted on the BVGSA website in November 2021, initiating a 21-day Draft GSP comment process.*

Throughout the GSP development process, public input was also solicited via the promotion of a single email address, where anyone could submit comments or request additional information. This email address was promoted at every publicly held meeting, in print materials, and on the BVGSA webpages. The email was monitored daily, and members of the BVGSA administration and the facilitation team answered all requests for additional information that were received.

7.6 Draft GSP Comment Period and Response

The GSA held a 21-day public comment period for the Draft GSP from November 12–December 3, 2021. The GSA received five comment letters from four commentors. This included a member of the public, the Lake County Community Development Department, a nongovernmental organization combined letter (Clean Water Action, The Nature Conservancy, Audubon California, Local Government Commission, Union of Concerned Scientists), and the Big Valley Band of Pomo Indians.

7.6.1 Overview of Comments Received on Draft GSP

The commentors' main themes and topics included:

- updating the basin characterization regarding cannabis and the Kelseyville Area Plan
- concerns over water quality including both cyanobacteria and geothermal water intrusion
- requests for additional analysis regarding impacts to disadvantaged communities, domestic well owners, Tribes, and GDEs
- concerns over the monitoring network for both groundwater levels and interconnected surface water
- concerns regarding the MO and MT for depletion of interconnected surface water

The comments were compiled into a matrix and responded to individually. When appropriate, and as noted in the comment matrix, the GSP content was updated. A summary of the public comments received, copies of the letters, and the matrix can be found in **Appendix 7C**.

7.7 Continued Outreach and Engagement During GSP Implementation

The development of this initial GSP is the start of a process that will extend for several decades under the SGMA timeline, through at least 2042. The BVGSA intends to use the foundation of the activities completed during the GSP development process and to look for ways to strengthen those tools and activities; creating new opportunities for engagement.

The BVGSA will keep members of the public and interested parties informed about progress implementing the GSP via relevant emails to the Interested Parties Database, periodic public meetings and educational events, continual Board of Supervisors' updates, and publicly noticed workshops and meetings focused on GSP implementation and groundwater activities.

Emails will be distributed to the Interested Parties Database on a regular basis to inform interested parties about upcoming meetings and public workshops, GSP implementation milestones, and the status of projects and management actions.

The BVGSA plans to maintain an easy-to-access website that includes archived GSP information, educational materials and resources, and promotional materials for generating greater awareness of groundwater issues in the Big Valley Basin. The website will be updated on an as-needed basis to include new information and announcements pertaining to GSP implementation. The website will also serve as a repository for copies of the Big Valley Basin Annual Reports and other materials used and developed during GSP implementation.

It is anticipated that the GSPAC will continue to meet after GSP adoption. The initial GSPAC charter established the group for a term through January 2022, to be rechartered for GSP implementation in February 2022. Meetings of the GSPAC will be held on a schedule established in the new GSPAC charter—but it is likely to meet on a bimonthly or quarterly basis after the initial GSP is submitted. All GSPAC meetings will be noticed on the BVGSA website and via email to the Interested Parties Database.

Additional public outreach activities may be conducted to support planning, design, and construction activities related to the groundwater management projects. Such activities will be noticed on the BVGSA website and via email to the Interested Parties Database.

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Resolution 2022-07 to Adopt the GSP

BOARD OF DIRECTORS
LAKE COUNTY WATERSHED PROTECTION DISTRICT
RESOLUTION ADOPTING A GROUNDWATER SUSTAINAIBILITY PLAN FOR THE BIG VALLEY GROUNDWATER BASIN OF LAKE COUNTY, CA

RESOLUTION NO. 2022-07

WHEREAS, the Sustainable Groundwater Management Act (SGMA) was signed into law on September 16, 2014 and went into effect as California Water Code, section 10720 et. seq. on January 1, 2015; and

WHEREAS, SGMA requires high- and medium- priority basins, as designated by the California Department of Water Resources (DWR) Bulletin 118, to be managed by one or more Groundwater Sustainability Agencies (GSA); and

WHEREAS, the Big Valley Groundwater Basin (5-015) of Lake County, CA has been designated by DWR as a medium-priority basin; and,

WHEREAS, the Board of Directors of the Lake County Watershed Protection District (Board of Directors) elected to form and serve as the Big Valley GSA (BVGSA) on August 27, 2019 for the Big Valley Groundwater Basin (5-105); and,

WHEREAS, SGMA requires that all basins designated by DWR Bulletin 118 as high-or medium-priority basins and not subject to critical conditions of overdraft be managed by a Groundwater Sustainability Plan (GSP) by January 31, 2022; and,

WHEREAS, the BVGSA filed an initial notification of its intent to develop a GSP for the Big Valley Groundwater Basin in accordance with Water Code Section 10727.8 on September 4, 2020; and,

WHEREAS, the BVGSA held a hearing on January 11, 2022 for the purpose of receiving public comment and consideration of the adoption of the GSP for the Big Valley Groundwater Basin.

NOW THEREFORE, BE IT RESOLVED by the Board of Directors acting as the Big Valley GSA as follows:

1. The foregoing is true and correct.

2. The GSP, in the form presented to this day to the Board of Directors and subject to any final non-substantive edits that may be made at the Watershed Protection Districts Director (Director) discretion prior to submittal to DWR, is hereby approved and adopted.

3. The Director or their appointee is authorized and directed to timely provide notification of this approval and adoption to DWR, including a copy of this Resolution, the approved GSP, and any additional information required by SGMA.

THIS RESOLUTION was passed by the Board of Directors acting as the Big Valley GSA at a regular meeting thereof held on January 11 ____________________, 2022 by the following vote:

AYES: Supervisors Simon, Sabatier, Scott, Pyska, and Crandell

NOES: None

ABSENT OR NOT VOTING: None

ATTEST: CAROL J. HUCHINGSON
Clerk of the Board

By: Johanna DeLong ____________________

____
Chair, Board of Directors

BOARD OF SUPERVISORS LAKE COUNTY, CAL.

APPROVED AS TO FORM:
ANITA L. GRANT
County Counsel

By: ____________________

APPENDIX 1B

GSA Formation Documents

BVGSA Charter

BOARD OF DIRECTORS
LAKE COUNTY WATERSHED PROTECTION DISTRICT
RESOLUTION APPROVING AND ACCEPTING THE BIG VALLEY GROUNDWATER SUSTAINABILITY AGENCY (GSA) CHARTER DOCUMENT

RESOLUTION NO. 2021-50

WHEREAS, the Sustainable Groundwater Management Act (SGMA) was signed into law on September 16, 2014 and went into effect as California Water Code, section 10720 et. seq. on January 1, 2015; and

WHEREAS, SGMA requires high and medium priority basins to be managed by one or more groundwater sustainability agencies (GSA); and

WHEREAS, the Board of Directors of the Lake County Watershed Protection District (Board of Directors) elected to form and serve as the Big Valley GSA (BVGSA) on August 27, 2019 for the Big Valley Groundwater Basin (5-105); and,

WHEREAS, Water Code section 10723.2 requires that a GSA considers the interests of all beneficial uses and users of groundwater, as well as those responsible for implementing groundwater sustainability plans (GSP); and

WHEREAS, the BVGSA is committed to working with regional partners to sustainably manage the groundwater resources through a GSA Advisory Group including county, tribal, municipal water suppliers, Chi Council, domestic well owner and agricultural representatives in and around the Big Valley Groundwater Basin; and

WHEREAS, A group of stakeholders has been participating in the past year in surveys, interviews, and sharing sessions as a basis for bringing together elements for a draft Charter for the Big Valley GSP Advisory Committee (GSPAC); and

WHEREAS, these stakeholders were selected based on their geographic location in Big Valley, for their identification as beneficial users and uses of groundwater within the Big Valley Basin, and for their previous experience in working on groundwater and water resources-related activities in Lake County; and

WHEREAS, the GSPAC Charter being presented to the Board of Directors, as the sitting Board of the BVGSA, includes details on the intent of, structure for, process of, reporting from, and duration of the initial GSPAC; and

WHEREAS, acceptance of this Charter allows the GSPAC members to formally convene in regular and ad hoc meetings, that will be publicly noticed and open to the public, as the BVGSA takes GSPAC guidance and recommendations while working through the development, adoption, and submission of its GSP due on January 31, 2022.

NOW THEREFORE, BE IT RESOLVED that the Board of Directors acting as the Big Valley GSA approve and accept the Big Valley GSA Charter Document.

THIS RESOLUTION was passed by the Directors acting as the Big Valley GSA at a regular meeting thereof held on April 27, 2021 by the following vote:

AYES: Supervisors Simon, Crandell, Scott, Pyska, and Sabatier

NOES: None

ABSENT OR NOT VOTING: None

ATTEST: CAROL J. HUCHINGSON
Clerk of the Board

By: johanna peelen (Apr 27, 2021 17:23 PDT)

Bruno Sabatier (Apr 27, 2021 22:45 PDT)
Chair, Board of Directors

BOARD OF SUPERVISORS LAKE COUNTY, CAL.

APPROVED AS TO FORM:
ANITA L. GRANT
County Counsel

By:

Big Valley Groundwater Sustainability Agency
Groundwater Sustainability Plan Advisory Committee
CHARTER

INTRODUCTION

The Sustainable Groundwater Management Act of 2014 (SGMA) provides a framework for sustainable management of groundwater supplies by local authorities. It also requires the formation of local Groundwater Sustainability Agencies (GSA). In August of 2019, in compliance with SGMA, the Lake County Board of Supervisors formed the Big Valley Groundwater Sustainability Agency (BVGSA). The BVGSA will assess conditions in the Big Valley groundwater subbasin and create and adopt a locally developed Groundwater Sustainability Plan (GSP). The Board of Directors of the BVGSA is the standing Lake County Board of Supervisors.

PURPOSE AND GOALS

The BVGSA GSP Advisory Committee (GSPAC) has been formed to advise the Lake County Board of Supervisors on the development of the Big Valley Subbasin Groundwater Sustainability Plan (GSP). The intent of the GSPAC is to provide community stakeholder perspective and participation in local SGMA implementation.

BACKGROUND AND IMPORTANCE

Due to regulations and legislative deadlines, completion of the GSP is time critical. The GSPAC will be instrumental in helping the BVGSA move through the GSP development process. Failure to meet these requirements could subject the subbasin to management by the State Water Resources Control Board. The focus of all BVGSA SGMA-related groundwater efforts is to maintain local management of Big Valley Subbasin groundwater resources, as stakeholders and the community work toward groundwater sustainability.

MISSION, KEY TASKS, AND DELIVERABLES

The GSPAC will review and provide recommendations to the BVGSA Board. The group is charged with undertaking activities including:

- Holding regular monthly meetings to discuss progress on GSP development
- Receiving background information and technical content updates
- Conducting GSP content review
- Providing community education and outreach as outlined in a Communications and Engagement Plan
- Keeping a decision log of key issues, discussion items, and decision-making outcomes

- Providing guidance to BVGSA Board and Lake County Watershed Protection District on groundwater-related issues, activities, and community engagement.

OUTCOMES

Products and recommendations of the group will be transmitted to the Lake County Board of Supervisors, as the standing Board of Directors for the BVGSA. GSPAC written recommendations will be provided in periodic reports and updates. The recommendations will identify the range of group perspectives and areas of agreement and disagreement on GSP related matters. Recommendations will be given the highest level of consideration in the development of the BVGSA GSP due for submission to the California Department of Water Resources on January 31, 2022.

ORGANIZATIONAL STRUCTURE AND MEMBERSHIP

The GSPAC will adopt a Charter describing its purpose, operating principles, and ground rules that will be accepted by the BVGSA Board of Directors.

The GSPAC is composed, as an ad-hoc advisory committee of Big Valley community members representatives, of a variety of groundwater beneficial users, as defined by SGMA regulations (Section 10723.2). GSPAC members are to:

- Serve as a strong, effective advocate for the interest group represented
- Work collaboratively with others
- Commit time needed for ongoing discussions
- Collectively reflect diversity of interests
- Act as a liaison to communicate information to and from their organizations
- Act in a manner that will enhance trust among all stakeholders
- Contribute technical expertise, data/information to clarify issues, eliminate false assumptions, and advance innovation in creating project advice for the area under consideration

The GSPAC will be most effective when the same member participant attends all meetings; however, each representative may nominate an alternate to fill in, as necessary. Alternates are expected to be fully briefed and able to represent the member during discussions and decision-making. Selected members include representatives from the following:

Beneficial User Category	Member	Staff Representative
Agricultural Users	Lake County Farm Bureau	Brenna Sullivan
Agricultural Users	Scully Packing Company	Pat Scully
Agricultural Users	Bella Vista Farming Company	David Weiss
Environmental/Ecosystem	Chi Council for the Clear Lake Hitch	Peter Windrem
Environmental/Ecosystem	open	open
Disadvantaged Community	open	open

Private Users – domestic well owner	open	open
Private Users – school district	Kelseyville Unified School District	Kyle Reams
Tribal Government	Big Valley Band of Pomo Indians	Sarah Ryan
Urban Users	Special Districts	Scott Hornung
Urban Users	Lake County Watershed Protection District	Marina Deligiannis

Member categories designated as "open" reflect beneficial user categories where the BVGSA is interested in identifying a local representative. Individuals interested in an open position should attend a GSPAC meeting, once the BVGSA has formally recognized the chartered committee, to express interest in serving on the GSPAC. These member positions may be filled at the agreement of the named GSPAC members, and with the approval of the BVGSA Board.

One designated member, selected by the membership as a whole, will act as the GSPAC lead. This person will be responsible for reporting consensus, progress, or perspectives that come out of GSPAC meetings and discussions, to provide guidance for the BVGSA Board. At the inception of the GSPAC, Marina Deligiannis, Deputy Director of Water Resources for the Lake County Watershed Protection District will serve as GSPAC lead.

Subcommittees may be convened by the GSPAC to address specific issues and to conduct specific tasks to advance its work. The GSPAC will develop a clear charge and scope of work for any subcommittee, bounded by specific timeframes and specific technical or policy questions to be considered. Subcommittees will be composed of GSPAC members and individuals with expertise necessary to address the questions under consideration. Subcommittee meetings will also be open to the public. In lieu of a subcommittee, it may be decided that a technical workshop be hosted by the GSPAC to focus on a key topic or technical issue.

KEY RESOURCES

In addition to the GSPAC members, key team resources will be integrated into the advisory committee process. These additional participants include, but are not limited to:

Lake County Watershed Protection District Staff: in addition to having a designated GSPAC member, other Lake County Watershed Protection District staff will be assisting with the activities and efforts of the GSPAC. Staff will be responsible for executing the Charter and coordinating with other Lake County staff and officials as needed.

GSP Technical Contractor Staff: consists of subject-matter experts working on the GSP development contractor team. Contractor staff members will communicate with the GSPAC and convene with them as needed to review, discuss, plan, and support the GSP development team on specific work assignments.

Additional Key Technical Support: will be provided by resource experts who function as technical advisors during ongoing discussions and development of the BVGSA GSP. Technical advisors may participate in GSPAC meetings to serve as an important resource on complex technical questions and issues. Technical support can come from the GSP development contractor team, Lake County internal personnel or contractor teams, or subject-matter experts that provide additional perspective and expertise.

Facilitation Team: The GSPAC will be facilitated by a neutral third-party group, Stantec Consulting, as contract resources are available. Facilitation services include GSPAC meeting coordination and planning, meeting facilitation, and assistance in the development of the GSPAC Charter and a BVGSA Communications and Engagement Plan. The facilitation team is focused on ensuring an open and productive process where all member interests are voiced, heard, and thoughtfully considered.

ATTENDANCE AND OPEN PROCESS

It is expected that GSPAC members will attend all scheduled meetings and, with proper notice, any ad hoc meetings that are convened for technical review during GSP development. If a member is not able to attend a GSPAC meeting, every attempt should be made to send a fully briefed alternate to participate in the meeting.

All meetings of the GSPAC are open to the public, and meetings will be announced through the BVGSA's communications channels, including the Lake County-managed list of interested parties, via postings on the Lake County groundwater website, and community calendar announcements. Opportunities to receive community input will include public comment periods during all GSPAC meetings and via continuous acceptance of written comments that can be submitted via email or through the Lake County groundwater website.

DECISION-MAKING PROCESS

The BVGSA Board will consider GSPAC recommendations when making decisions. GSPAC recommendations will be fact-based and rely on the best available science. If the BVGSA Board does not agree with the recommendations of the GSPAC, the GSA Board shall state the reasons for its decision.

Consensus Seeking

The GSPAC will be a consensus-seeking committee. Consensus here means that all group members either support or can live with a recommendation. In reaching consensus, it is useful to refer to the Gradients of Agreement below. This scale makes it easier for participants to determine their position and register less-than-whole-hearted support in an effort to reflect the variety of perspectives and levels of agreement.

1	2	3	4	5		6
Fully endorse!	Endorsement with minor issues	Conditional agreement	Stand Aside / Abstain / Neutral	Disagreement		Reject
I strongly support the proposal.	I generally like it. Proceed with my support.	I can support if some steps are taken now or in the future.	I neither support nor reject the proposal – Proceed.	I don't agree with the proposal in its current form but will not reject it outright.		I cannot support the proposal at all.

When unable to reach consensus on recommendations, the GSPAC will outline the areas in which it does not agree, providing key discussion points and an explanation to inform GSA Board decision-making.

The GSPAC, in coordination with the facilitation team, will develop and archive meeting notes memorializing discussion points, agreements, the range of opinions when consensus is not achieved, action items, and next steps. Meeting notes will capture the names of GSPAC members in support or opposition when making decisions including, but not limited to, recommendations to the BVGSA Board. Following GSPAC meetings, meeting notes will be distributed to all GSPAC members for review and comments, and comments received by GSPAC members and a draft final version will be prepared for review and approval at the subsequent GSPAC meeting. The facilitation team then distributes the final, approved meeting notes to the GSPAC.

DURATION AND COMPLETION DATE

The GSPAC will be formally acknowledged upon the BVGSA Board's review and approval of this Charter. Regularly scheduled monthly meetings for the GSPAC will begin in May 2021, with ad hoc meetings being added throughout the duration of GSP development. The terms of engagement for the identified members of the GSPAC is through the BVGSA GSP submission date of January 31, 2022 and may be reconvened in the event there is a need to respond to comments received after review by DWR.

PARTICIPATION AND PROCESS AGREEMENTS

The GSPAC members acknowledge the following protocols and agreements for all meetings and efforts related to GSP development for the Big Valley Subbasin.

<u>Participation and Collaboration</u>

Engage Actively and Fully. The more you put in, the more you will get out. The more you put in, the more other people, and the process as a whole, get out as well.

Be Present. Give each other the gift of our time, meaning please refrain from non-meeting related activities, such as checking emails, texts, answering phone calls—except during breaks.

Listen Generously. Listen with the intent of finding what we have in common, while practicing patience, attention, and respect for different views.

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Suspend Certainty. Be curious and respectful about new information, alternative approaches, and differing opinions.

Process Agreements

Meeting Attendance. All GSPAC members will make every effort to attend all committee meetings. Consistent attendance is critical to ensure the creation of shared knowledge and a common language. Meetings will start on time. GSPAC members who know that they will be absent, late, or have to leave early will inform facilitators in advance. After a missed meeting, GSPAC members will work to get up to speed.

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GSPAC members are encouraged to attend and participate in all BVGSA and groundwater-related meetings, such as standing Board of Supervisors meetings with BVGSA updates and community engagement public meetings that will be held often throughout GSP development. These are ideal ways for members to deepen their understanding of the issues and attendance is encouraged.

RESOURCES

All initial GSPAC meetings will be held virtually, via Zoom, and a virtual component for meeting attendance will be included if in-person meetings are allowable in the GSP development timeframe. All GSPAC members will have access to background materials, content documents, meeting agendas and archived notes via a GSPAC-designated SharePoint site.

CHARTER AMENDMENTS

The GSPAC may recommend future additions or updates to this Charter by presenting those changes to the BVGSA Board for consideration, discussion, and acceptance. All changes to the Charter will be made in the form of amendments to this original document.

CHARTER ACCEPTANCE DATE

The Lake County Board of Supervisors approved the GSPAC Charter on [insert day, month, year] during a regularly scheduled Lake County Board of Supervisors meeting.

BVGSA GSP Advisory Committee Charter

Big Valley Groundwater Sustainability Agency
Groundwater Sustainability Plan Advisory Committee
CHARTER

INTRODUCTION

The Sustainable Groundwater Management Act of 2014 (SGMA) provides a framework for sustainable management of groundwater supplies by local authorities. It also requires the formation of local Groundwater Sustainability Agencies (GSA). In August of 2019, in compliance with SGMA, the Lake County Board of Supervisors formed the Big Valley Groundwater Sustainability Agency (BVGSA). The BVGSA will assess conditions in the Big Valley groundwater Basin and create and adopt a locally developed Groundwater Sustainability Plan (GSP). The Board of Directors of the BVGSA is the standing Lake County Board of Supervisors.

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Disadvantaged Community	open	open

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RESOURCES

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CHARTER AMENDMENTS

The GSPAC may recommend future additions or updates to this Charter by presenting those changes to the BVGSA Board for consideration, discussion, and acceptance. All changes to the Charter will be made in the form of amendments to this original document.

CHARTER ACCEPTANCE DATE

The Lake County Board of Supervisors approved the GSPAC Charter on 27, April, 2021 during a regularly scheduled Lake County Board of Supervisors meeting.

APPENDIX 1C

Elements Guide

Article 5.			Plan Contents for Sample Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
§ 354.			**Introduction to Plan Contents**					
			This Article describes the required contents of Plans submitted to the Department for evaluation, including administrative information, a description of the basin setting, sustainable management criteria, description of the monitoring network, and projects and management actions.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
SubArticle 1.			**Administrative Information**					
§ 354.2.			**Introduction to Administrative Information**					
			This Subarticle describes information in the Plan relating to administrative and other general information about the Agency that has adopted the Plan and the area covered by the Plan.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.4.			**General Information**					
			Each Plan shall include the following general information:					
(a)			An executive summary written in plain language that provides an overview of the Plan and description of groundwater conditions in the basin.	5:19	ES			
(b)			A list of references and technical studies relied upon by the Agency in developing the Plan. Each Agency shall provide to the Department electronic copies of reports and other documents and materials cited as references that are not generally available to the public.	354:358	8			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10733.2 and 10733.4, Water Code.					
§ 354.6.			**Agency Information**					
			When submitting an adopted Plan to the Department, the Agency shall include a copy of the information provided pursuant to Water Code Section 10723.8, with any updates, if necessary, along with the following information:					
(a)			The name and mailing address of the Agency.	37	1.3			
(b)			The organization and management structure of the Agency, identifying persons with management authority for implementation of the Plan.	37	1.3			
(c)			The name and contact information, including the phone number, mailing address and electronic mail address, of the plan manager.	37	1.3			
(d)			The legal authority of the Agency, with specific reference to citations setting forth the duties, powers, and responsibilities of the Agency, demonstrating that the Agency has the legal authority to implement the Plan.	38	1.3.2			
(e)			An estimate of the cost of implementing the Plan and a general description of how the Agency plans to meet those costs.	38, 339:340	1.3.3, 6.5			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.8, 10727.2, and 10733.2, Water Code.					
§ 354.8.			**Description of Plan Area**					

Article 5.			Plan Contents for Sample Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
			Each Plan shall include a description of the geographic areas covered, including the following information:					
(a)			One or more maps of the basin that depict the following, as applicable:					
	(1)		The area covered by the Plan, delineating areas managed by the Agency as an exclusive Agency and any areas for which the Agency is not an exclusive Agency, and the name and location of any adjacent basins.	36		1-1		
	(2)		Adjudicated areas, other Agencies within the basin, and areas covered by an Alternative.	49:52	2.1.1			
	(3)		Jurisdictional boundaries of federal or state land (including the identity of the agency with jurisdiction over that land), tribal land, cities, counties, agencies with water management responsibilities, and areas covered by relevant general plans.	50		2-1		
	(4)		Existing land use designations and the identification of water use sector and water source type.	52:56	2.1.2	2-2		
	(5)		The density of wells per square mile, by dasymetric or similar mapping techniques, showing the general distribution of agricultural, industrial, and domestic water supply wells in the basin, including de minimis extractors, and the location and extent of communities dependent upon groundwater, utilizing data provided by the Department, as specified in Section 353.2, or the best available information.	61:62		2-4, 2-5		
(b)			A written description of the Plan area, including a summary of the jurisdictional areas and other features depicted on the map.	49:74, 50	2.1	2-1		
(c)			Identification of existing water resource monitoring and management programs, and description of any such programs the Agency plans to incorporate in its monitoring network or in development of its Plan. The Agency may coordinate with existing water resource monitoring and management programs to incorporate and adopt that program as part of the Plan.	65:73	2.1.5:2.1.6			
(d)			A description of how existing water resource monitoring or management programs may limit operational flexibility in the basin, and how the Plan has been developed to adapt to those limits.	65	2.1.5			
(e)			A description of conjunctive use programs in the basin.	72	2.1.6.2			
(f)			A plain language description of the land use elements or topic categories of applicable general plans that includes the following:					
	(1)		A summary of general plans and other land use plans governing the basin.	56:57	2.1.2.4			
	(2)		A general description of how implementation of existing land use plans may change water demands within the basin or affect the ability of the Agency to achieve sustainable groundwater management over the planning and implementation horizon, and how the Plan addresses those potential effects	56:57	2.1.2.4			
	(3)		A general description of how implementation of the Plan may affect the water supply assumptions of relevant land use plans over the planning and implementation horizon.	56:57	2.1.2.4			

Article 5.			Plan Contents for Sample Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
	(4)		A summary of the process for permitting new or replacement wells in the basin, including adopted standards in local well ordinances, zoning codes, and policies contained in adopted land use plans.	73	2.1.6.4			
	(5)		To the extent known, the Agency may include information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management.	56:57	2.1.2.4			The County General Plan is inclusive of the Basin and areas outside the Basin.
(g)			A description of any of the additional Plan elements included in Water Code Section 10727.4 that the Agency determines to be appropriate.	73:74	2.1.7			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10720.3, 10727.2, 10727.4, 10733, and 10733.2, Water Code.					
§ 354.10.			**Notice and Communication**					
			Each Plan shall include a summary of information relating to notification and communication by the Agency with other agencies and interested parties including the following:					
(a)			A description of the beneficial uses and users of groundwater in the basin, including the land uses and property interests potentially affected by the use of groundwater in the basin, the types of parties representing those interests, and the nature of consultation with those parties.	345	7.2			
(b)			A list of public meetings at which the Plan was discussed or considered by the Agency.	346:350	7.3.2		7-1	
(c)			Comments regarding the Plan received by the Agency and a summary of any responses by the Agency.	351	7.6			Also see Appendix 7C for more detailed information and a copy of the public comment letters.
(d)			A communication section of the Plan that includes the following:					
	(1)		An explanation of the Agency's decision-making process.	344:345	7.1			
	(2)		Identification of opportunities for public engagement and a discussion of how public input and response will be used.	346:350	7.3			
	(3)		A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of the population within the basin.	346:350	7.3			
	(4)		The method the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions.	346	7.3.1			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.8, 10728.4, and 10733.2, Water Code					
SubArticle 2.			**Basin Setting**					
§ 354.12.			**Introduction to Basin Setting**					

Article 5.			Plan Contents for Sample Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
			This Subarticle describes the information about the physical setting and characteristics of the basin and current conditions of the basin that shall be part of each Plan, including the identification of data gaps and levels of uncertainty, which comprise the basin setting that serves as the basis for defining and assessing reasonable sustainable management criteria and projects and management actions. Information provided pursuant to this Subarticle shall be prepared by or under the direction of a professional geologist or professional engineer.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.14.			**Hydrogeologic Conceptual Model**					
(a)			Each Plan shall include a descriptive hydrogeologic conceptual model of the basin based on technical studies and qualified maps that characterizes the physical components and interaction of the surface water and groundwater systems in the basin.	75:104	2.2.1			
(b)			The hydrogeologic conceptual model shall be summarized in a written description that includes the following:					
	(1)		The regional geologic and structural setting of the basin including the immediate surrounding area, as necessary for geologic consistency.	75	2.2.1.1			
	(2)		Lateral basin boundaries, including major geologic features that significantly affect groundwater flow.	97	2.2.1.8			
	(3)		The definable bottom of the basin.	97:98	2.2.1.8	2-18		
	(4)		Principal aquifers and aquitards, including the following information:					
		(A)	Formation names, if defined.	78:81	2.2.1.5			
		(B)	Physical properties of aquifers and aquitards, including the vertical and lateral extent, hydraulic conductivity, and storativity, which may be based on existing technical studies or other best available information.	99:104	2.2.1.9			
		(C)	Structural properties of the basin that restrict groundwater flow within the principal aquifers, including information regarding stratigraphic changes, truncation of units, or other features.	75:76	2.2.1.2			
		(D)	General water quality of the principal aquifers, which may be based on information derived from existing technical studies or regulatory programs.	117:124	2.2.2.3			
		(E)	Identification of the primary use or uses of each aquifer, such as domestic, irrigation, or municipal water supply.	63:64	2.1.4			
	(5)		Identification of data gaps and uncertainty within the hydrogeologic conceptual model	104	2.2.1.10			
(c)			The hydrogeologic conceptual model shall be represented graphically by at least two scaled cross-sections that display the information required by this section and are sufficient to depict major stratigraphic and structural features in the basin.	85:96	2.2.1.7			
(d)			Physical characteristics of the basin shall be represented on one or more maps that depict the following:					

				GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
	(1)		Topographic information derived from the U.S. Geological Survey or another reliable source.	110	2.2.2.1	2-24		
	(2)		Surficial geology derived from a qualified map including the locations of cross-sections required by this Section.	76	2.2.1.2	2-8		
	(3)		Soil characteristics as described by the appropriate Natural Resources Conservation Service soil survey or other applicable studies.	103	2.2.1.9	2-21		
	(4)		Delineation of existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas, including significant active springs, seeps, and wetlands within or adjacent to the basin.	102:103	2.2.1.9	2-21		
	(5)		Surface water bodies that are significant to the management of the basin.	57:60	2.1.3.1	2-3		
	(6)		The source and point of delivery for imported water supplies.	N/A				There are no imported water supplies into Big Valley Basin.
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10727.2, 10733, and 10733.2, Water Code.					
§ 354.16.			**Groundwater Conditions**					
			Each Plan shall provide a description of current and historical groundwater conditions in the basin, including data from January 1, 2015, to current conditions, based on the best available information that includes the following:					
(a)			Groundwater elevation data demonstrating flow directions, lateral and vertical gradients, and regional pumping patterns, including:					
	(1)		Groundwater elevation contour maps depicting the groundwater table or potentiometric surface associated with the current seasonal high and seasonal low for each principal aquifer within the basin.	104:113	2.2.2.1	2-24, 2-25, 2-26, 2-27		
	(2)		Hydrographs depicting long-term groundwater elevations, historical highs and lows, and hydraulic gradients between principal aquifers.	105	2.2.2.1	2-22		Additional hydrographs can be found in Appendix 2A
(b)			A graph depicting estimates of the change in groundwater in storage, based on data, demonstrating the annual and cumulative change in the volume of groundwater in storage between seasonal high groundwater conditions, including the annual groundwater use and water year type.	114:116	2.2.2.2	2-29		Change in groundwater storage is depicted in a map.
(c)			Seawater intrusion conditions in the basin, including maps and cross-sections of the seawater intrusion front for each principal aquifer.	N/A				Seawater intrusion is not present nor is expected to occur in Big Valley Basin.
(d)			Groundwater quality issues that may affect the supply and beneficial uses of groundwater, including a description and map of the location of known groundwater contamination sites and plumes.	117:124	2.2.2.3	2-34		
(e)			The extent, cumulative total, and annual rate of land subsidence, including maps depicting total subsidence, utilizing data available from the Department, as specified in Section 353.2, or the best available information.	125:126	2.2.2.4	2-35		
(f)			Identification of interconnected surface water systems within the basin and an estimate of the quantity and timing of depletions of those systems, utilizing data available from the Department, as specified in Section 353.2, or the best available information.	127:144	2.2.2.5			

Article 5.			Plan Contents for Sample Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(g)			Identification of groundwater dependent ecosystems within the basin, utilizing data available from the Department, as specified in Section 353.2, or the best available information.	145:163	2.2.3			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.2, 10727.4, and 10733.2, Water Code.					
§ 354.18.			**Water Budget**					
(a)			Each Plan shall include a water budget for the basin that provides an accounting and assessment of the total annual volume of groundwater and surface water entering and leaving the basin, including historical, current and projected water budget conditions, and the change in the volume of water stored. Water budget information shall be reported in tabular and graphical form.	164:249	2.2.4			
(b)			The water budget shall quantify the following, either through direct measurements or estimates based on data:					
	(1)		Total surface water entering and leaving a basin by water source type.	181:247	2.2.4.6:2.2.4.11			
	(2)		Inflow to the groundwater system by water source type, including subsurface groundwater inflow and infiltration of precipitation, applied water, and surface water systems, such as lakes, streams, rivers, canals, springs and conveyance systems.	181:247	2.2.4.6:2.2.4.11			
	(3)		Outflows from the groundwater system by water use sector, including evapotranspiration, groundwater extraction, groundwater discharge to surface water sources, and subsurface groundwater outflow.	181:247	2.2.4.6:2.2.4.11			
	(4)		The change in the annual volume of groundwater in storage between seasonal high conditions.	181:247	2.2.4.6:2.2.4.11			
	(5)		If overdraft conditions occur, as defined in Bulletin 118, the water budget shall include a quantification of overdraft over a period of years during which water year and water supply conditions approximate average conditions.	N/A				Big Valley Basin is not in an overdraft condition as evidence by the relatively stable groundwater elevations.
	(6)		The water year type associated with the annual supply, demand, and change in groundwater stored.	167	2.2.4.3		2-7	
	(7)		An estimate of sustainable yield for the basin.	250-252	2.2.5			
(c)			Each Plan shall quantify the current, historical, and projected water budget for the basin as follows:					
	(1)		Current water budget information shall quantify current inflows and outflows for the basin using the most recent hydrology, water supply, water demand, and land use information.	198:201	2.2.4.7			
	(2)		Historical water budget information shall be used to evaluate availability or reliability of past surface water supply deliveries and aquifer response to water supply and demand trends relative to water year type. The historical water budget shall include the following:					

				GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
		(A)	A quantitative evaluation of the availability or reliability of historical surface water supply deliveries as a function of the historical planned versus actual annual surface water deliveries, by surface water source and water year type, and based on the most recent ten years of surface water supply information.	N/A				There are no surface water deliveries in Big Valley Basin.
		(B)	A quantitative assessment of the historical water budget, starting with the most recently available information and extending back a minimum of 10 years, or as is sufficient to calibrate and reduce the uncertainty of the tools and methods used to estimate and project future water budget information and future aquifer response to proposed sustainable groundwater management practices over the planning and implementation horizon.	181:197	2.2.4.6			
		(C)	A description of how historical conditions concerning hydrology, water demand, and surface water supply availability or reliability have impacted the ability of the Agency to operate the basin within sustainable yield. Basin hydrology may be characterized and evaluated using water year type.	181:197	2.2.4.6			
	(3)		Projected water budgets shall be used to estimate future baseline conditions of supply, demand, and aquifer response to Plan implementation, and to identify the uncertainties of these projected water budget components. The projected water budget shall utilize the following methodologies and assumptions to estimate future baseline conditions concerning hydrology, water demand and surface water supply availability or reliability over the planning and implementation horizon:					
		(A)	Projected hydrology shall utilize 50 years of historical precipitation, evapotranspiration, and streamflow information as the baseline condition for estimating future hydrology. The projected hydrology information shall also be applied as the baseline condition used to evaluate future scenarios of hydrologic uncertainty associated with projections of climate change and sea level rise.	201:247	2.2.4.8:2.2.4.11			
		(B)	Projected water demand shall utilize the most recent land use, evapotranspiration, and crop coefficient information as the baseline condition for estimating future water demand. The projected water demand information shall also be applied as the baseline condition used to evaluate future scenarios of water demand uncertainty associated with projected changes in local land use planning, population growth, and climate.	201:247	2.2.4.8:2.2.4.11			
		(C)	Projected surface water supply shall utilize the most recent water supply information as the baseline condition for estimating future surface water supply. The projected surface water supply shall also be applied as the baseline condition used to evaluate future scenarios of surface water supply availability and reliability as a function of the historical surface water supply identified in Section 354.18(c)(2)(A), and the projected changes in local land use planning, population growth, and climate.	201:247	2.2.4.8:2.2.4.11			
(d)			The Agency shall utilize the following information provided, as available, by the Department pursuant to Section 353.2, or other data of comparable quality, to develop the water budget:					

				GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
	(1)		Historical water budget information for mean annual temperature, mean annual precipitation, water year type, and land use.	181:197	2.2.4.6			
	(2)		Current water budget information for temperature, water year type, evapotranspiration, and land use.	198:201	2.2.4.7			
	(3)		Projected water budget information for population, population growth, climate change, and sea level rise.	203	2.2.4.8		2-20	
(e)			Each Plan shall rely on the best available information and best available science to quantify the water budget for the basin in order to provide an understanding of historical and projected hydrology, water demand, water supply, land use, population, climate change, sea level rise, groundwater and surface water interaction, and subsurface groundwater flow. If a numerical groundwater and surface water model is not used to quantify and evaluate the projected water budget conditions and the potential impacts to beneficial uses and users of groundwater, the Plan shall identify and describe an equally effective method, tool, or analytical model to evaluate projected water budget conditions.	164:249	2.2.4			
(f)			The Department shall provide the California Central Valley Groundwater-Surface Water Simulation Model (C2VSIM) and the Integrated Water Flow Model (IWFM) for use by Agencies in developing the water budget. Each Agency may choose to use a different groundwater and surface water model, pursuant to Section 352.4.	166:169	2.2.4.3			The Big Valley Integrated Hydrologic Model utilized MODFLOW.
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10721, 10723.2, 10727.2, 10727.6, 10729, and 10733.2, Water Code.					
§ 354.20.			**Management Areas**					
(a)			Each Agency may define one or more management areas within a basin if the Agency has determined that creation of management areas will facilitate implementation of the Plan. Management areas may define different minimum thresholds and be operated to different measurable objectives than the basin at large, provided that undesirable results are defined consistently throughout the basin.	304	4.12			There are no management areas in Big Valley Basin.
(b)			A basin that includes one or more management areas shall describe the following in the Plan:					
	(1)		The reason for the creation of each management area.	N/A				There are no management areas in Big Valley Basin.
	(2)		The minimum thresholds and measurable objectives established for each management area, and an explanation of the rationale for selecting those values, if different from the basin at large.	N/A				There are no management areas in Big Valley Basin.
	(3)		The level of monitoring and analysis appropriate for each management area.	N/A				There are no management areas in Big Valley Basin.
	(4)		An explanation of how the management area can operate under different minimum thresholds and measurable objectives without causing undesirable results outside the management area, if applicable.	N/A				There are no management areas in Big Valley Basin.

Article 5.			Plan Contents for Sample Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(c)			If a Plan includes one or more management areas, the Plan shall include descriptions, maps, and other information required by this Subarticle sufficient to describe conditions in those areas.	N/A				There are no management areas in Big Valley Basin.
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10733.2 and 10733.4, Water Code.					
SubArticle 3.			**Sustainable Management Criteria**					
§ 354.22.			**Introduction to Sustainable Management Criteria**					
			This Subarticle describes criteria by which an Agency defines conditions in its Plan that constitute sustainable groundwater management for the basin, including the process by which the Agency shall characterize undesirable results, and establish minimum thresholds and measurable objectives for each applicable sustainability indicator.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.24.			**Sustainability Goal**					
			Each Agency shall establish in its Plan a sustainability goal for the basin that culminates in the absence of undesirable results within 20 years of the applicable statutory deadline. The Plan shall include a description of the sustainability goal, including information from the basin setting used to establish the sustainability goal, a discussion of the measures that will be implemented to ensure that the basin will be operated within its sustainable yield, and an explanation of how the sustainability goal is likely to be achieved within 20 years of Plan implementation and is likely to be maintained through the planning and implementation horizon.	275	4.3			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10721, 10727, 10727.2, 10733.2, and 10733.8, Water Code.					
§ 354.26.			**Undesirable Results**					
(a)			Each Agency shall describe in its Plan the processes and criteria relied upon to define undesirable results applicable to the basin. Undesirable results occur when significant and unreasonable effects for any of the sustainability indicators are caused by groundwater conditions occurring throughout the basin.	276:303	4.4:4.9			
(b)			The description of undesirable results shall include the following:					
	(1)		The cause of groundwater conditions occurring throughout the basin that would lead to or has led to undesirable results based on information described in the basin setting, and other data or models as appropriate.	276:303	4.4:4.9			
	(2)		The criteria used to define when and where the effects of the groundwater conditions cause undesirable results for each applicable sustainability indicator. The criteria shall be based on a quantitative description of the combination of minimum threshold exceedances that cause significant and unreasonable effects in the basin.	276:303	4.4:4.9			

				GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
	(3)		Potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results.	276:303	4.4:4.9			
(c)			The Agency may need to evaluate multiple minimum thresholds to determine whether an undesirable result is occurring in the basin. The determination that undesirable results are occurring may depend upon measurements from multiple monitoring sites, rather than a single monitoring site.	N/A				The Big Valley Basin does not have multple MTs to determine whether an undesirable result is occurring.
(d)			An Agency that is able to demonstrate that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin shall not be required to establish criteria for undesirable results related to those sustainability indicators.	289	4.6			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10721, 10723.2, 10727.2, 10733.2, and 10733.8, Water Code.					
§ 354.28.			**Minimum Thresholds**					
(a)			Each Agency in its Plan shall establish minimum thresholds that quantify groundwater conditions for each applicable sustainability indicator at each monitoring site or representative monitoring site established pursuant to Section 354.36. The numeric value used to define minimum thresholds shall represent a point in the basin that, if exceeded, may cause undesirable results as described in Section 354.26.	274, 276:303	4.4:4.9		4-1	
(b)			The description of minimum thresholds shall include the following:					
	(1)		The information and criteria relied upon to establish and justify the minimum thresholds for each sustainability indicator. The justification for the minimum threshold shall be supported by information provided in the basin setting, and other data or models as appropriate, and qualified by uncertainty in the understanding of the basin setting.	276:303	4.4:4.9			
	(2)		The relationship between the minimum thresholds for each sustainability indicator, including an explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators.	276:303	4.4:4.9			
	(3)		How minimum thresholds have been selected to avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals.	276:303	4.4:4.9			
	(4)		How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.	276:303	4.4:4.9			
	(5)		How state, federal, or local standards relate to the relevant sustainability indicator. If the minimum threshold differs from other regulatory standards, the Agency shall explain the nature of and basis for the difference.	276:303	4.4:4.9			
	(6)		How each minimum threshold will be quantitatively measured, consistent with the monitoring network requirements described in Subarticle 4.	276:303	4.4:4.9			
(c)			Minimum thresholds for each sustainability indicator shall be defined as follows:					

Article 5.			Plan Contents for Sample Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
	(1)		Chronic Lowering of Groundwater Levels. The minimum threshold for chronic lowering of groundwater levels shall be the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results. Minimum thresholds for chronic lowering of groundwater levels shall be supported by the following:					
		(A)	The rate of groundwater elevation decline based on historical trends, water year type, and projected water use in the basin.	276:288	4.4			
		(B)	Potential effects on other sustainability indicators.	277	4.4.1.2			
	(2)		Reduction of Groundwater Storage. The minimum threshold for reduction of groundwater storage shall be a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results. Minimum thresholds for reduction of groundwater storage shall be supported by the sustainable yield of the basin, calculated based on historical trends, water year type, and projected water use in the basin.	288:289	4.5			
	(3)		Seawater Intrusion. The minimum threshold for seawater intrusion shall be defined by a chloride concentration isocontour for each principal aquifer where seawater intrusion may lead to undesirable results. Minimum thresholds for seawater intrusion shall be supported by the following:					
		(A)	Maps and cross-sections of the chloride concentration isocontour that defines the minimum threshold and measurable objective for each principal aquifer.	N/A				Seawater intrusion is not present nor is expected to occur in Big Valley Basin.
		(B)	A description of how the seawater intrusion minimum threshold considers the effects of current and projected sea levels.	N/A				Seawater intrusion is not present nor is expected to occur in Big Valley Basin.
	(4)		Degraded Water Quality. The minimum threshold for degraded water quality shall be the degradation of water quality, including the migration of contaminant plumes that impair water supplies or other indicator of water quality as determined by the Agency that may lead to undesirable results. The minimum threshold shall be based on the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined by the Agency to be of concern for the basin. In setting minimum thresholds for degraded water quality, the Agency shall consider local, state, and federal water quality standards applicable to the basin.	289:292	4.7			
	(5)		Land Subsidence. The minimum threshold for land subsidence shall be the rate and extent of subsidence that substantially interferes with surface land uses and may lead to undesirable results. Minimum thresholds for land subsidence shall be supported by the following:					
		(A)	Identification of land uses and property interests that have been affected or are likely to be affected by land subsidence in the basin, including an explanation of how the Agency has determined and considered those uses and interests, and the Agency's rationale for establishing minimum thresholds in light of those effects.	N/A				Inelastic land subsidence that reults in permanent land compaction and loss of groundwater storage is not occuring in Big Valley Basin.
		(B)	Maps and graphs showing the extent and rate of land subsidence in the basin that defines the minimum threshold and measurable objectives.	125:126	2.2.2.4	2-35		

Article 5.			Plan Contents for Sample Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
	(6)		Depletions of Interconnected Surface Water. The minimum threshold for depletions of interconnected surface water shall be the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results. The minimum threshold established for depletions of interconnected surface water shall be supported by the following:					
		(A)	The location, quantity, and timing of depletions of interconnected surface water.	127:144, 296:298	2.2.2.5, 4.9			
		(B)	A description of the groundwater and surface water model used to quantify surface water depletion. If a numerical groundwater and surface water model is not used to quantify surface water depletion, the Plan shall identify and describe an equally effective method, tool, or analytical model to accomplish the requirements of this Paragraph.	127:144, 296:298	2.2.2.5, 4.9			
(d)			An Agency may establish a representative minimum threshold for groundwater elevation to serve as the value for multiple sustainability indicators, where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual minimum thresholds as supported by adequate evidence.	288, 296:298	4.5, 4.9.1.4			
(e)			An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish minimum thresholds related to those sustainability indicators.	289	4.6			Seawater intrustion is not present or likely to occur in Big Valley Basin. As such, no minimum threshold was set.
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.2, 10733, 10733.2, and 10733.8, Water Code.					
§ 354.30.			**Measurable Objectives**					
(a)			Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin within 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.	276:303	4.4:4.9			
(b)			Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metrics and monitoring sites as are used to define the minimum thresholds.	276:303	4.4:4.9			
(c)			Measurable objectives shall provide a reasonable margin of operational flexibility under adverse conditions which shall take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought, and be commensurate with levels of uncertainty.	276:303	4.4:4.9			
(d)			An Agency may establish a representative measurable objective for groundwater elevation to serve as the value for multiple sustainability indicators where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual measurable objectives as supported by adequate evidence.	276:303	4.4:4.9			

Article 5.			Plan Contents for Sample Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(e)			Each Plan shall describe a reasonable path to achieve the sustainability goal for the basin within 20 years of Plan implementation, including a description of interim milestones for each relevant sustainability indicator, using the same metric as the measurable objective, in increments of five years. The description shall explain how the Plan is likely to maintain sustainable groundwater management over the planning and implementation horizon.	275:276	4.3.3			
(f)			Each Plan may include measurable objectives and interim milestones for additional Plan elements described in Water Code Section 10727.4 where the Agency determines such measures are appropriate for sustainable groundwater management in the basin.	N/A				There are no other measurable objectives nor interim milestones set for additional Plan elements.
(g)			An Agency may establish measurable objectives that exceed the reasonable margin of operational flexibility for the purpose of improving overall conditions in the basin, but failure to achieve those objectives shall not be grounds for a finding of inadequacy of the Plan.	275	4.3.2			Measuable objectives were set within the reasonable margin of operational flexibility.
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10727.2, 10727.4, and 10733.2, Water Code.					
SubArticle 4.			**Monitoring Networks**					
§ 354.32.			**Introduction to Monitoring Networks**					
			This Subarticle describes the monitoring network that shall be developed for each basin, including monitoring objectives, monitoring protocols, and data reporting requirements. The monitoring network shall promote the collection of data of sufficient quality, frequency, and distribution to characterize groundwater and related surface water conditions in the basin and evaluate changing conditions that occur through implementation of the Plan.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.34.			**Monitoring Network**					
(a)			Each Agency shall develop a monitoring network capable of collecting sufficient data to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface conditions, and yield representative information about groundwater conditions as necessary to evaluate Plan implementation.	253:270	3			
(b)			Each Plan shall include a description of the monitoring network objectives for the basin, including an explanation of how the network will be developed and implemented to monitor groundwater and related surface conditions, and the interconnection of surface water and groundwater, with sufficient temporal frequency and spatial density to evaluate the affects and effectiveness of Plan implementation. The monitoring network objectives shall be implemented to accomplish the following:					
	(1)		Demonstrate progress toward achieving measurable objectives described in the Plan.	253	3.1			
	(2)		Monitor impacts to the beneficial uses or users of groundwater.	253	3.1			

Article 5.			Plan Contents for Sample Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
	(3)		Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds.	253	3.1			
	(4)		Quantify annual changes in water budget components.	253	3.1			
(c)			Each monitoring network shall be designed to accomplish the following for each sustainability indicator:					
	(1)		Chronic Lowering of Groundwater Levels. Demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features by the following methods:					
		(A)	A sufficient density of monitoring wells to collect representative measurements through depth-discrete perforated intervals to characterize the groundwater table or potentiometric surface for each principal aquifer.	253:270	3.2:3.5			
		(B)	Static groundwater elevation measurements shall be collected at least two times per year, to represent seasonal low and seasonal high groundwater conditions.	253:262	3.2		3-1	
	(2)		Reduction of Groundwater Storage. Provide an estimate of the change in annual groundwater in storage.	253:262	3.2			Groundwater levels are used as a proxy for groundwater storage monitoring.
	(3)		Seawater Intrusion. Monitor seawater intrusion using chloride concentrations, or other measurements convertible to chloride concentrations, so that the current and projected rate and extent of seawater intrusion for each applicable principal aquifer may be calculated.	N/A				Seawater intrusion is not present or likely to occur in Big Valley Basin. As such, there is no associated monitoring network.
	(4)		Degraded Water Quality. Collect sufficient spatial and temporal data from each applicable principal aquifer to determine groundwater quality trends for water quality indicators, as determined by the Agency, to address known water quality issues.	262:265	3.3			
	(5)		Land Subsidence. Identify the rate and extent of land subsidence, which may be measured by extensometers, surveying, remote sensing technology, or other appropriate method.	265:267	3.4			
	(6)		Depletions of Interconnected Surface Water. Monitor surface water and groundwater, where interconnected surface water conditions exist, to characterize the spatial and temporal exchanges between surface water and groundwater, and to calibrate and apply the tools and methods necessary to calculate depletions of surface water caused by groundwater extractions. The monitoring network shall be able to characterize the following:					
		(A)	Flow conditions including surface water discharge, surface water head, and baseflow contribution.	267:270	3.5			
		(B)	Identifying the approximate date and location where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable.	267:270	3.5			
		(C)	Temporal change in conditions due to variations in stream discharge and regional groundwater extraction.	267:270	3.5			
		(D)	Other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water.	267:270	3.5			

Article 5.			Plan Contents for Sample Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(d)			The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.	253:270	3.2:3.5			
(e)			A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.	253:270	3			
(f)			The Agency shall determine the density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends based upon the following factors:					
	(1)		Amount of current and projected groundwater use.	253:270	3.2:3.5			
	(2)		Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow.	253:270	3.2:3.5			
	(3)		Impacts to beneficial uses and users of groundwater and land uses and property interests affected by groundwater production, and adjacent basins that could affect the ability of that basin to meet the sustainability goal.	253:270	3.2:3.5			
	(4)		Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.	253:270	3.2:3.5			
(g)			Each Plan shall describe the following information about the monitoring network:					
	(1)		Scientific rationale for the monitoring site selection process.	253:270	3.2:3.5			
	(2)		Consistency with data and reporting standards described in Section 352.4. If a site is not consistent with those standards, the Plan shall explain the necessity of the site to the monitoring network, and how any variation from the standards will not affect the usefulness of the results obtained.	253:270	3.2:3.5			
	(3)		For each sustainability indicator, the quantitative values for the minimum threshold, measurable objective, and interim milestones that will be measured at each monitoring site or representative monitoring sites established pursuant to Section 354.36.	253:270	3.2:3.5			
(h)			The location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used.	255:257, 259, 260, 263, 266, 268, 269,		3-1, 3-2, 3-3	3-1, 3-2, 3-5, 3-6, 3-7,	
(i)			The monitoring protocols developed by each Agency shall include a description of technical standards, data collection methods, and other procedures or protocols pursuant to Water Code Section 10727.2(f) for monitoring sites or other data collection facilities to ensure that the monitoring network utilizes comparable data and methodologies.	253:270	3.2:3.5			Additional information on monitoring protocols can be found in Appendix 3A.
(j)			An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish a monitoring network related to those sustainability indicators.	253:270	3			No monitoring network has been established for seawater intrustion.
			Note: Authority cited: Section 10733.2, Water Code.					

Article 5.			Plan Contents for Sample Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
			Reference: Sections 10723.2, 10727.2, 10727.4, 10728, 10733, 10733.2, and 10733.8, Water Code					
§ 354.36.			**Representative Monitoring**					
			Each Agency may designate a subset of monitoring sites as representative of conditions in the basin or an area of the basin, as follows:					
(a)			Representative monitoring sites may be designated by the Agency as the point at which sustainability indicators are monitored, and for which quantitative values for minimum thresholds, measurable objectives, and interim milestones are defined.	253:270	3.2:3.5			
(b)			(b) Groundwater elevations may be used as a proxy for monitoring other sustainability indicators if the Agency demonstrates the following:					
	(1)		Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy.	253:262, 288, 296:298	3.2, 4.5, 4.9.1.4			Groundwater elevation serves as a proxy for reduced groundwater storage and depletion of interconnected surface water.
	(2)		Measurable objectives established for groundwater elevation shall include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.	288	4.4.3			
(c)			The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area.	258:260	3.2.2			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10727.2 and 10733.2, Water Code					
§ 354.38.			**Assessment and Improvement of Monitoring Network**					
(a)			Each Agency shall review the monitoring network and include an evaluation in the Plan and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin.	338	6.3.2			
(b)			Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency.	253:270	3.2:3.5			
(c)			If the monitoring network contains data gaps, the Plan shall include a description of the following:					
	(1)		The location and reason for data gaps in the monitoring network.	253:270	3.2:3.5			
	(2)		Local issues and circumstances that limit or prevent monitoring.	253:270	3.2:3.5			
(d)			Each Agency shall describe steps that will be taken to fill data gaps before the next five-year assessment, including the location and purpose of newly added or installed monitoring sites.	253:270	3.2:3.5			

Article 5.			Plan Contents for Sample Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(e)			Each Agency shall adjust the monitoring frequency and density of monitoring sites to provide an adequate level of detail about site-specific surface water and groundwater conditions and to assess the effectiveness of management actions under circumstances that include the following:					
	(1)		Minimum threshold exceedances.	253:270, 331	3.2:3.5, 5.6.1			
	(2)		Highly variable spatial or temporal conditions.	253:270, 331	3.2:3.5, 5.6.1			
	(3)		Adverse impacts to beneficial uses and users of groundwater.	253:270, 331	3.2:3.5, 5.6.1			
	(4)		The potential to adversely affect the ability of an adjacent basin to implement its Plan or impede achievement of sustainability goals in an adjacent basin.	N/A				There is no adjacent basin with a GSP.
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.2, 10728.2, 10733, 10733.2, and 10733.8, Water Code					
§ 354.40.			**Reporting Monitoring Data to the Department**					
			Monitoring data shall be stored in the data management system developed pursuant to Section 352.6. A copy of the monitoring data shall be included in the Annual Report and submitted electronically on forms provided by the Department.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10728, 10728.2, 10733.2, and 10733.8, Water Code.					
SubArticle 5.			**Projects and Management Actions**					
§ 354.42.			**Introduction to Projects and Management Actions**					
			This Subarticle describes the criteria for projects and management actions to be included in a Plan to meet the sustainability goal for the basin in a manner that can be maintained over the planning and implementation horizon.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.44.			**Projects and Management Actions**					
(a)			Each Plan shall include a description of the projects and management actions the Agency has determined will achieve the sustainability goal for the basin, including projects and management actions to respond to changing conditions in the basin.	306:332	5			
(b)			Each Plan shall include a description of the projects and management actions that include the following:					
	(1)		A list of projects and management actions proposed in the Plan with a description of the measurable objective that is expected to benefit from the project or management action. The list shall include projects and management actions that may be utilized to meet interim milestones, the exceedance of minimum thresholds, or where undesirable results have occurred or are imminent. The Plan shall include the following:					

Article 5.			Plan Contents for Sample Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
		(A)	A description of the circumstances under which projects or management actions shall be implemented, the criteria that would trigger implementation and termination of projects or management actions, and the process by which the Agency shall determine that conditions requiring the implementation of particular projects or management actions have occurred.	306:307, 330:332	5.2, 5.6			
		(B)	The process by which the Agency shall provide notice to the public and other agencies that the implementation of projects or management actions is being considered or has been implemented, including a description of the actions to be taken.	308:322	5.3			
	(2)		If overdraft conditions are identified through the analysis required by Section 354.18, the Plan shall describe projects or management actions, including a quantification of demand reduction or other methods, for the mitigation of overdraft.	N/A				Overdraft conditions were not identified.
	(3)		A summary of the permitting and regulatory process required for each project and management action.	308:322	5.3			
	(4)		The status of each project and management action, including a time-table for expected initiation and completion, and the accrual of expected benefits.	308, 323, 328			5-2, 5-4, 5-5	
	(5)		An explanation of the benefits that are expected to be realized from the project or management action, and how those benefits will be evaluated.	308:330	5.3:5.5			
	(6)		An explanation of how the project or management action will be accomplished. If the projects or management actions rely on water from outside the jurisdiction of the Agency, an explanation of the source and reliability of that water shall be included.	308:330	5.3:5.5			
	(7)		A description of the legal authority required for each project and management action, and the basis for that authority within the Agency.	308:322	5.3			
	(8)		A description of the estimated cost for each project and management action and a description of how the Agency plans to meet those costs.	308, 323, 328			5-2, 5-4, 5-5	
	(9)		A description of the management of groundwater extractions and recharge to ensure that chronic lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels or storage during other periods.	308:327	5.3:5.4			
(c)			Projects and management actions shall be supported by best available information and best available science.	308:330	5.3:5.5			
(d)			An Agency shall take into account the level of uncertainty associated with the basin setting when developing projects or management actions.	308:330	5.3:5.5			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10727.2, 10727.4, and 10733.2, Water Code.					

APPENDIX 2A

Water Level Hydrographs and Trends of Seasonal High Groundwater Elevation Change

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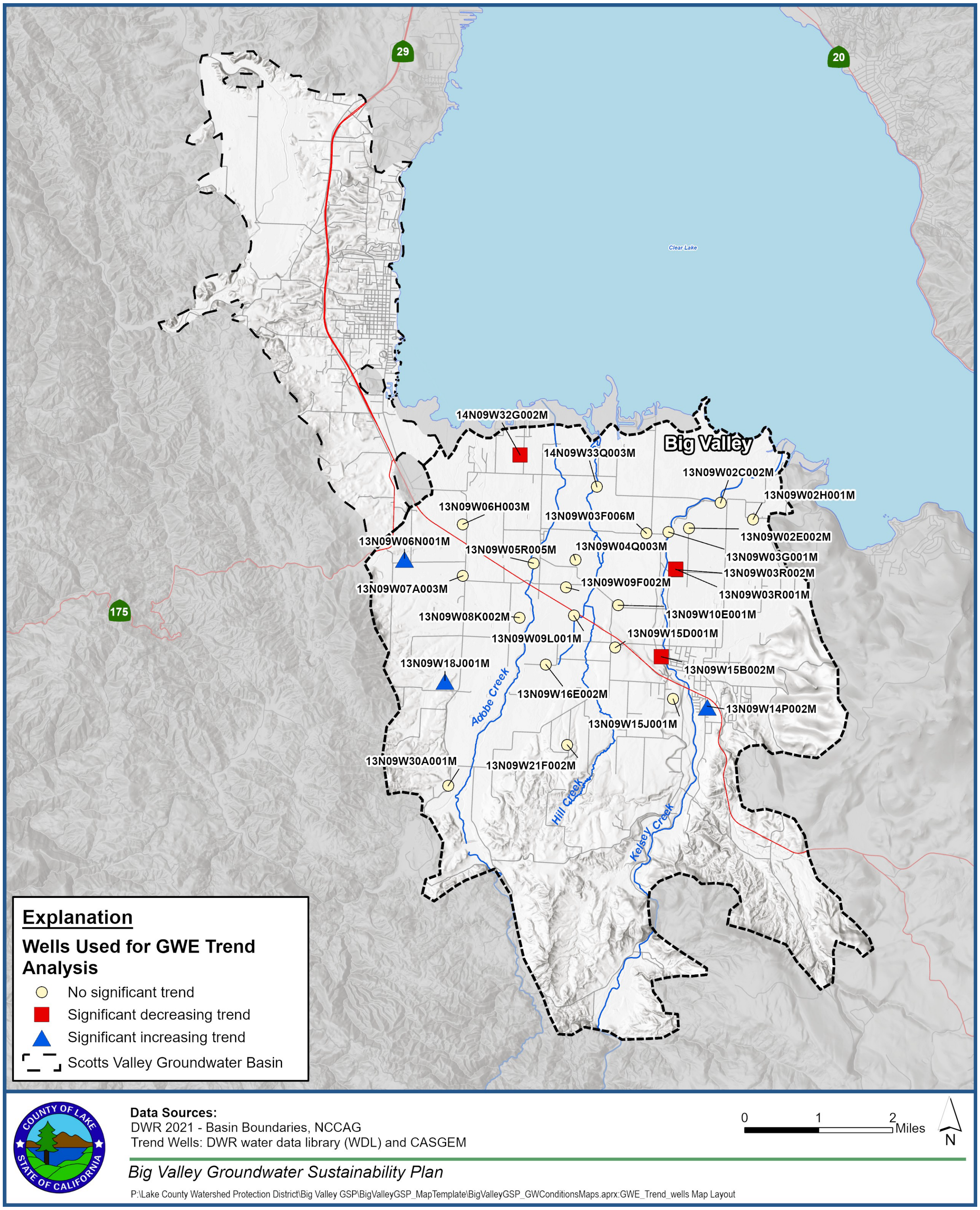
29
20
175
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Big Valley
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13N09W03F006M
13N09W02E002M
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13N09W03G001M
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13N09W03R001M
13N09W08K002M
13N09W10E001M
13N09W09L001M
13N09W15D001M
13N09W18J001M
13N09W15B002M
13N09W16E002M
13N09W14P002M
13N09W15J001M
13N09W30A001M
13N09W21F002M
Adobe Creek
Hill Creek
Kelsey Creek
Explanation
Wells Used for GWE Trend Analysis
No significant trend
Significant decreasing trend
Significant increasing trend
Scotts Valley Groundwater Basin
COUNTY OF LAKE
STATE OF CALIFORNIA
Data Sources:
DWR 2021 - Basin Boundaries, NCCAG
Trend Wells: DWR water data library (WDL) and CASGEM
0
1
2
Miles
N
Big Valley Groundwater Sustainability Plan
P:\Lake County Watershed Protection District\Big Valley GSP\BigValleyGSP_MapTemplate\BigValleyGSP_GWConditionsMaps.aprx:GWE_Trend_wells Map Layout

Table 1. Trends of Seasonal High Groundwater Elevation Change from 1990 to 2020

State Well Number	Number of Water Levels	Parametric Method (Ordinary Least Squares Regression)			Nonparametric Methods		Number of Water Level Outliers (Rosner's Outlier Test)
		Regression (ft/year)	R^2	p-value	Mann-Kendall Trend Test Results	Theil-Sen Slope (ft/year)	
13N09W02C002M	31	-0.05	0.03	0.37	No significant trend	-0.07	NA
13N09W02E002M	31	-0.04	0.01	0.54	No significant trend	-0.09	1 (in 1991)
13N09W02H001M	31	-0.04	0.02	0.44	No significant trend	-0.05	NA
13N09W03F006M	30	0.00	0.00	0.97	No significant trend	-0.09	2 (in 1991, 2014)
13N09W03G001M	31	-0.04	0.08	0.12	No significant trend	-0.05	NA
13N09W03R001M	31	-0.13	0.31	0.00	Significant decreasing trend	-0.14	NA
13N09W03R002M	31	-0.13	0.33	0.00	Significant decreasing trend	-0.13	NA
13N09W04Q003M	31	0.05	0.01	0.64	No significant trend	-0.01	NA
13N09W05R005M	31	0.00	0.00	0.98	No significant trend	-0.11	NA
13N09W06H003M	31	-0.12	0.03	0.34	No significant trend	-0.13	1 (in 2001)
13N09W06N001M	31	0.00	0.00	0.95	No significant trend	0.02	NA
13N09W07A003M	31	0.03	0.01	0.69	No significant trend	-0.02	NA
13N09W08K002M	31	0.00	0.00	0.95	No significant trend	0.00	NA
13N09W09F002M	31	0.27	0.10	0.08	No significant trend	0.03	3 (in 1991, 1992, 1994)
13N09W09L001M	31	0.00	0.00	0.99	No significant trend	-0.09	NA
13N09W10E001M	31	0.16	0.11	0.07	No significant trend	0.12	NA
13N09W14P002M	31	0.27	0.23	0.01	Significant increasing trend	0.18	NA
13N09W15B002M	31	-0.09	0.14	0.04	Significant decreasing trend	-0.12	1 (in 2010)
13N09W15D001M	31	0.04	0.00	0.76	No significant trend	0.05	NA
13N09W15J001M	31	0.11	0.04	0.27	No significant trend	0.10	NA
13N09W16E002M	31	-0.07	0.03	0.33	No significant trend	-0.09	NA
13N09W18J001M	31	0.49	0.33	0.00	Significant increasing trend	0.27	3 (in 1995, 1994, 1990)
13N09W21F002M	30	-0.15	0.04	0.26	No significant trend	-0.13	NA
13N09W30A001M	31	-0.02	0.01	0.58	No significant trend	-0.03	1 (in 1998)
14N09W32G002M	31	-0.09	0.08	0.12	Significant decreasing trend	-0.13	NA
14N09W33Q003M	30	0.01	0.00	0.91	No significant trend	-0.04	1 (in 1991)

Note:

All statistical test results are at 5% siginificance level.

Key:

Water Level Hydrographs of Wells Selected for Seasonal High Groundwater Level Trend Analysis

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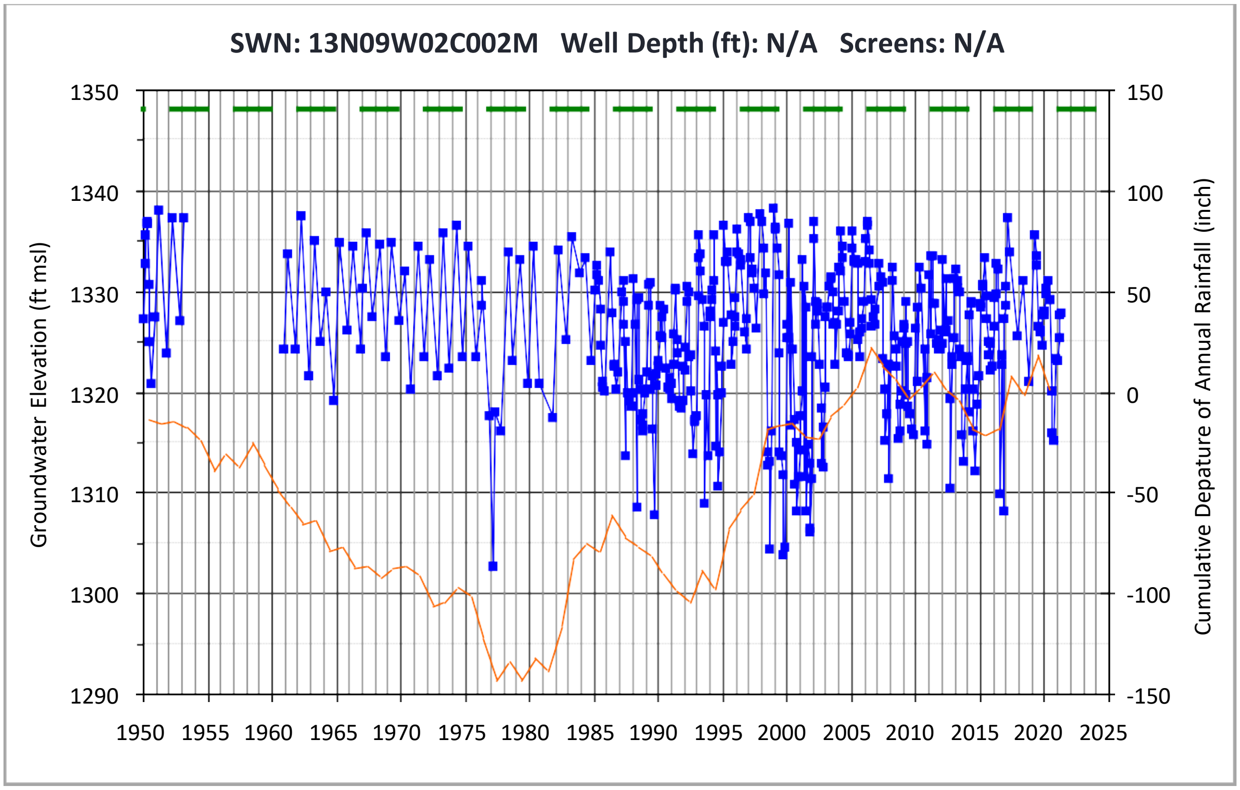
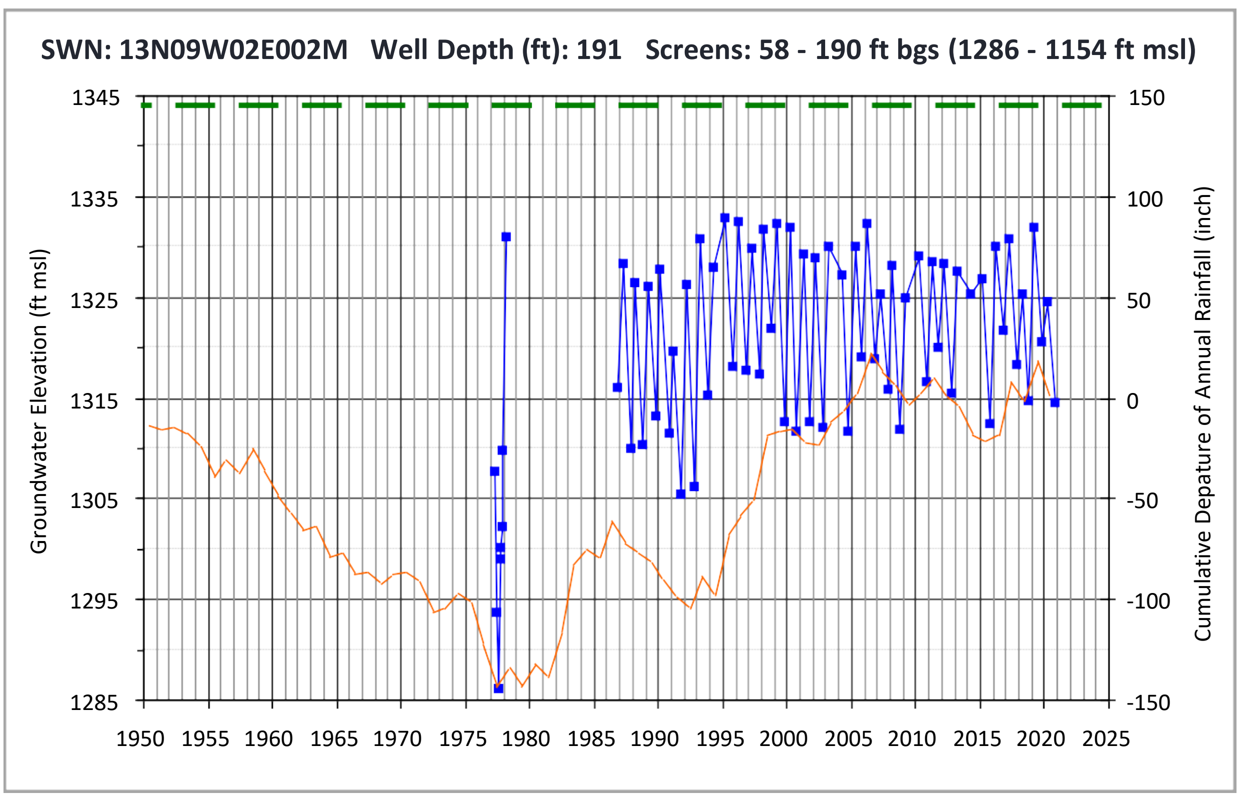
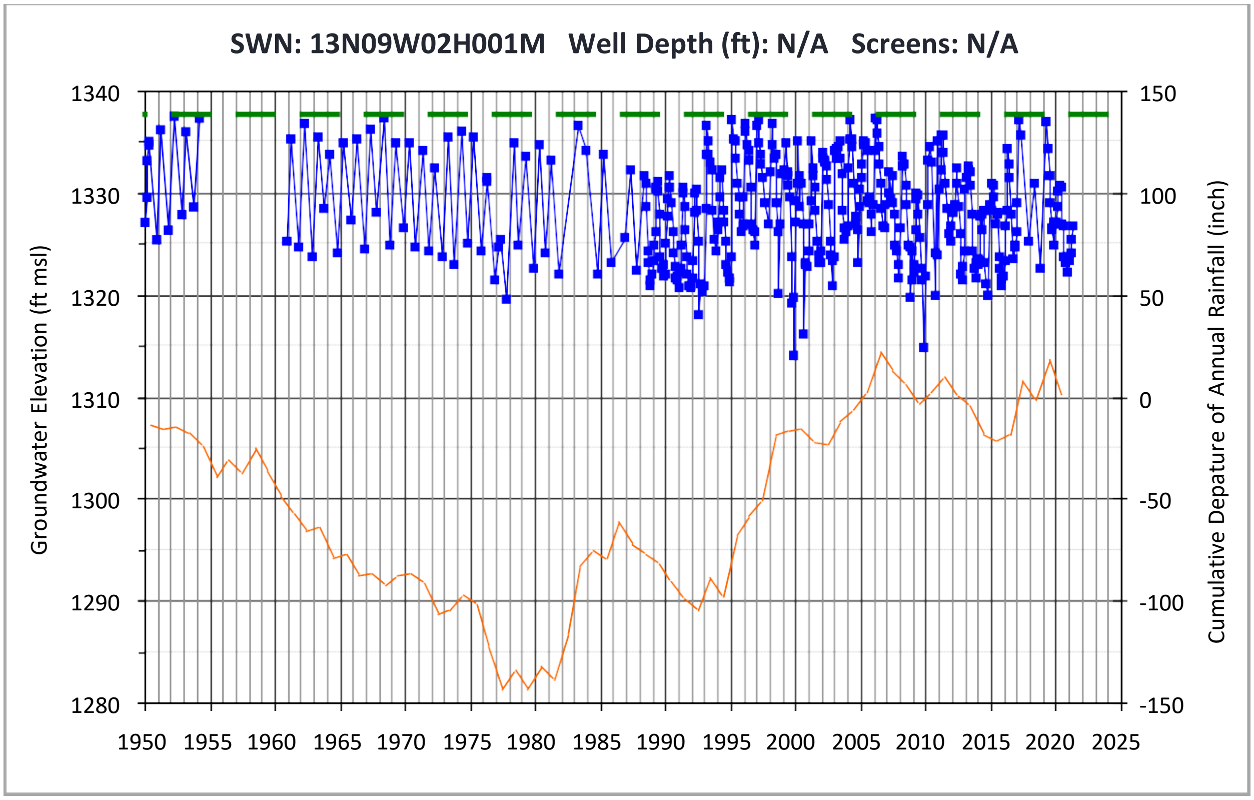
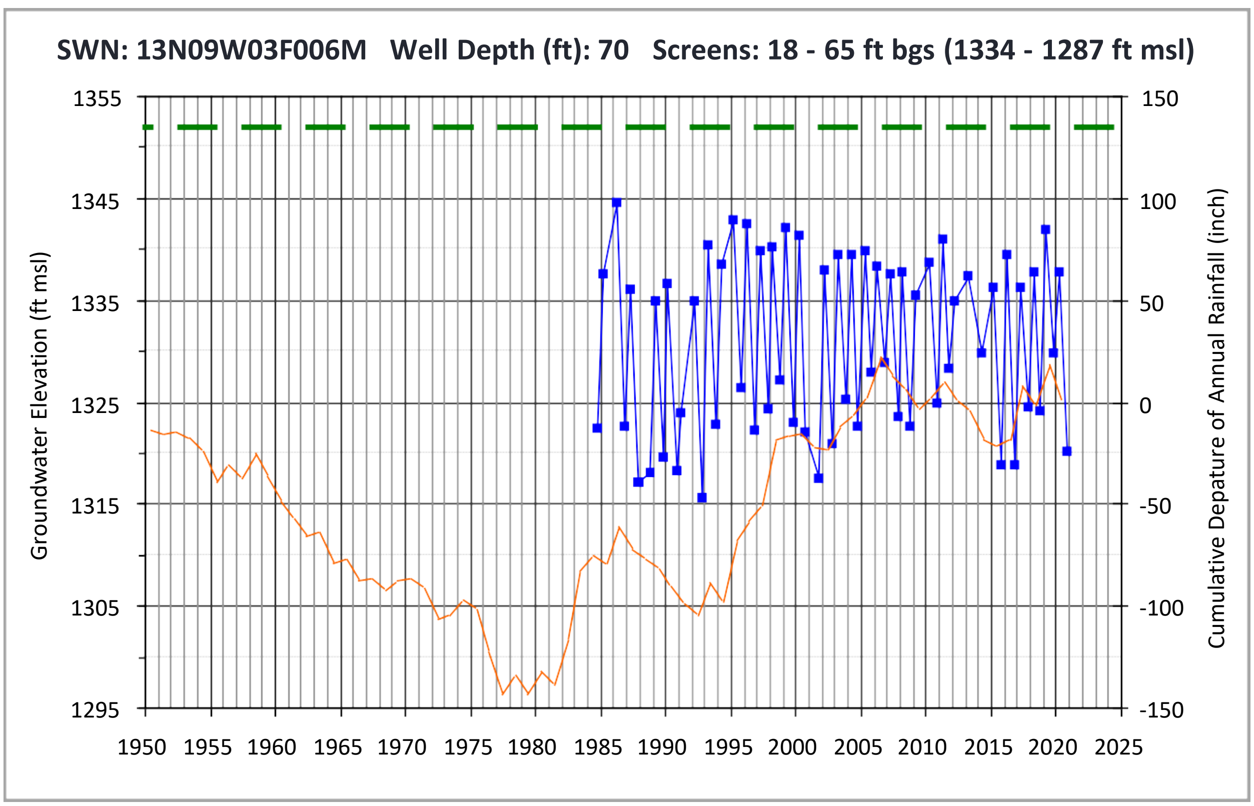

SWN: 13N09W02C002M Well Depth (ft): N/A Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1350
1340
1330
1320
1310
1300
1290
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025

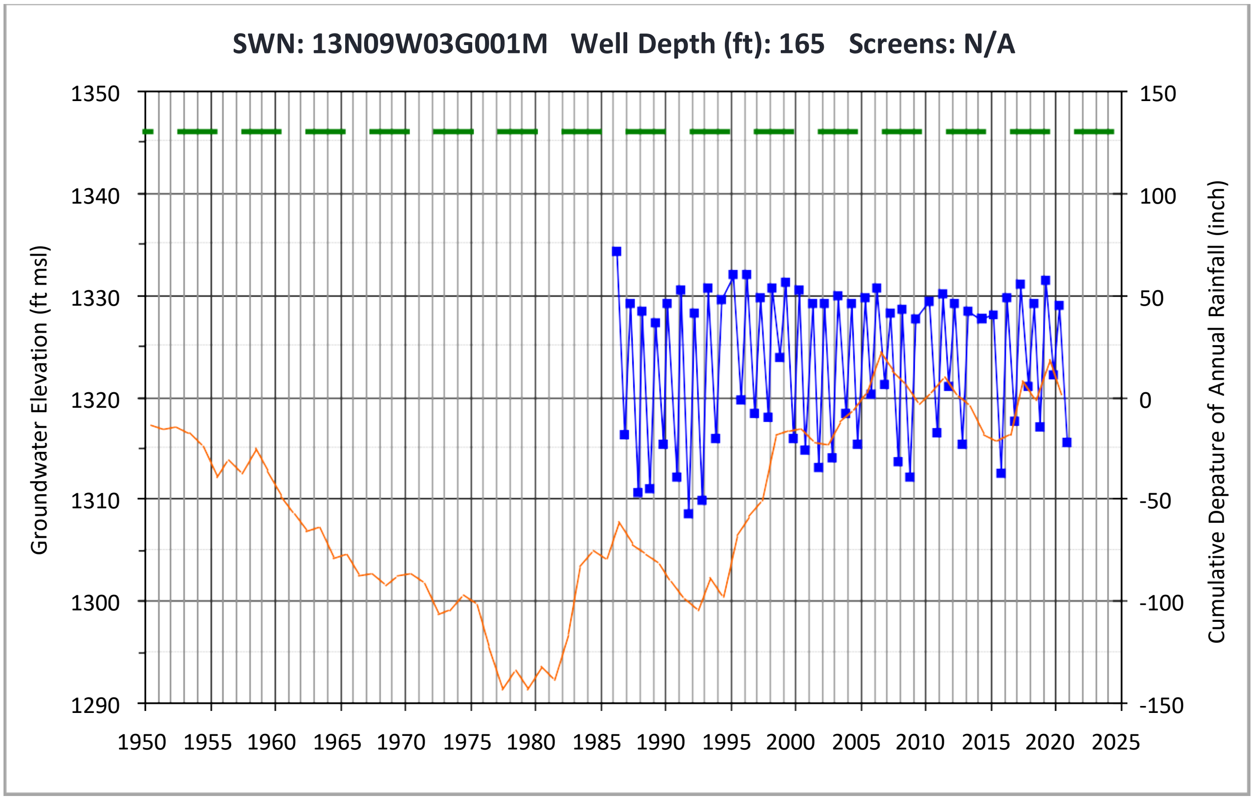

SWN: 13N09W02E002M Well Depth (ft): 191 Screens: 58 - 190 ft bgs (1286 - 1154 ft msl)
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1345
1335
1325
1315
1305
1295
1285
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025

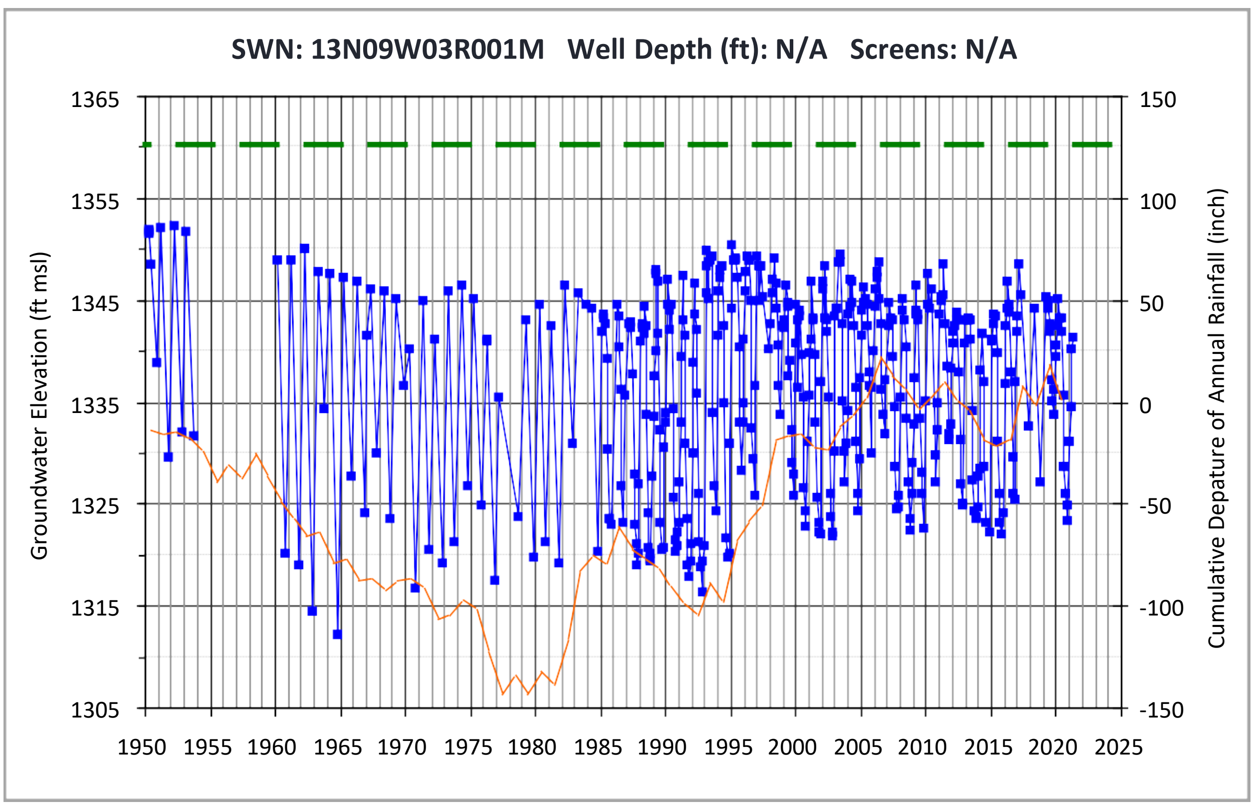

Groundwater elevation
Ground Surface elevation
Cumulative departure of annual rainfall from mean (based on water year)


SWN: 13N09W02H001M Well Depth (ft): N/A Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1340
1330
1320
1310
1300
1290
1280
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025

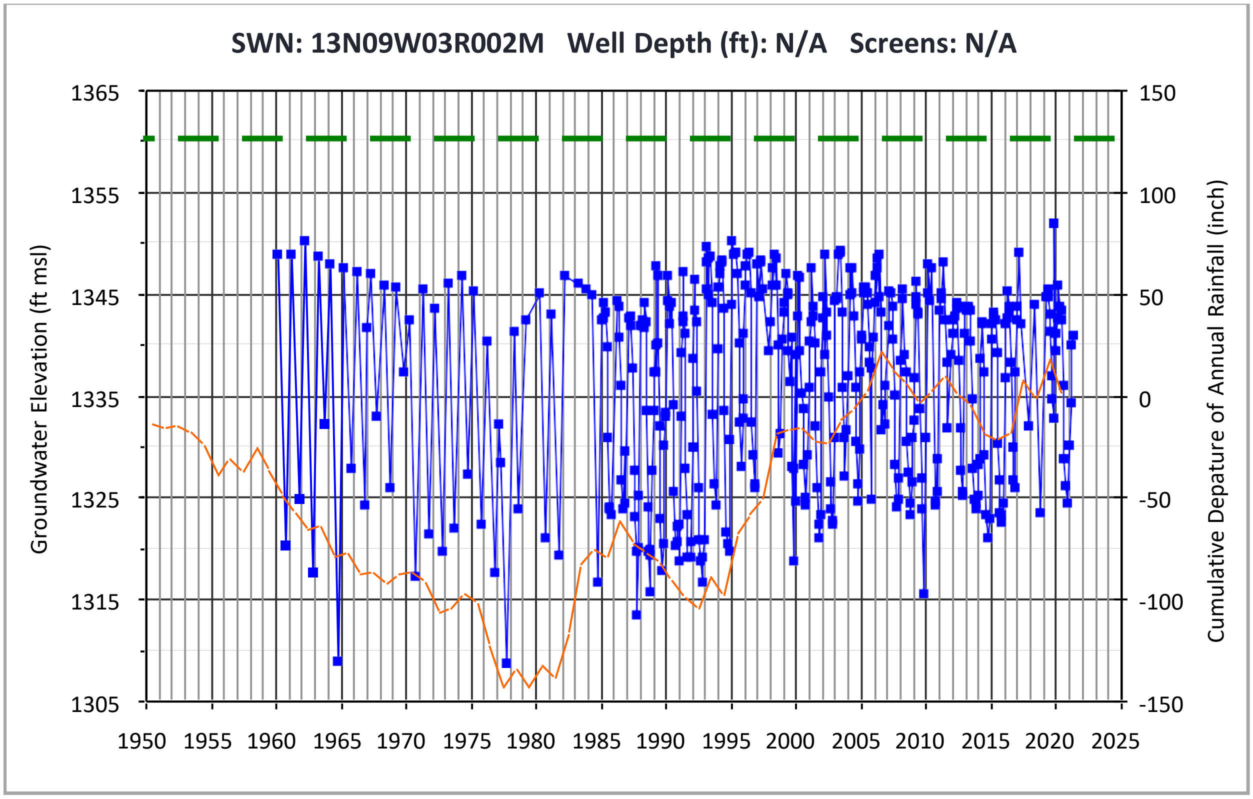

SWN: 13N09W03F006M Well Depth (ft): 70 Screens: 18 - 65 ft bgs (1334 - 1287 ft msl)
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1355
1345
1335
1325
1315
1305
1295
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025


Groundwater elevation
Ground Surface elevation
Cumulative departure of annual rainfall from mean (based on water year)


SWN: 13N09W03G001M Well Depth (ft): 165 Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1350
1340
1330
1320
1310
1300
1290
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025


SWN: 13N09W03R001M Well Depth (ft): N/A Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1365
1355
1345
1335
1325
1315
1305
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025


Groundwater elevation
Ground Surface elevation
Cumulative departure of annual rainfall from mean (based on water year)


SWN: 13N09W03R002M Well Depth (ft): N/A Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1365
1355
1345
1335
1325
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-100
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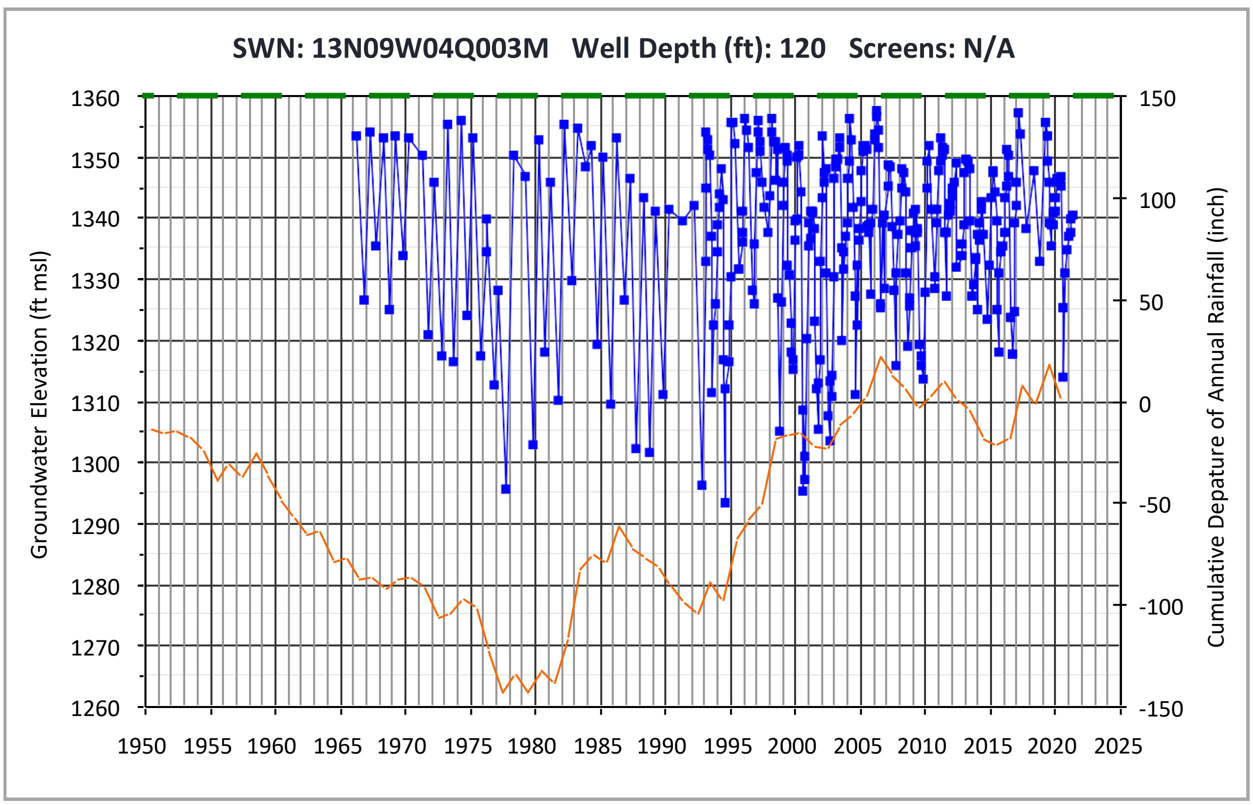
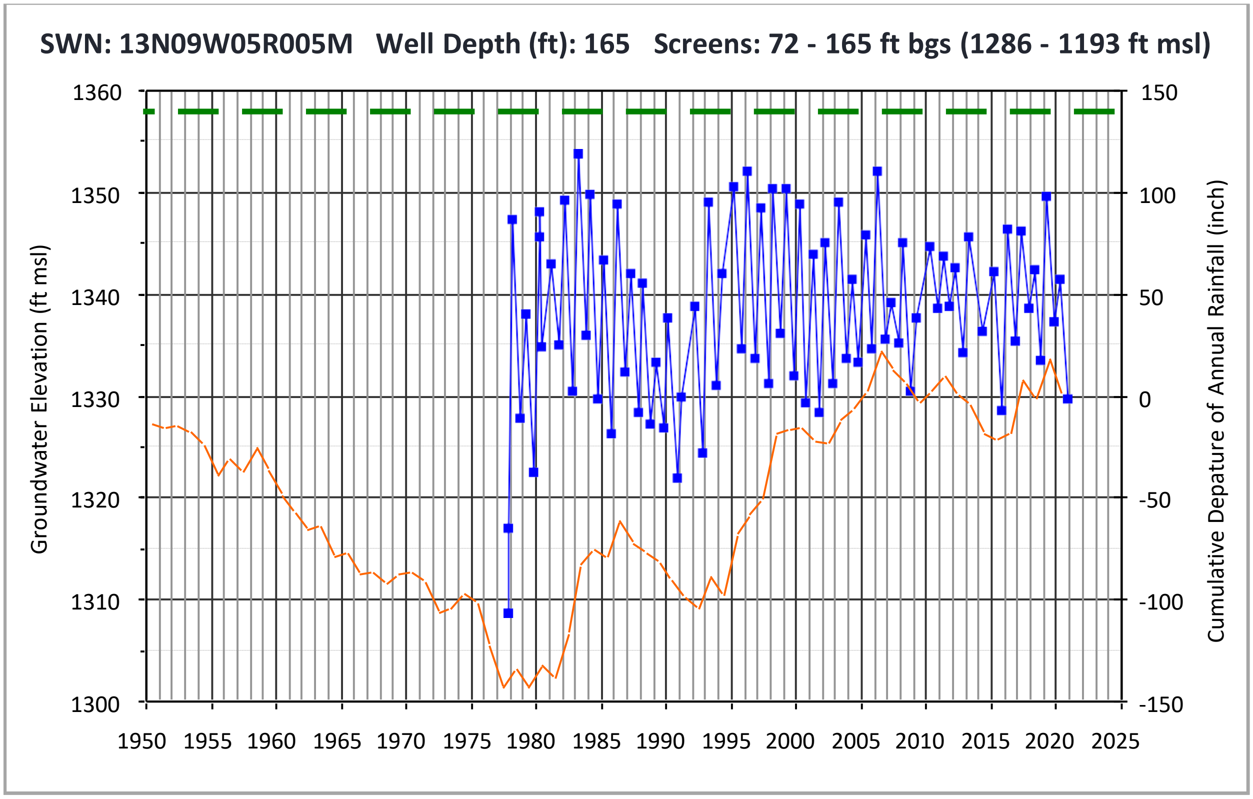
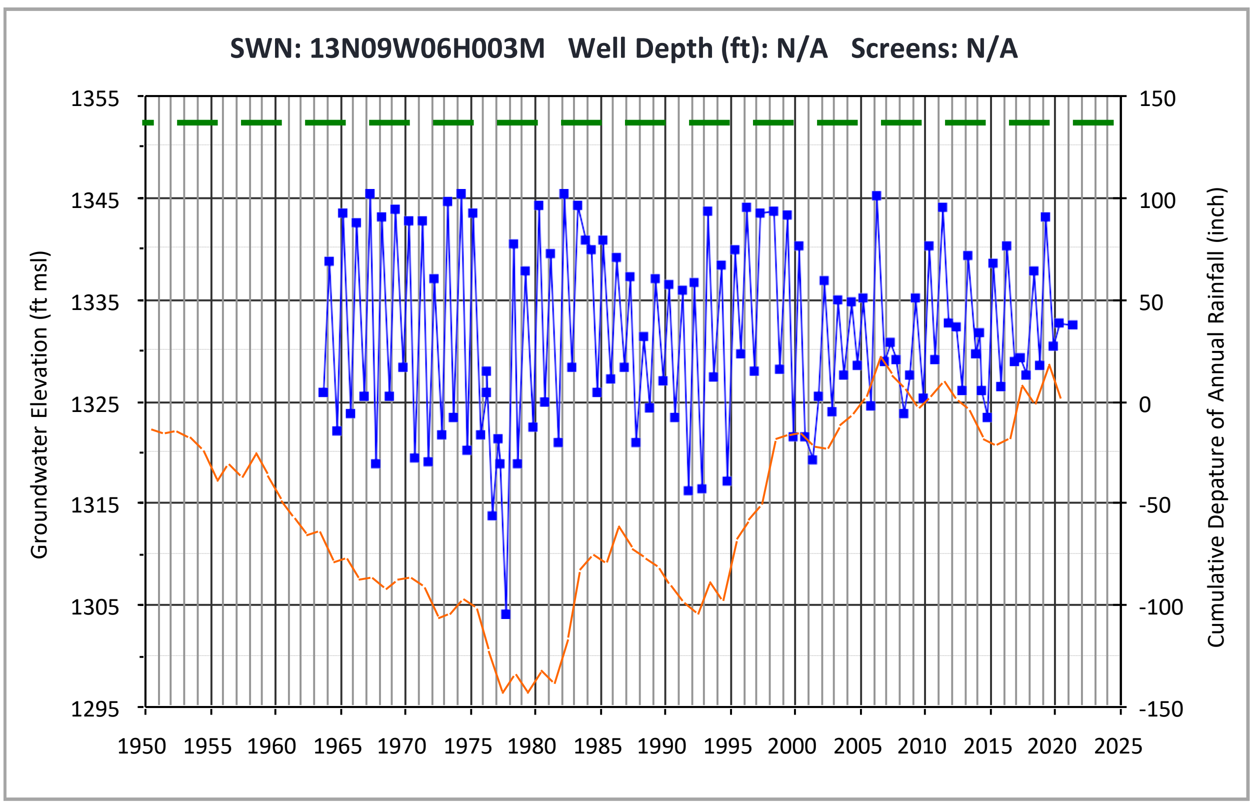
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025

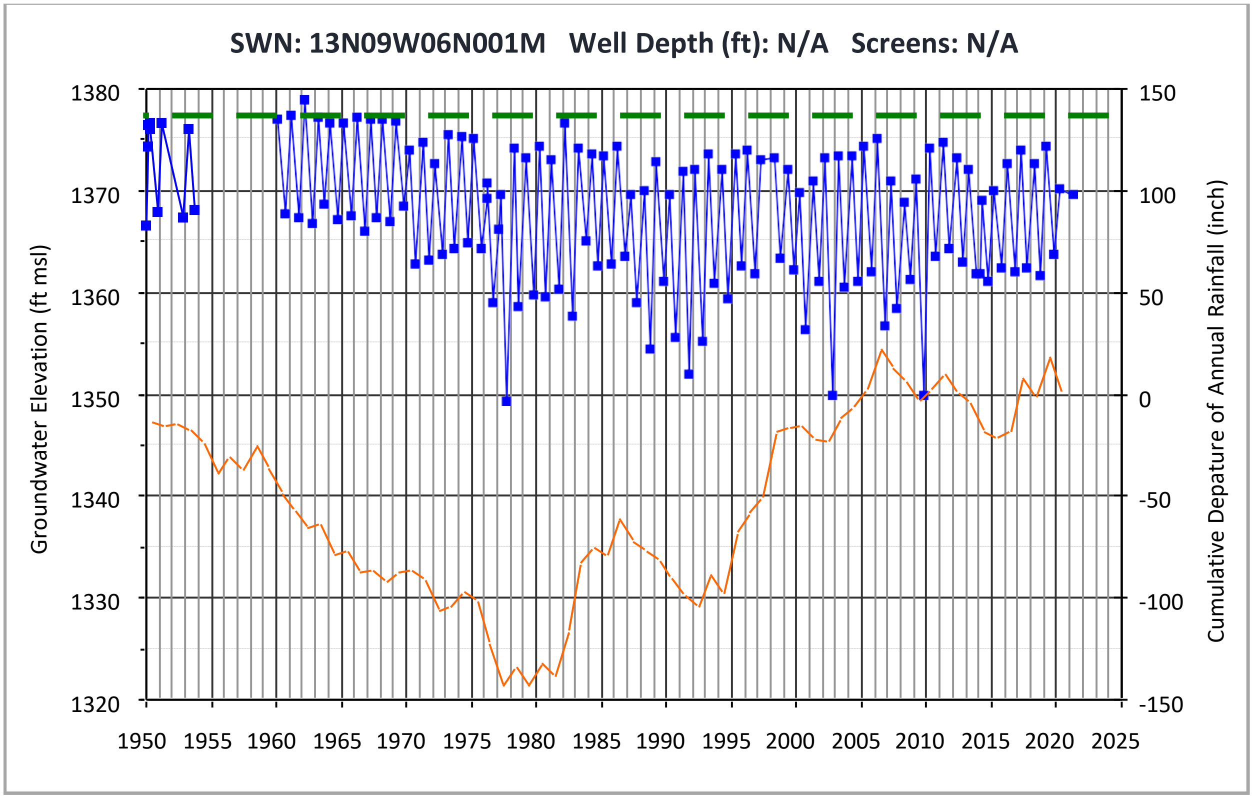

SWN: 13N09W04Q003M Well Depth (ft): 120 Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1360
1350
1340
1330
1320
1310
1300
1290
1280
1270
1260
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025

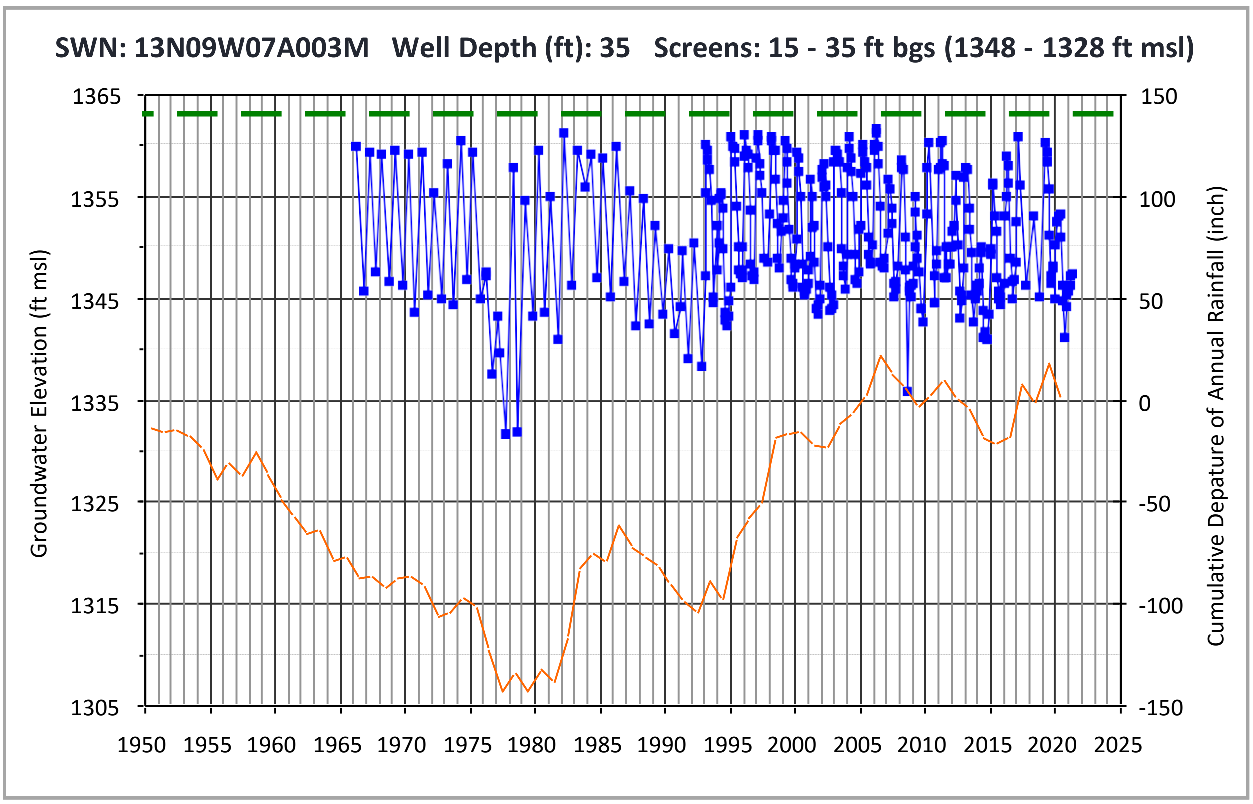

Groundwater elevation
Ground Surface elevation
Cumulative departure of annual rainfall from mean (based on water year)


SWN: 13N09W05R005M Well Depth (ft): 165 Screens: 72 - 165 ft bgs (1286 - 1193 ft msl)
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1360
1350
1340
1330
1320
1310
1300
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025

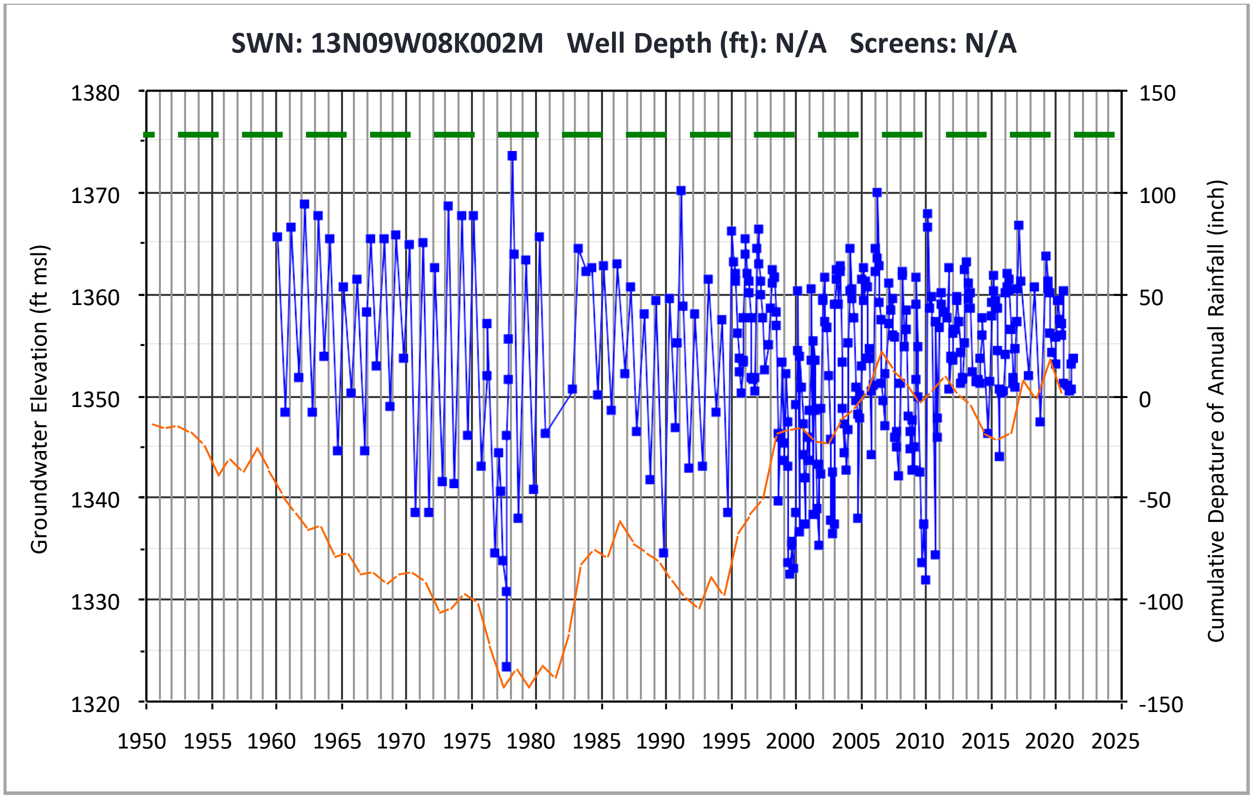

SWN: 13N09W06H003M Well Depth (ft): N/A Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1355
1345
1335
1325
1315
1305
1295
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025

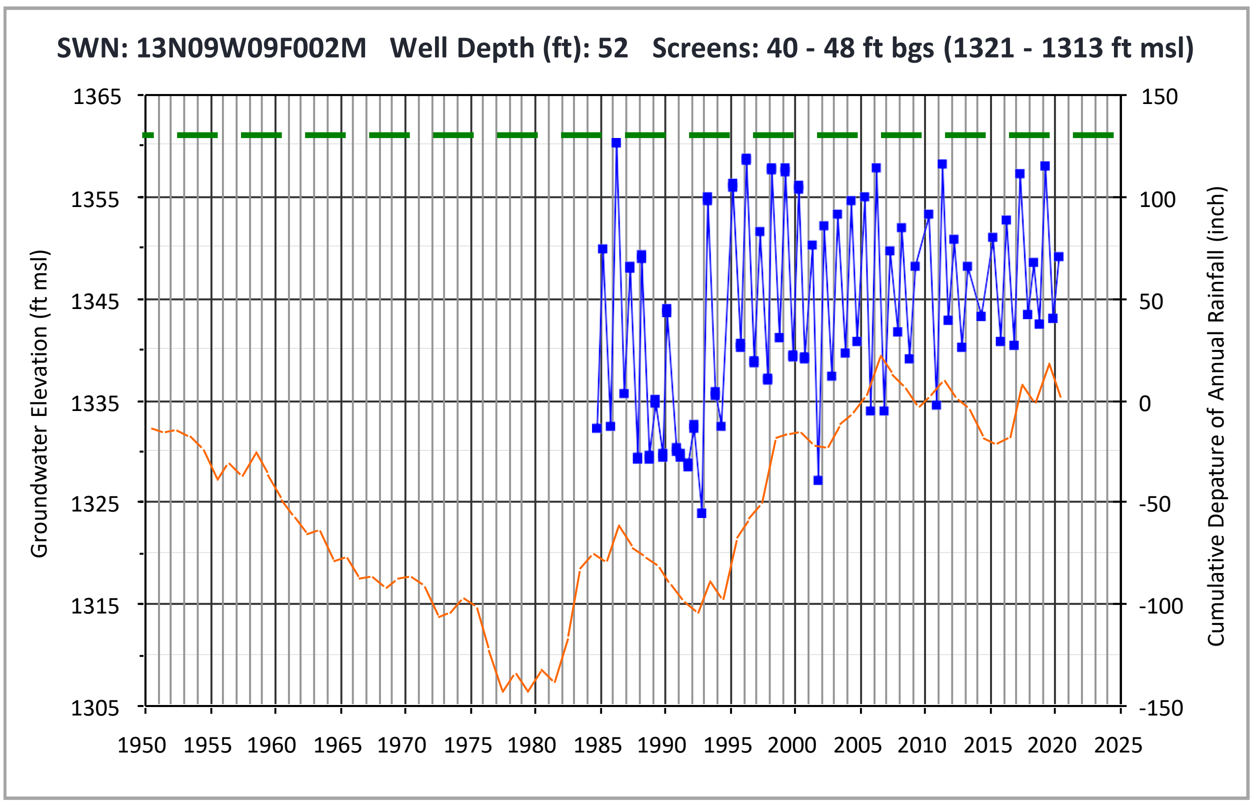

Groundwater elevation
Ground Surface elevation
Cumulative departure of annual rainfall from mean (based on water year)



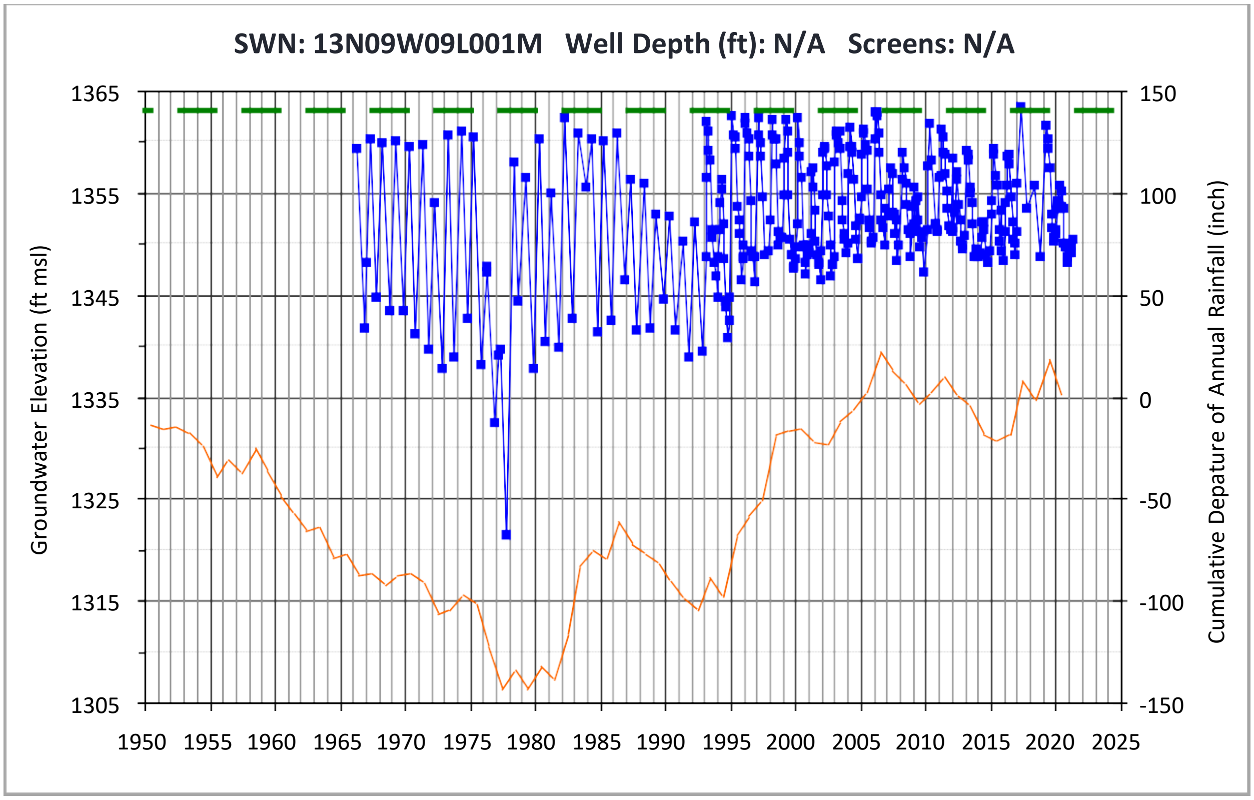


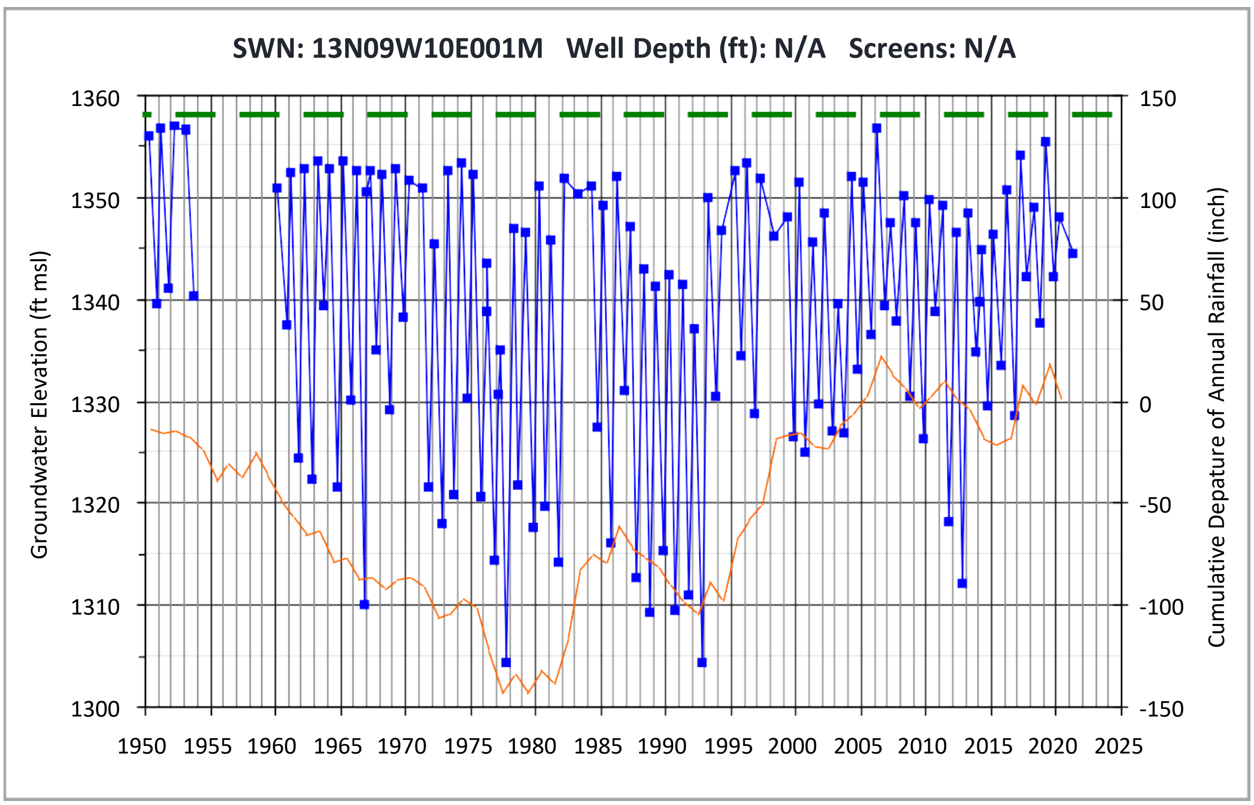
Groundwater elevation
Ground Surface elevation
Cumulative departure of annual rainfall from mean (based on water year)



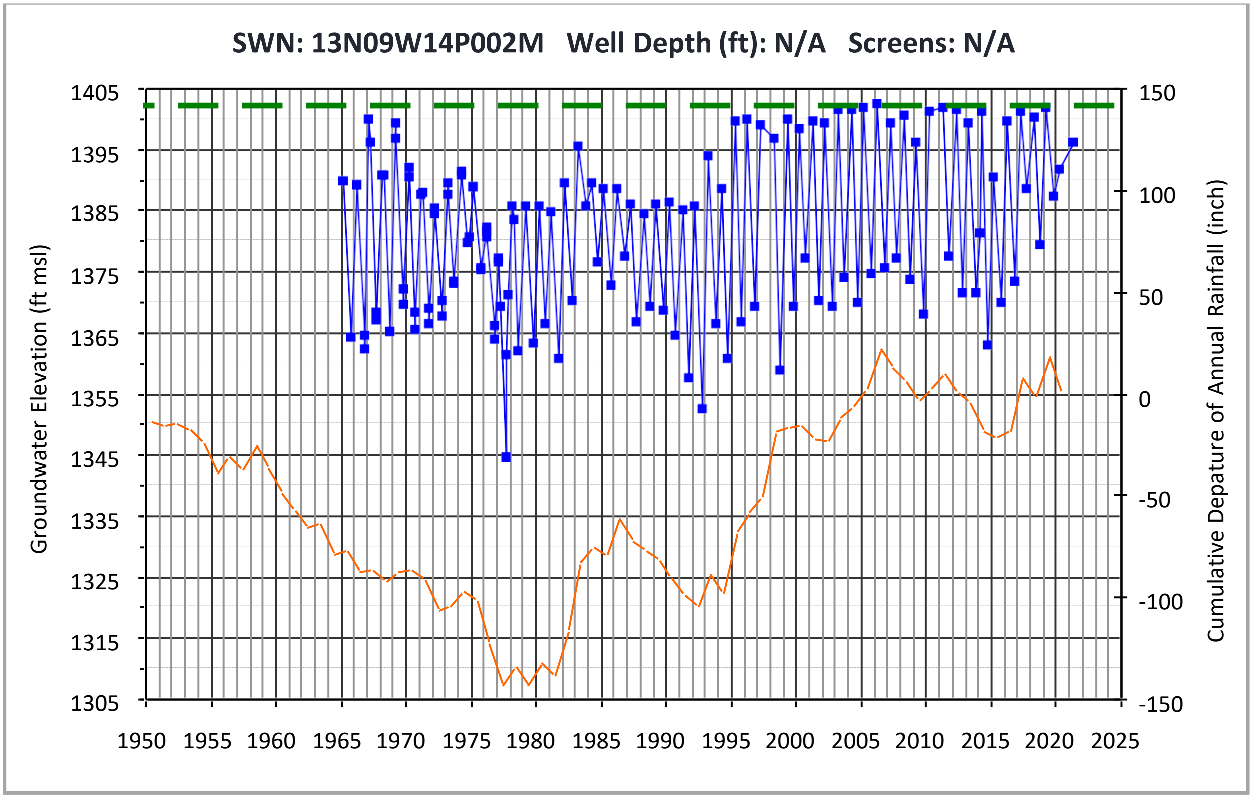


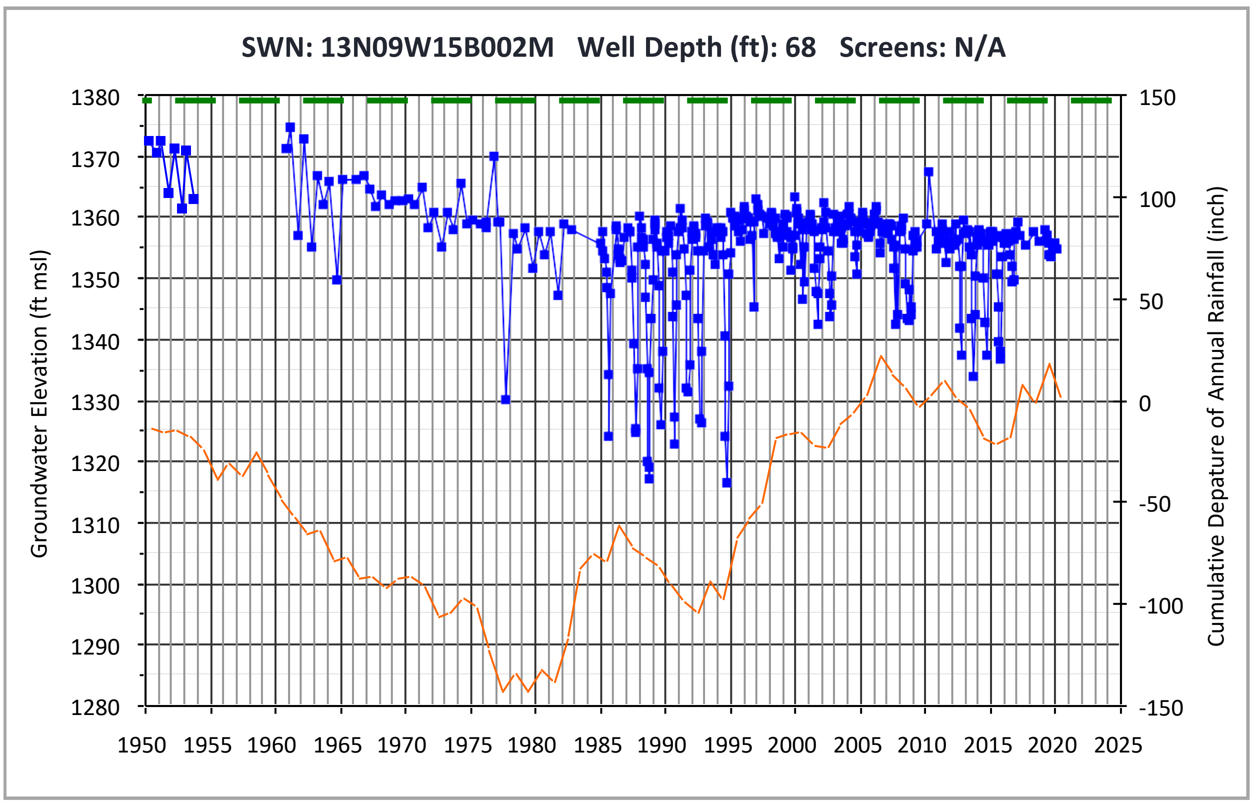
Groundwater elevation | Ground Surface elevation | Cumulative departure of annual rainfall from mean (based on water year)


SWN: 13N09W09L001M Well Depth (ft): N/A Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1365
1355
1345
1335
1325
1315
1305
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025


SWN: 13N09W10E001M Well Depth (ft): N/A Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1360
1350
1340
1330
1320
1310
1300
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025


Groundwater elevation
Ground Surface elevation
Cumulative departure of annual rainfall from mean (based on water year)

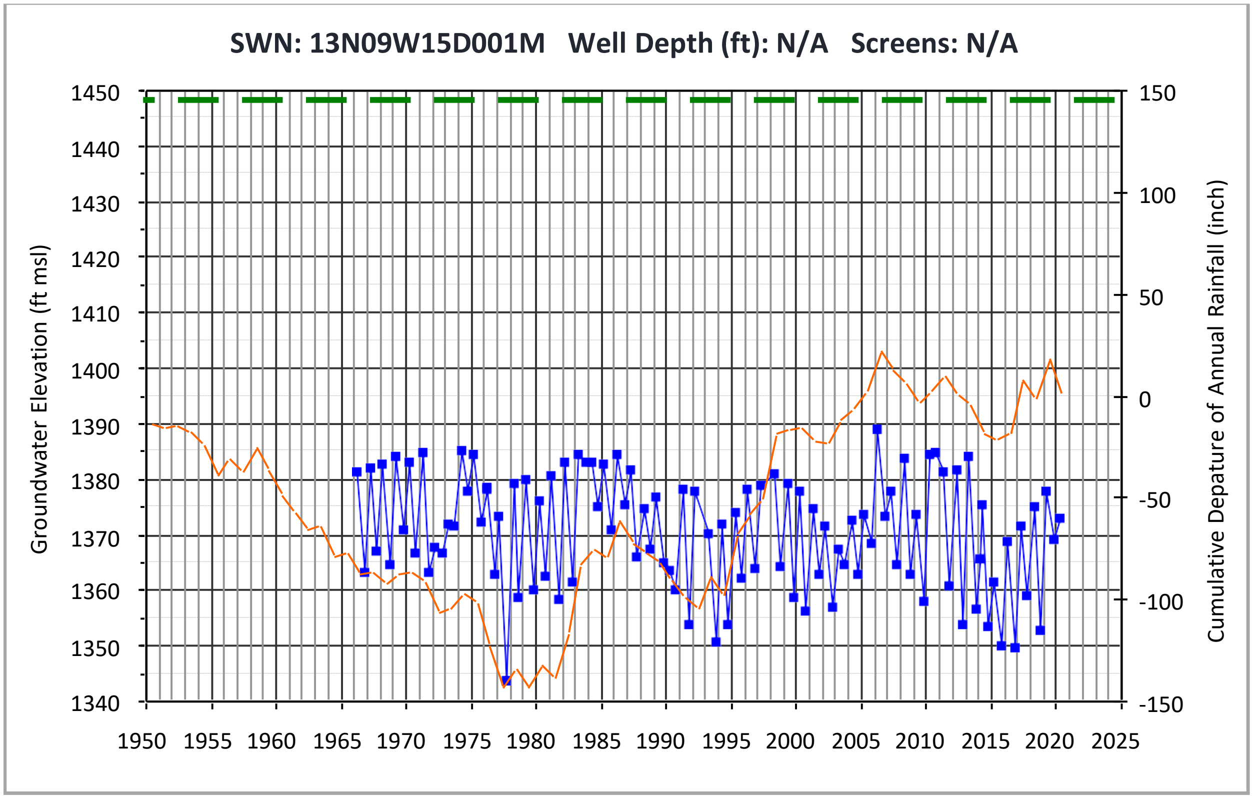


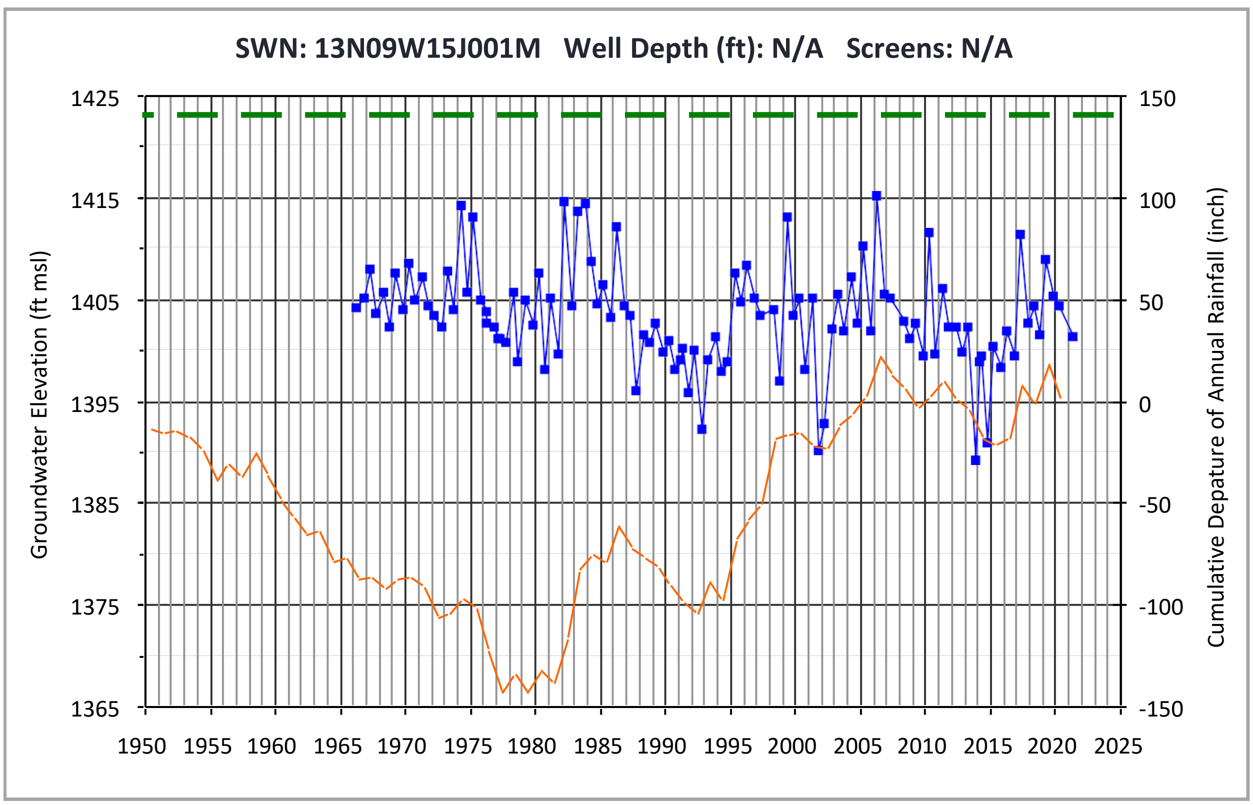


Groundwater elevation

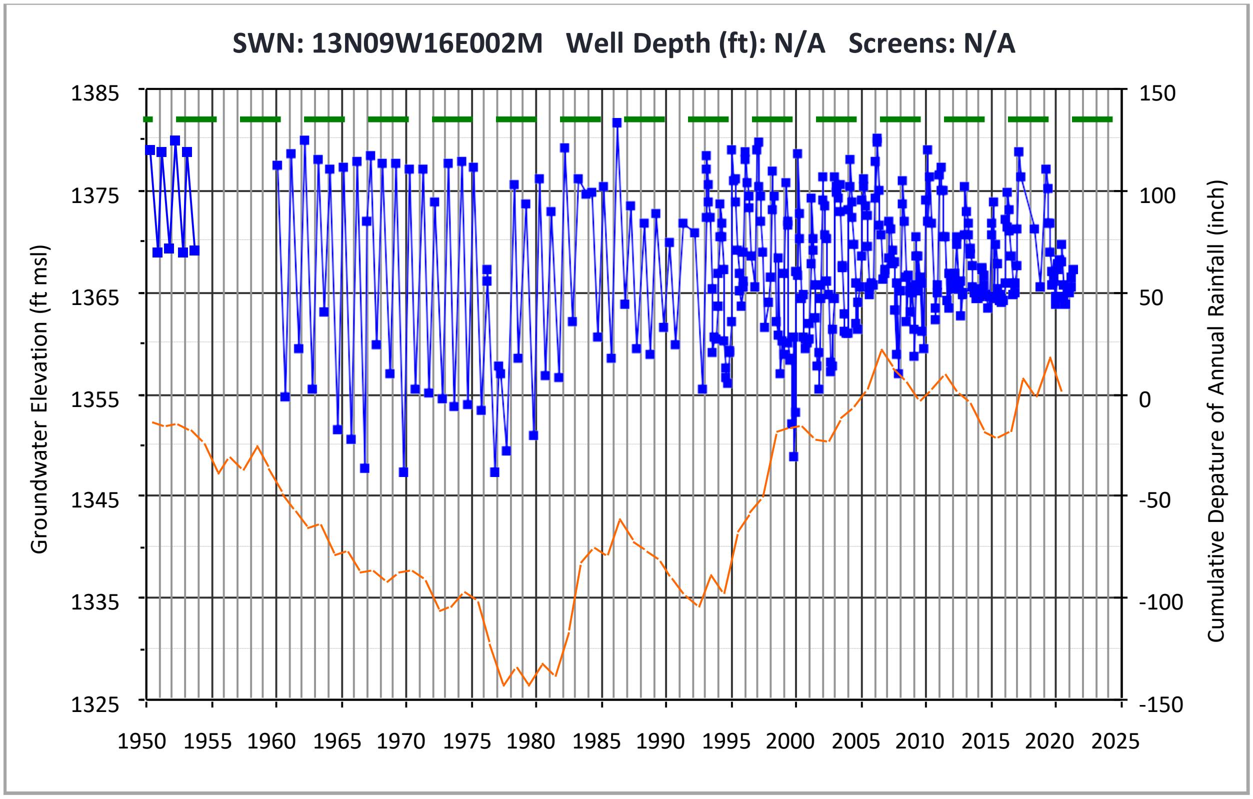
Ground Surface elevation

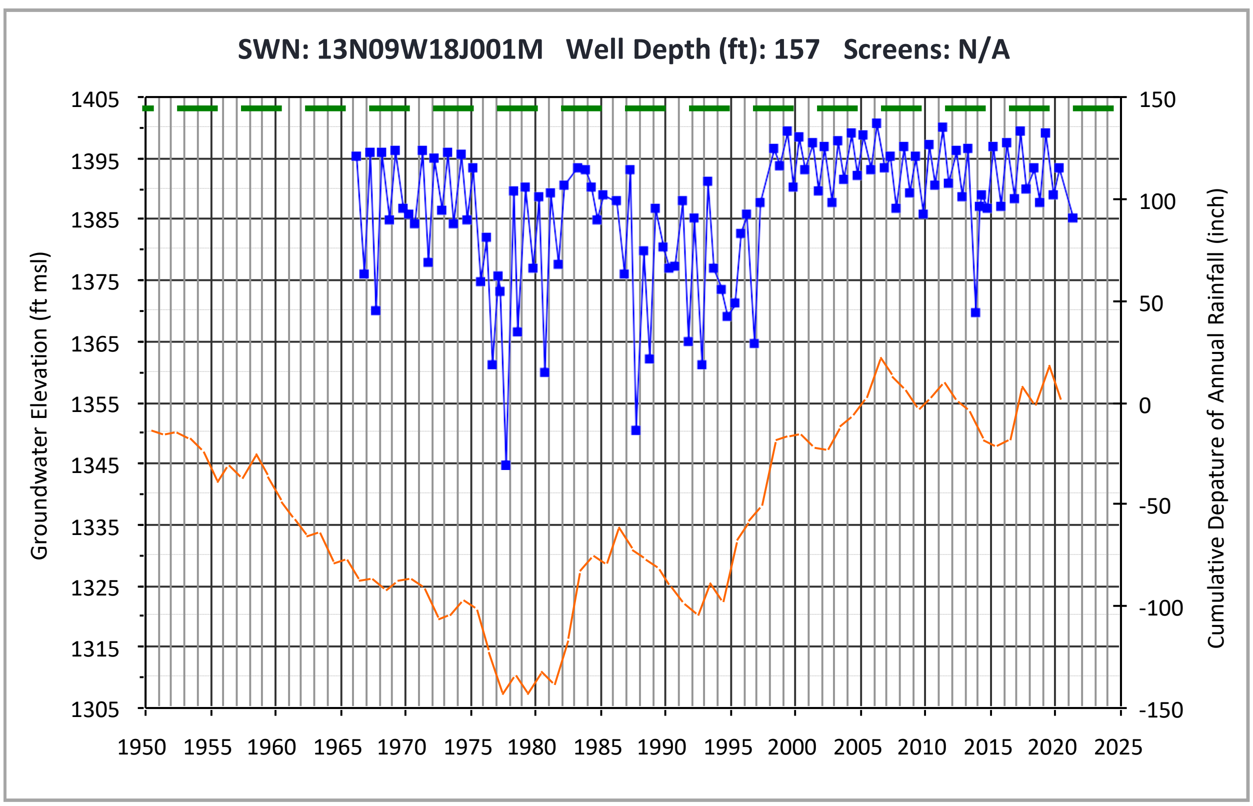
Cumulative departure of annual rainfall from mean (based on water year)


SWN: 13N09W15D001M Well Depth (ft): N/A Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1450
1440
1430
1420
1410
1400
1390
1380
1370
1360
1350
1340
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025

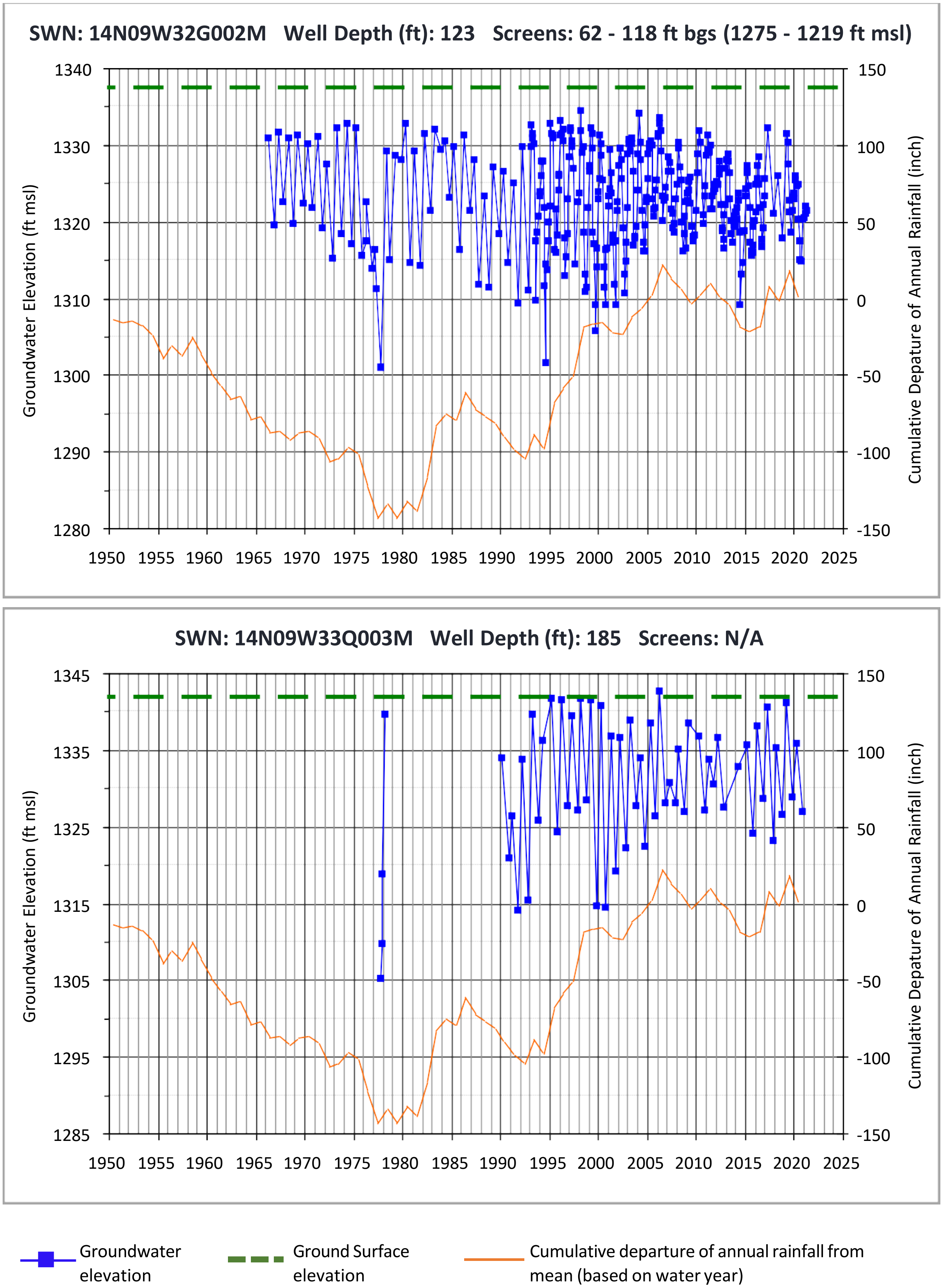

SWN: 13N09W15J001M Well Depth (ft): N/A Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1425
1415
1405
1395
1385
1375
1365
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025


Groundwater elevation
Ground Surface elevation
Cumulative departure of annual rainfall from mean (based on water year)


SWN: 13N09W16E002M Well Depth (ft): N/A Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1385
1375
1365
1355
1345
1335
1325
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025


SWN: 13N09W18J001M Well Depth (ft): 157 Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1405
1395
1385
1375
1365
1355
1345
1335
1325
1315
1305
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025


Groundwater elevation
Ground Surface elevation
Cumulative departure of annual rainfall from mean (based on water year)


SWN: 14N09W32G002M Well Depth (ft): 123 Screens: 62 - 118 ft bgs (1275 - 1219 ft msl)
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1340
1330
1320
1310
1300
1290
1280
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025
SWN: 14N09W33Q003M Well Depth (ft): 185 Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1345
1335
1325
1315
1305
1295
1285
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025
Groundwater elevation
Ground Surface elevation
Cumulative departure of annual rainfall from mean (based on water year)

Water level Hydrographs of Other Wells

(Wells were selected based on the span of available water level data.)

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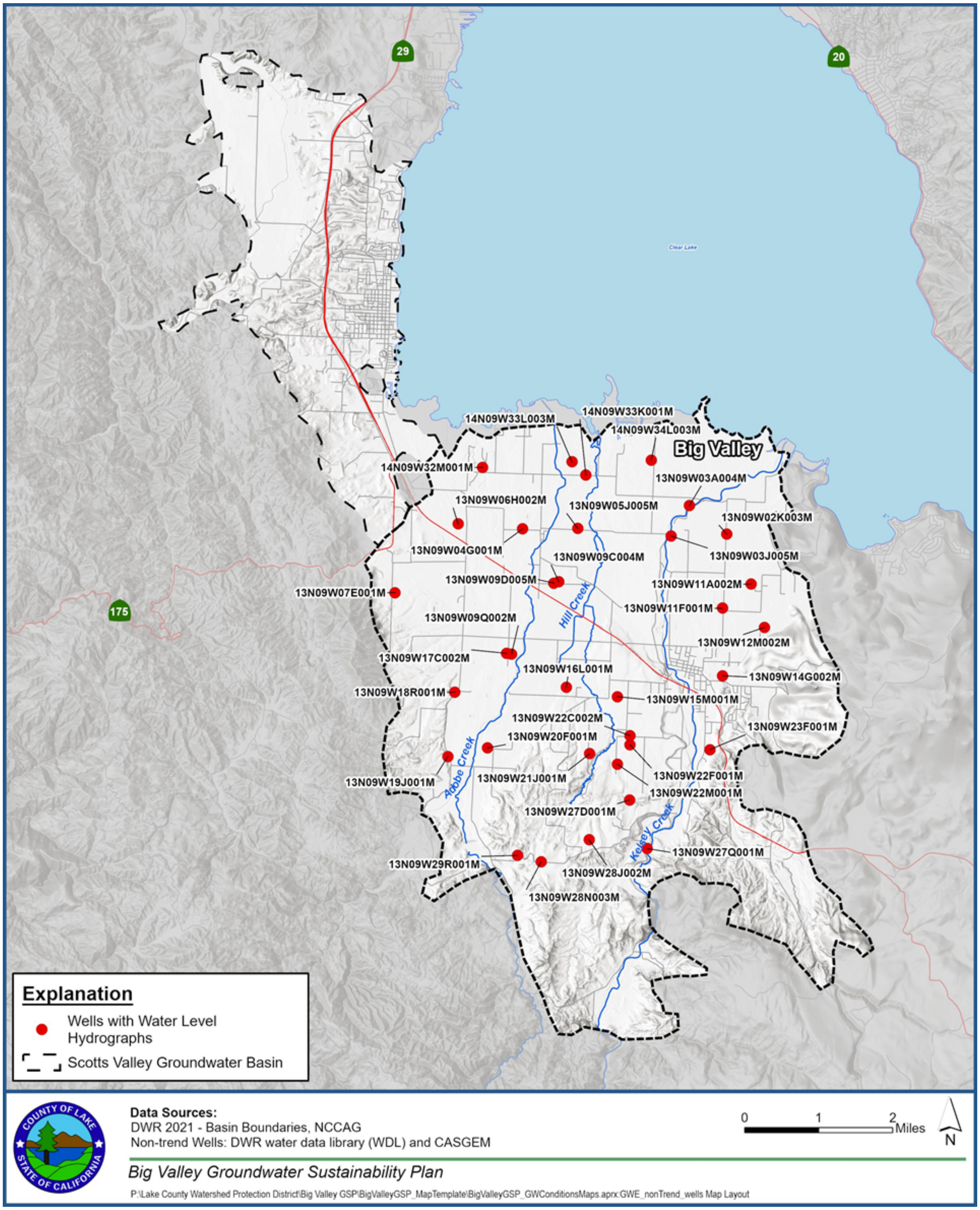
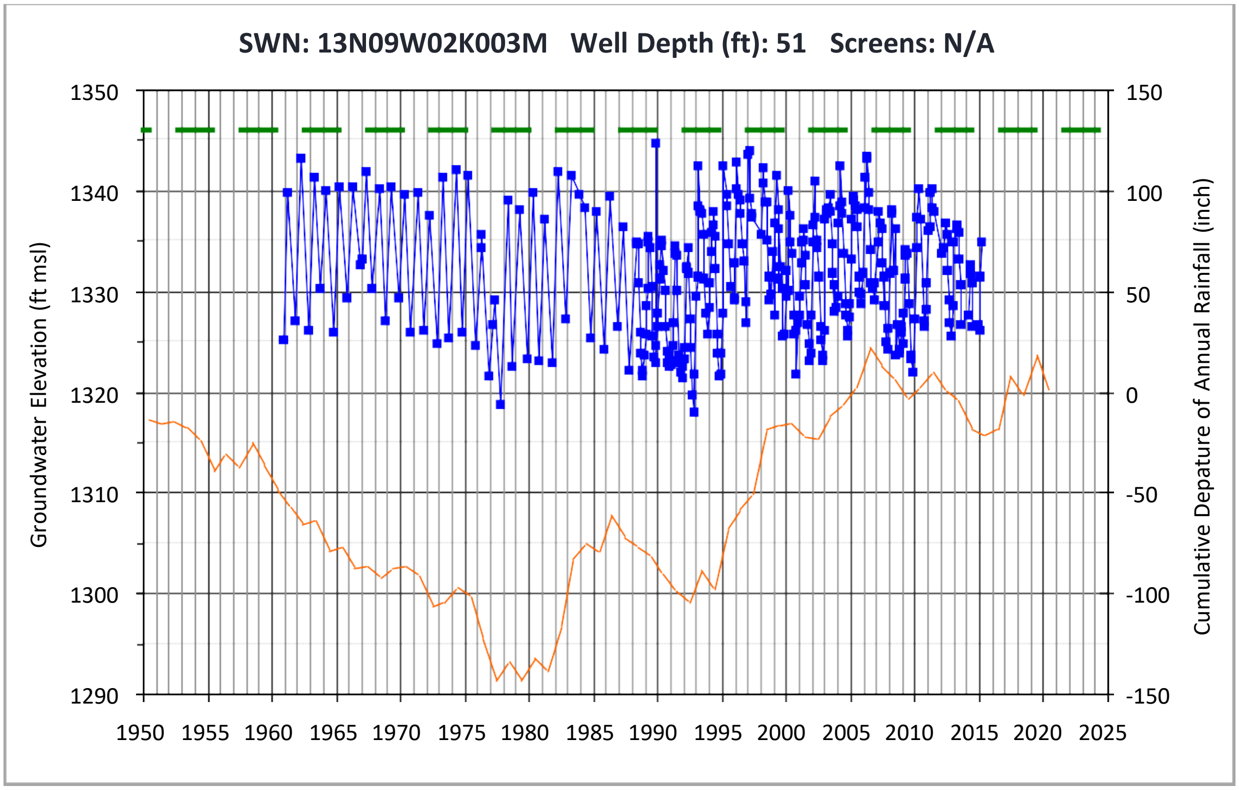
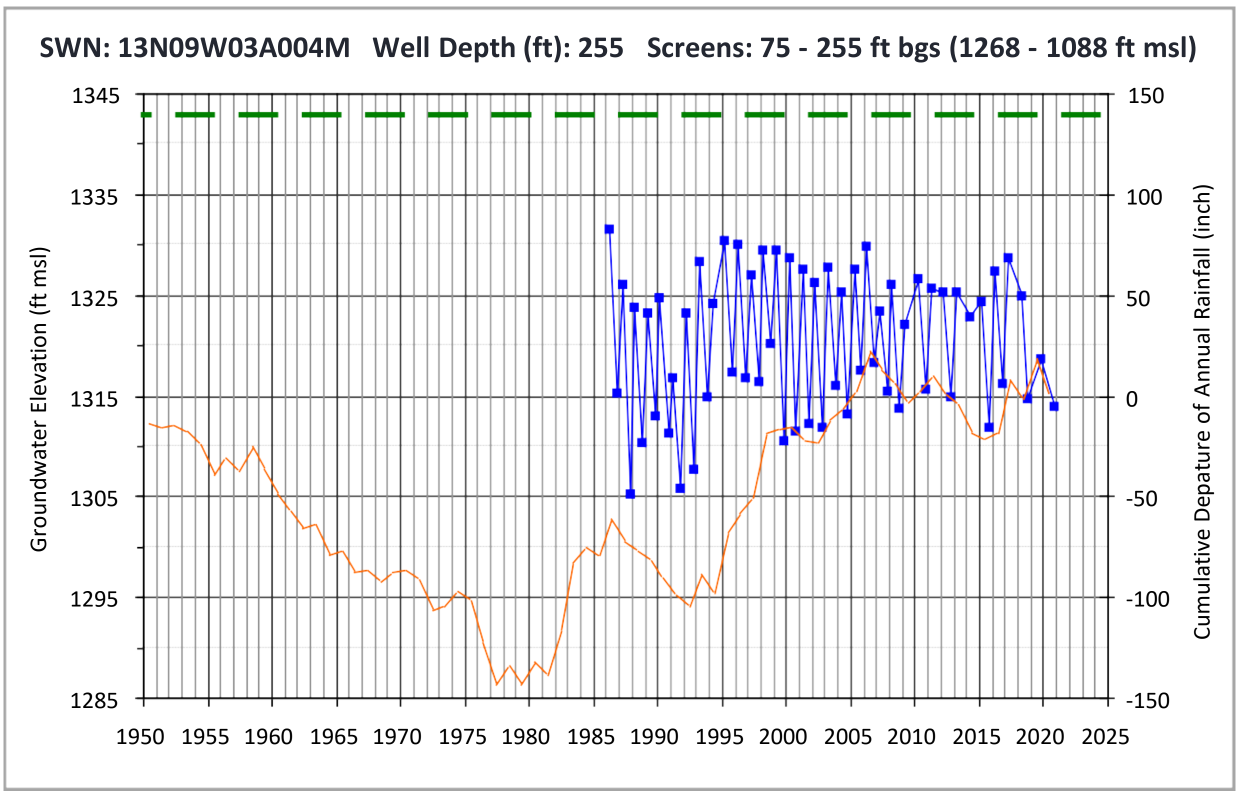
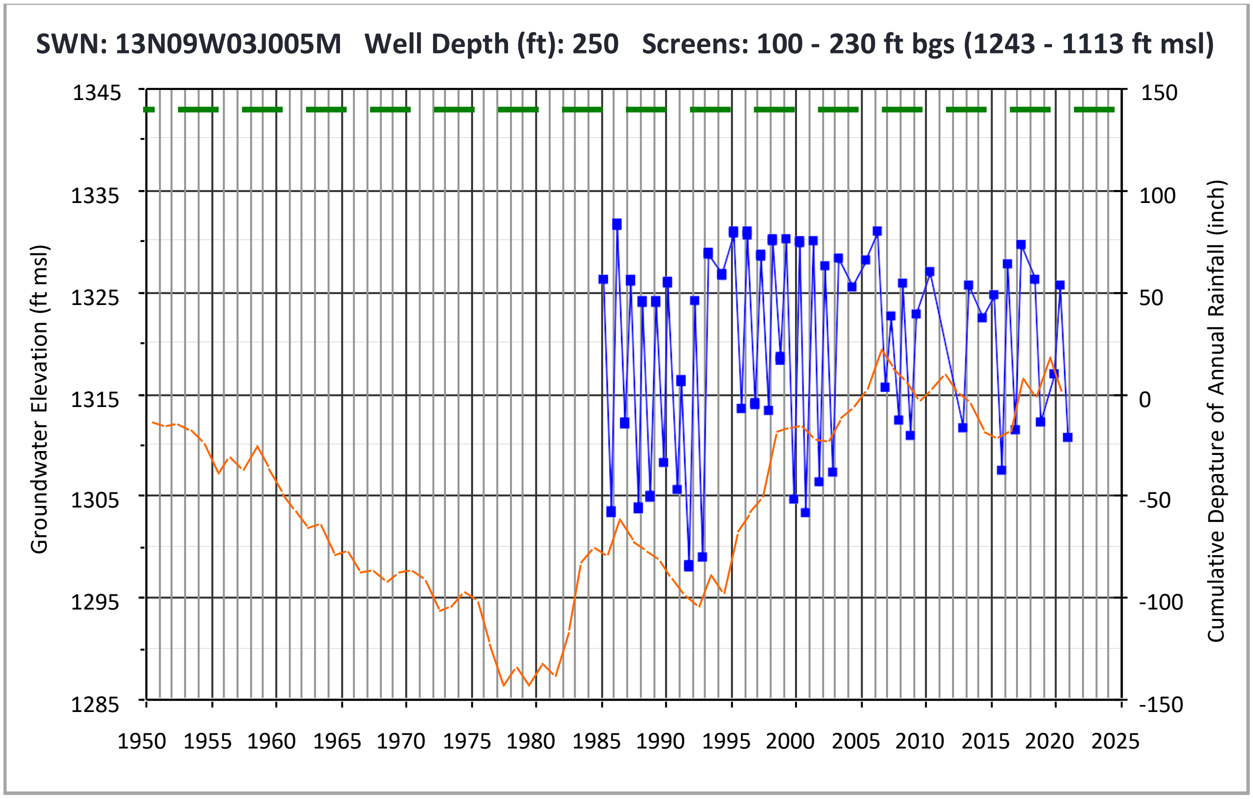


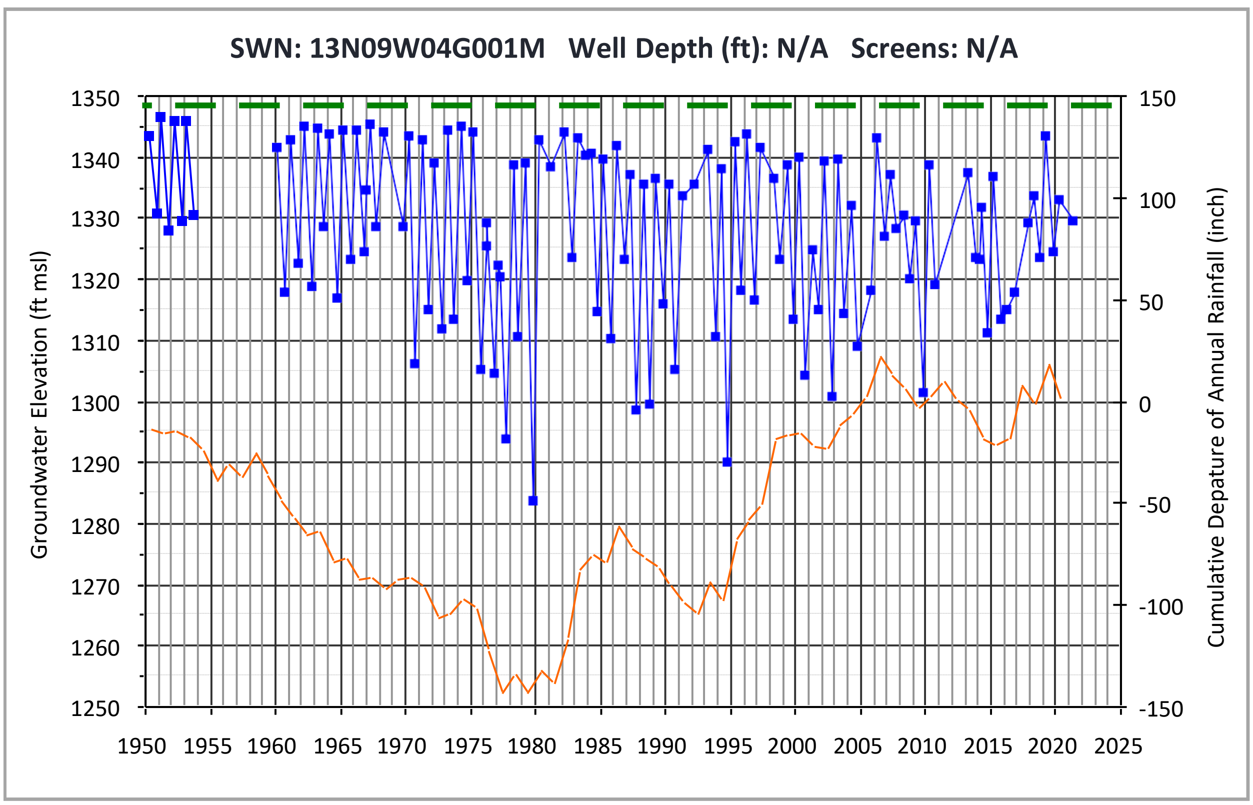
Figure 2. Locations of Wells with Long-term Water Level Data Used for Hydrographs



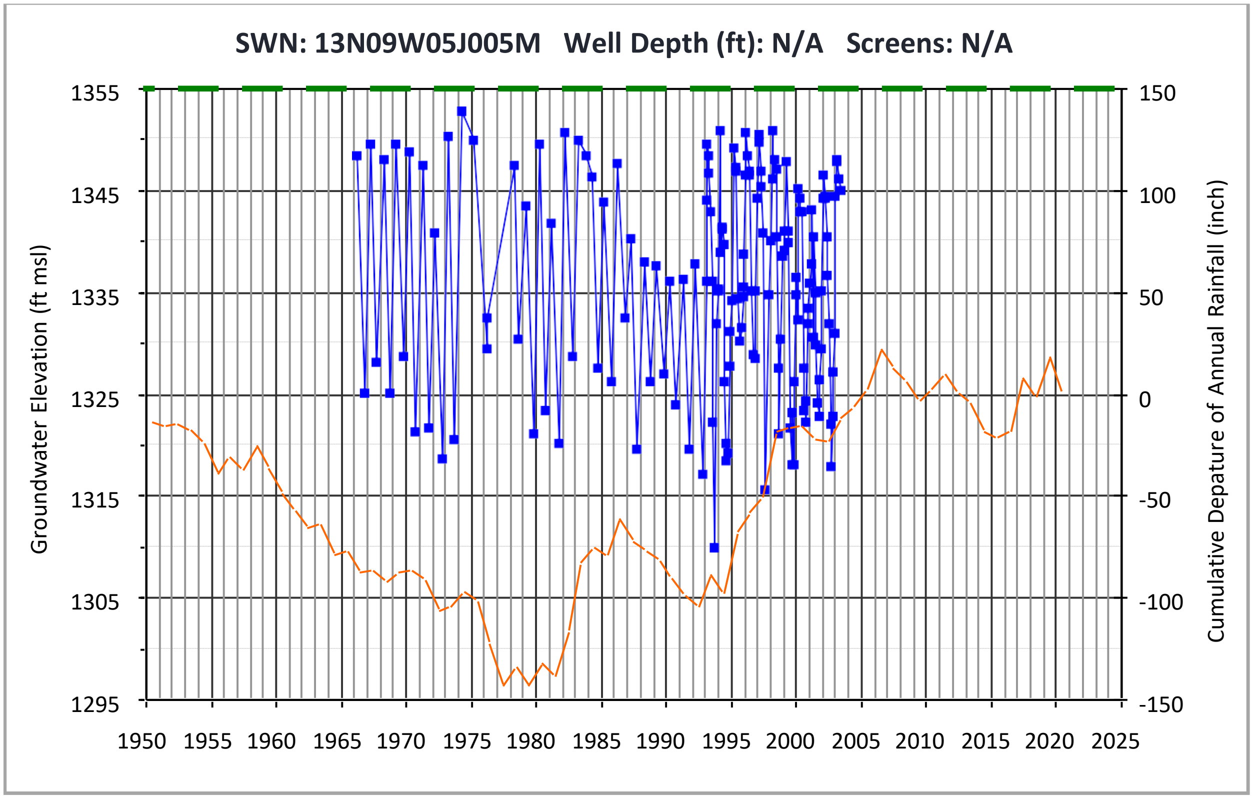


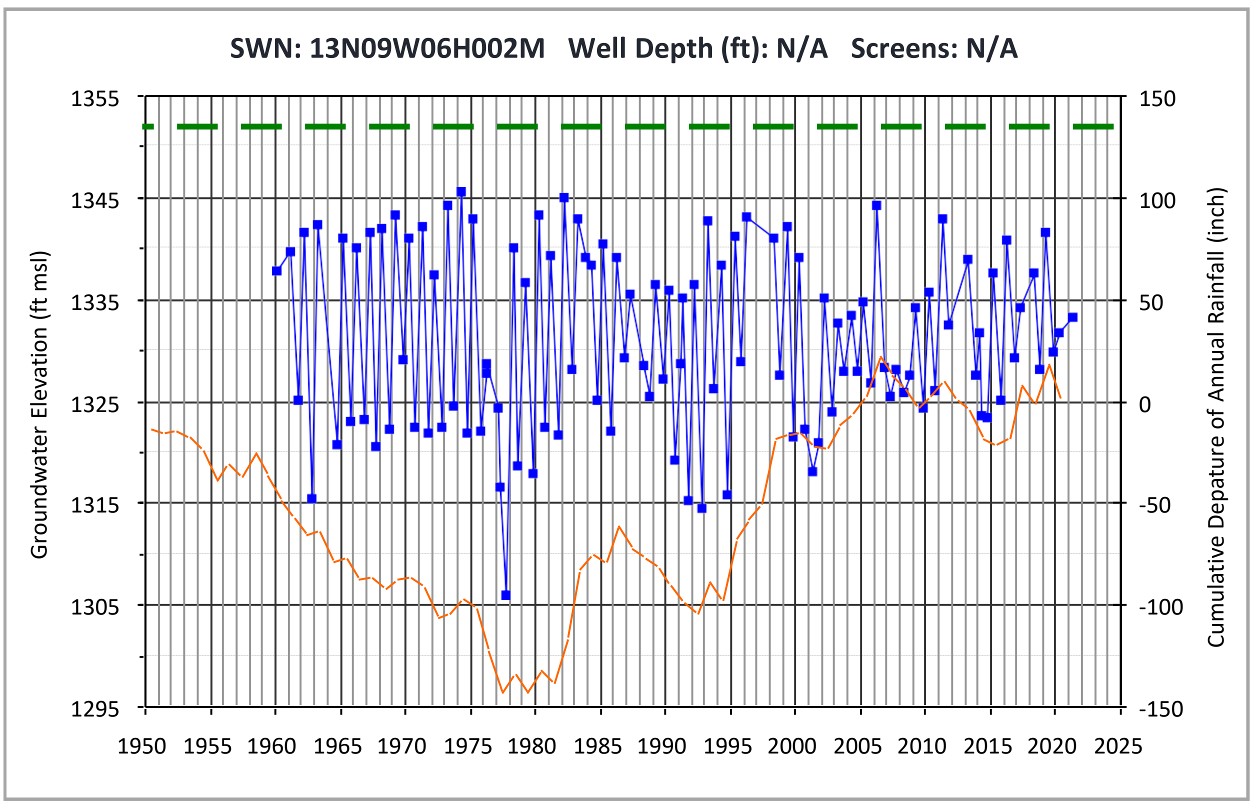
Groundwater elevation | Ground Surface elevation | Cumulative departure of annual rainfall from mean (based on water year)


SWN: 13N09W03J005M Well Depth (ft): 250 Screens: 100 - 230 ft bgs (1243 - 1113 ft msl)
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1345
1335
1325
1315
1305
1295
1285
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025

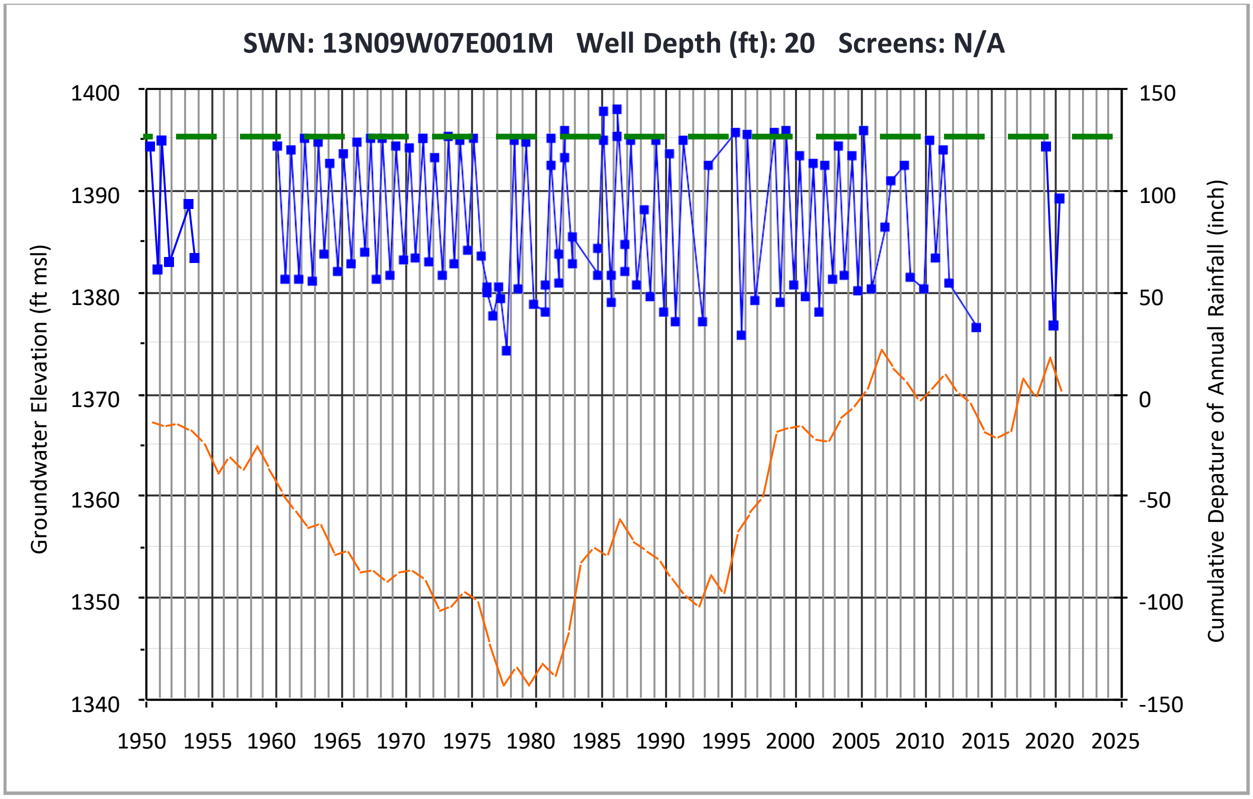

SWN: 13N09W04G001M Well Depth (ft): N/A Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1350
1340
1330
1320
1310
1300
1290
1280
1270
1260
1250
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025

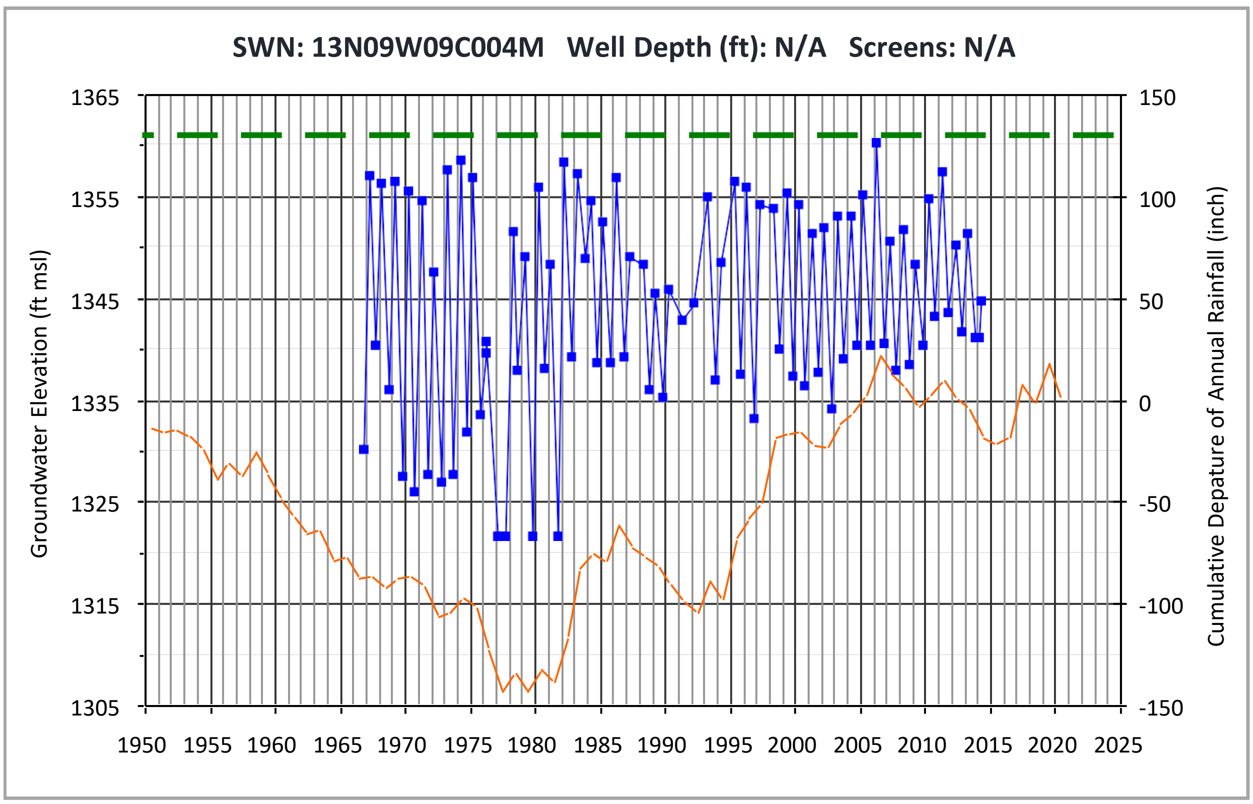

Groundwater elevation
Ground Surface elevation
Cumulative departure of annual rainfall from mean (based on water year)


SWN: 13N09W05J005M Well Depth (ft): N/A Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1355
1345
1335
1325
1315
1305
1295
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025

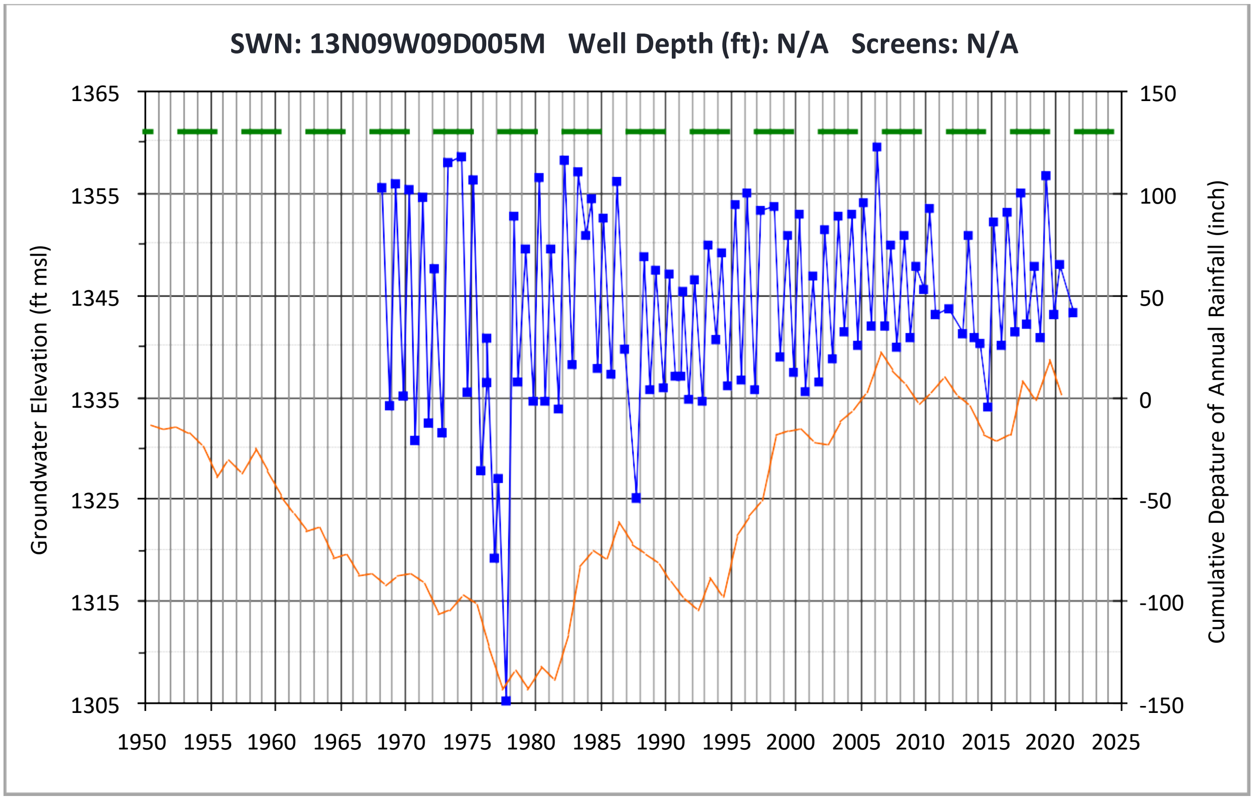

SWN: 13N09W06H002M Well Depth (ft): N/A Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1355
1345
1335
1325
1315
1305
1295
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025

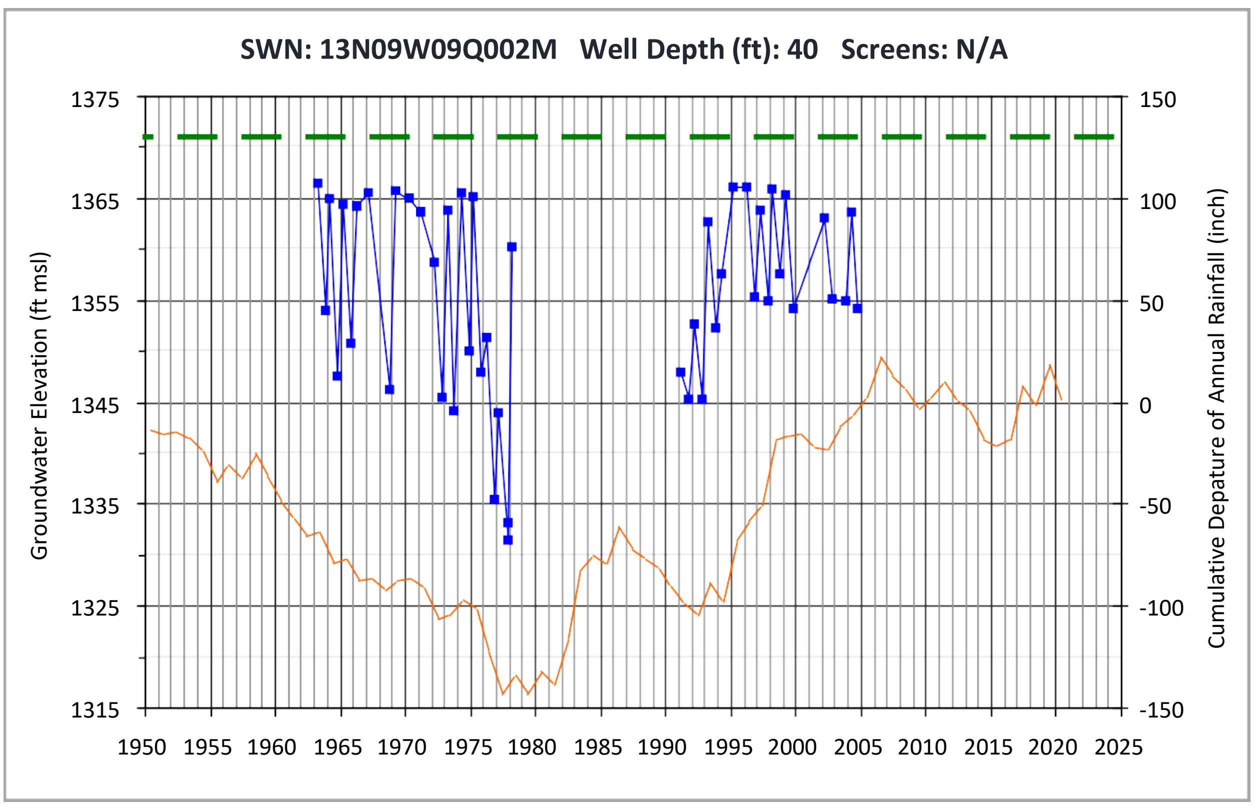

Groundwater elevation
Ground Surface elevation
Cumulative departure of annual rainfall from mean (based on water year)



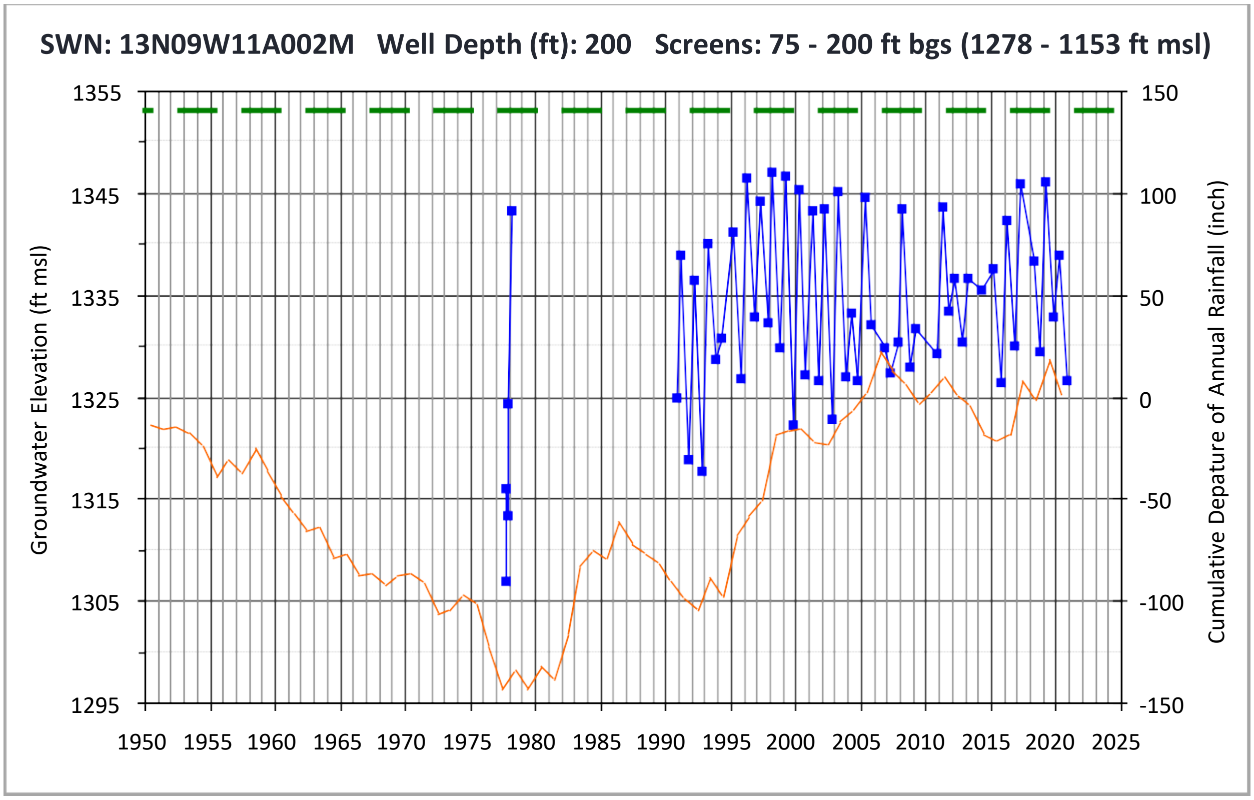


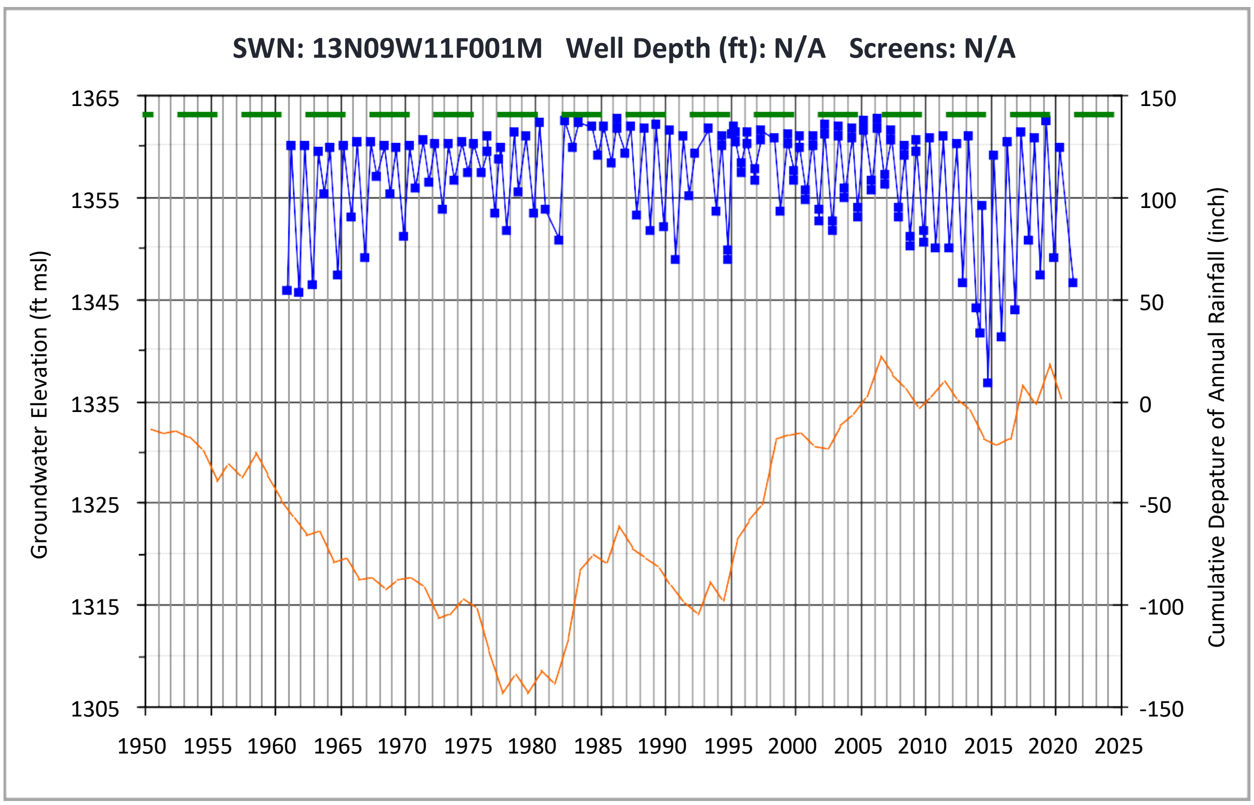
Groundwater elevation
Ground Surface elevation
Cumulative departure of annual rainfall from mean (based on water year)


SWN: 13N09W09D005M Well Depth (ft): N/A Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1365
1355
1345
1335
1325
1315
1305
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025

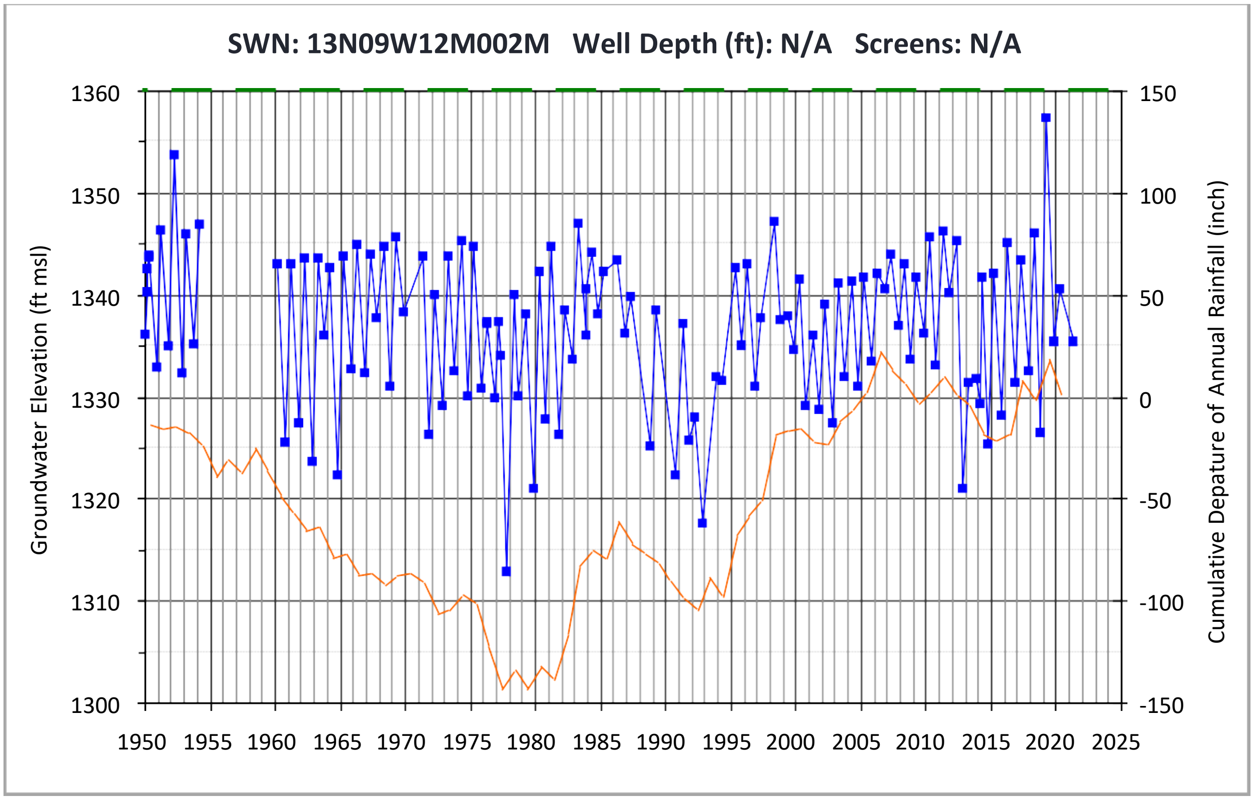

SWN: 13N09W09Q002M Well Depth (ft): 40 Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1375
1365
1355
1345
1335
1325
1315
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025

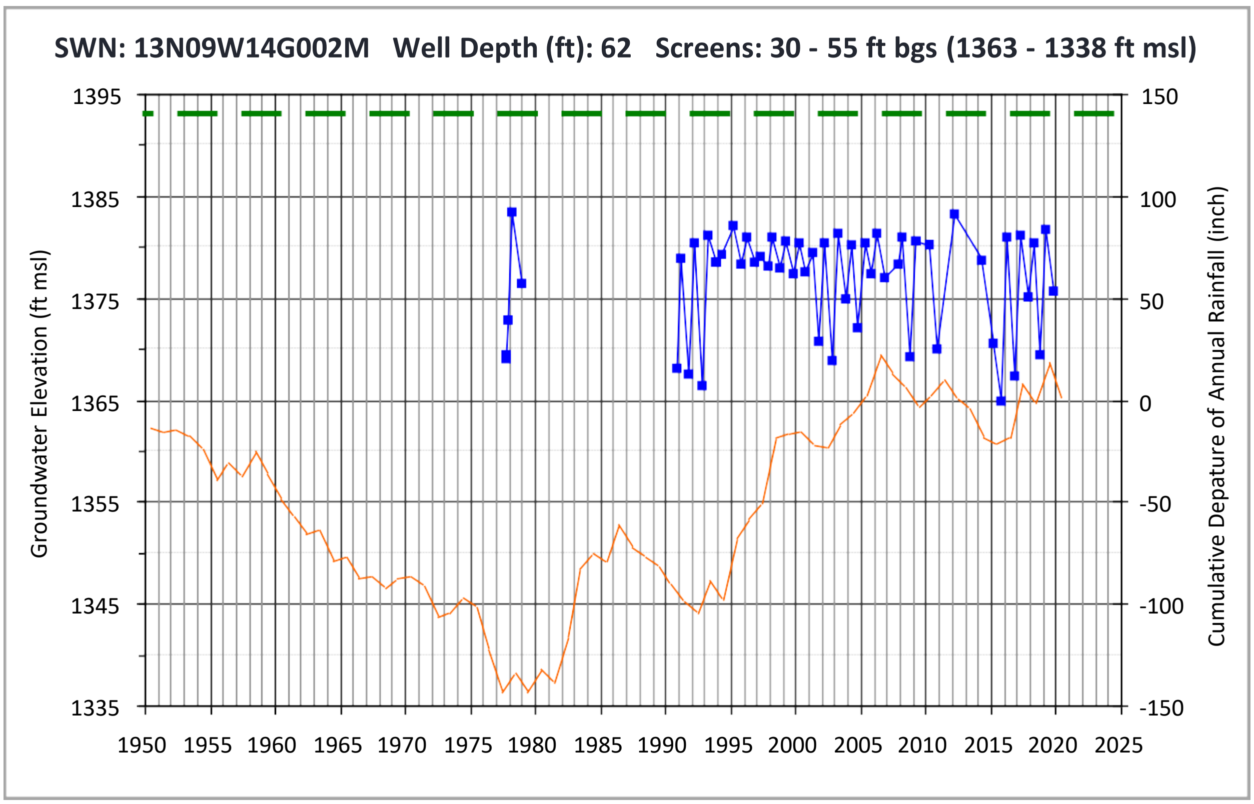

Groundwater elevation
Ground Surface elevation
Cumulative departure of annual rainfall from mean (based on water year)


SWN: 13N09W11A002M Well Depth (ft): 200 Screens: 75 - 200 ft bgs (1278 - 1153 ft msl)
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1355
1345
1335
1325
1315
1305
1295
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025

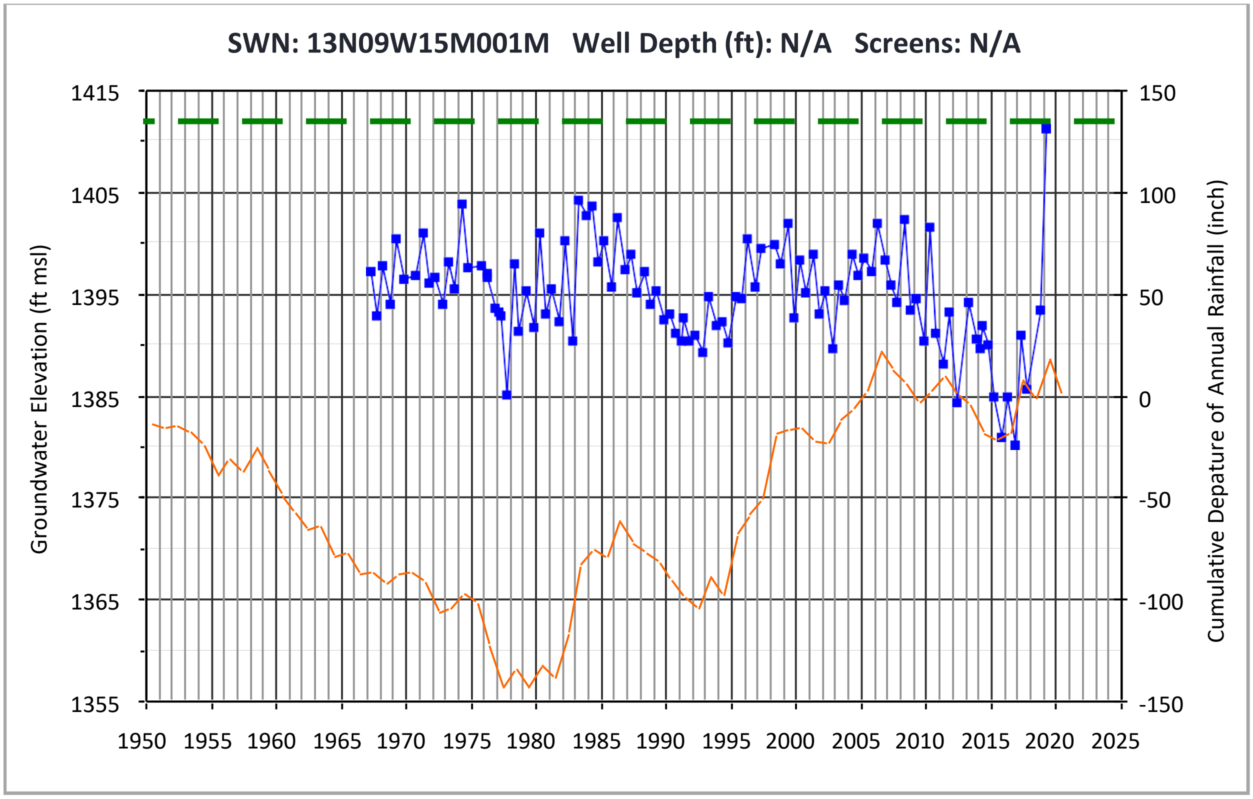

SWN: 13N09W11F001M Well Depth (ft): N/A Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1365
1355
1345
1335
1325
1315
1305
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025

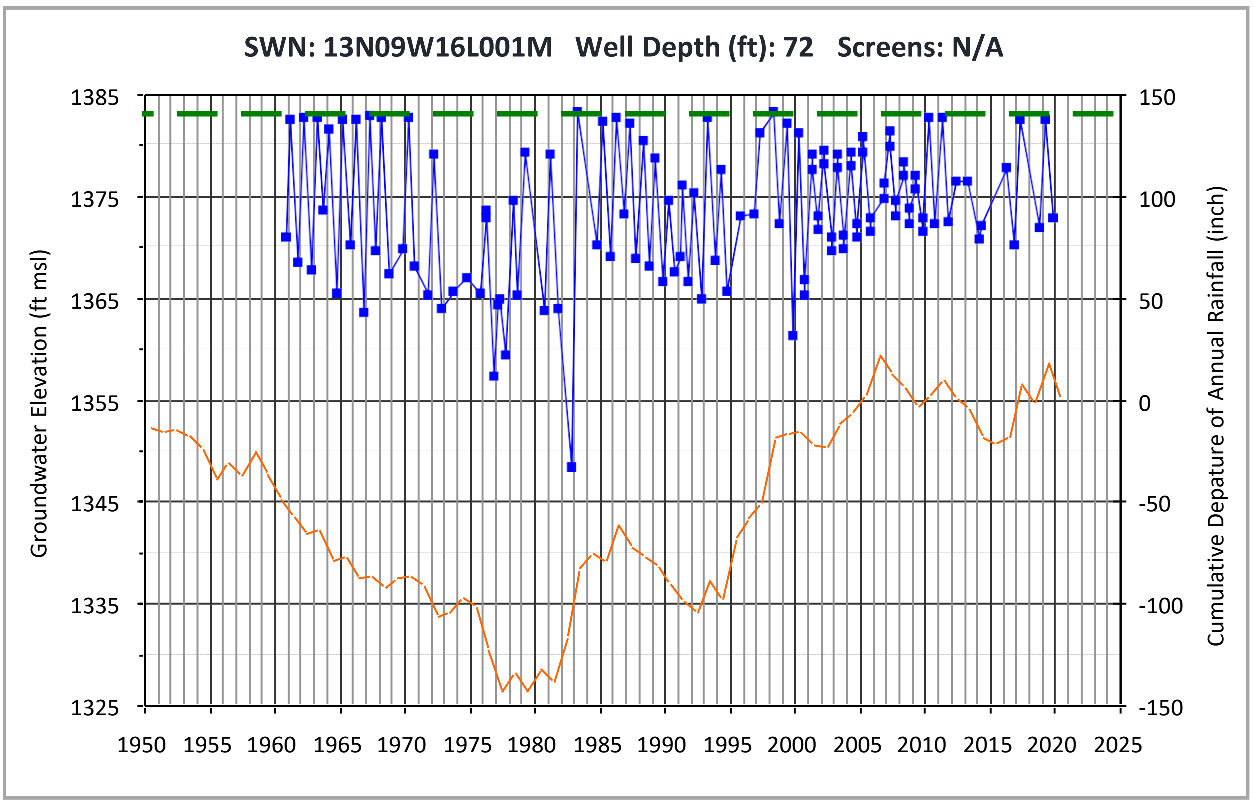

Groundwater elevation
Ground Surface elevation
Cumulative departure of annual rainfall from mean (based on water year)





Groundwater elevation
Ground Surface elevation
Cumulative departure of annual rainfall from mean (based on water year)

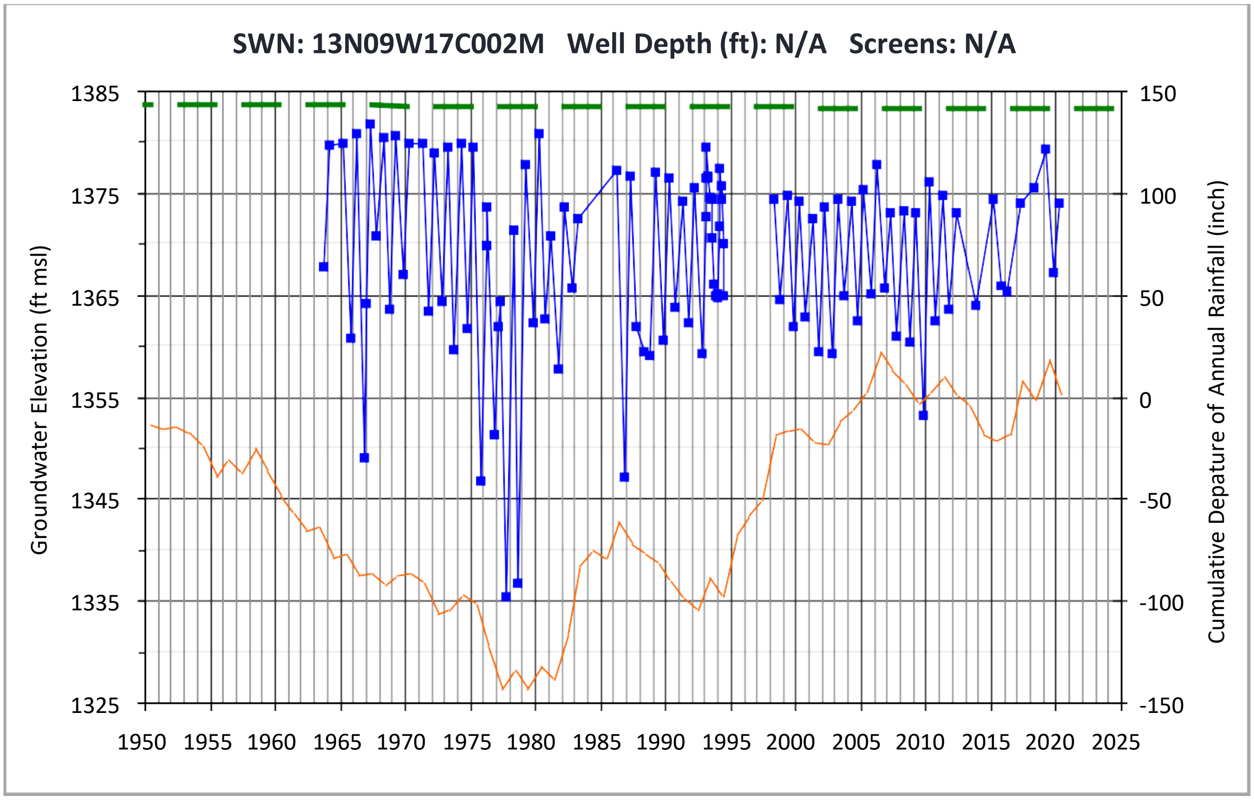


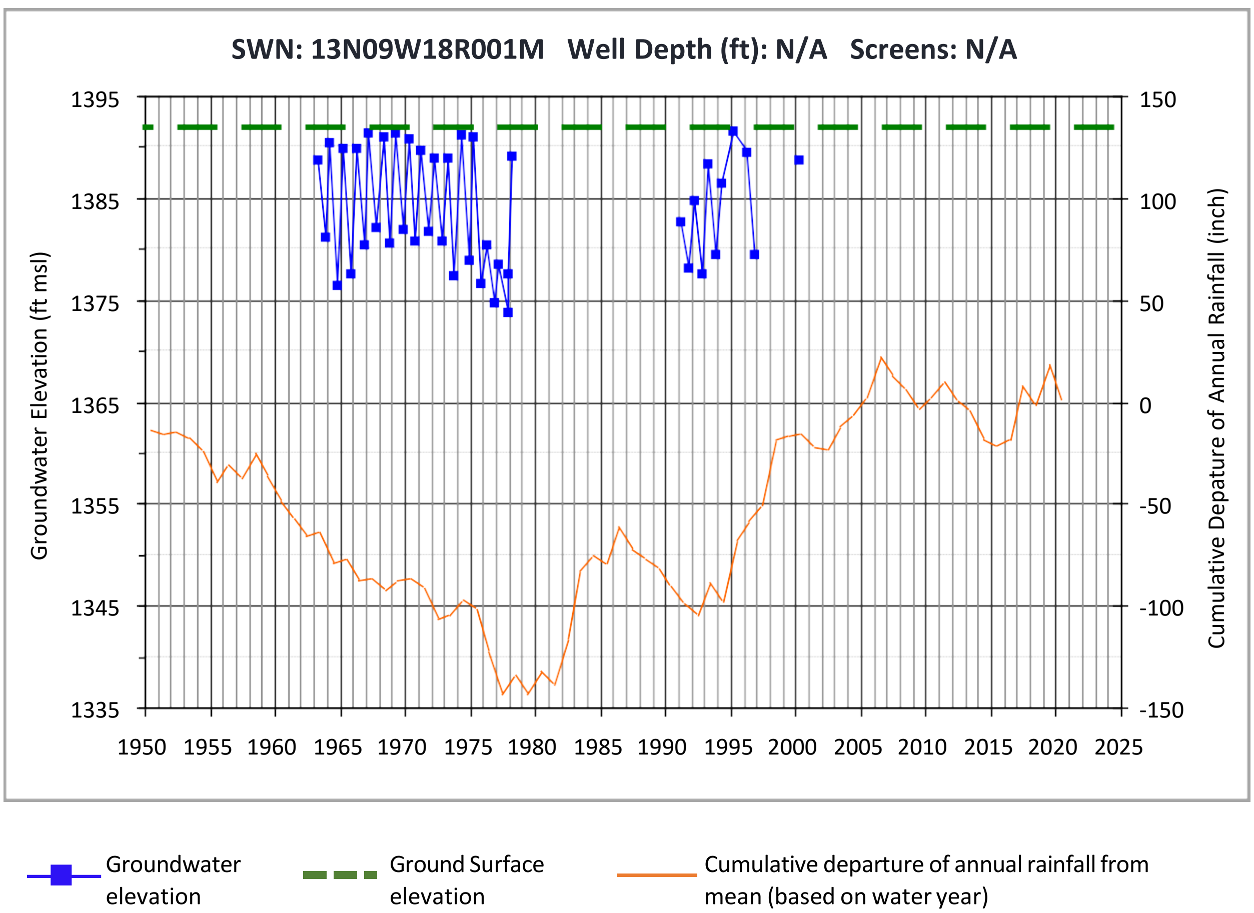


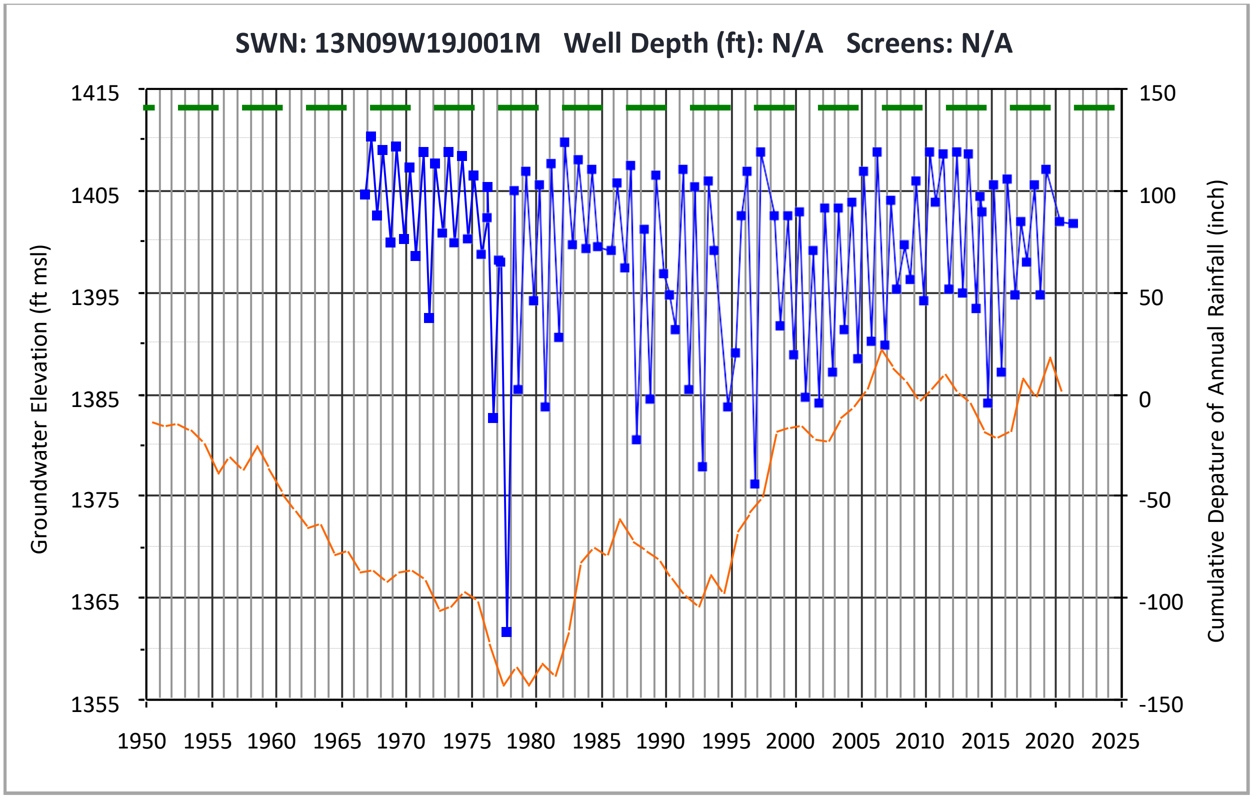
Groundwater elevation

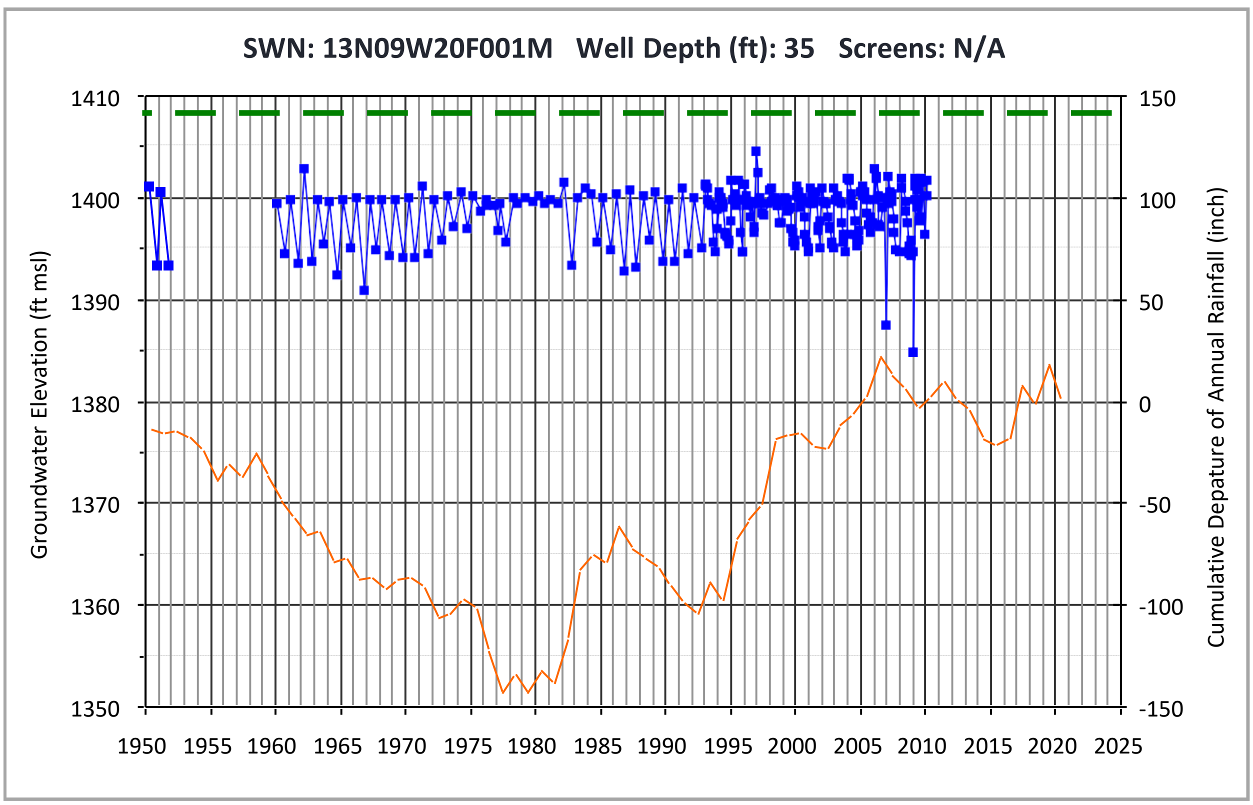
Ground Surface elevation

Cumulative departure of annual rainfall from mean (based on water year)


SWN: 13N09W17C002M Well Depth (ft): N/A Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1385
1375
1365
1355
1345
1335
1325
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025


SWN: 13N09W18R001M Well Depth (ft): N/A Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1395
1385
1375
1365
1355
1345
1335
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025
Groundwater elevation
Ground Surface elevation
Cumulative departure of annual rainfall from mean (based on water year)

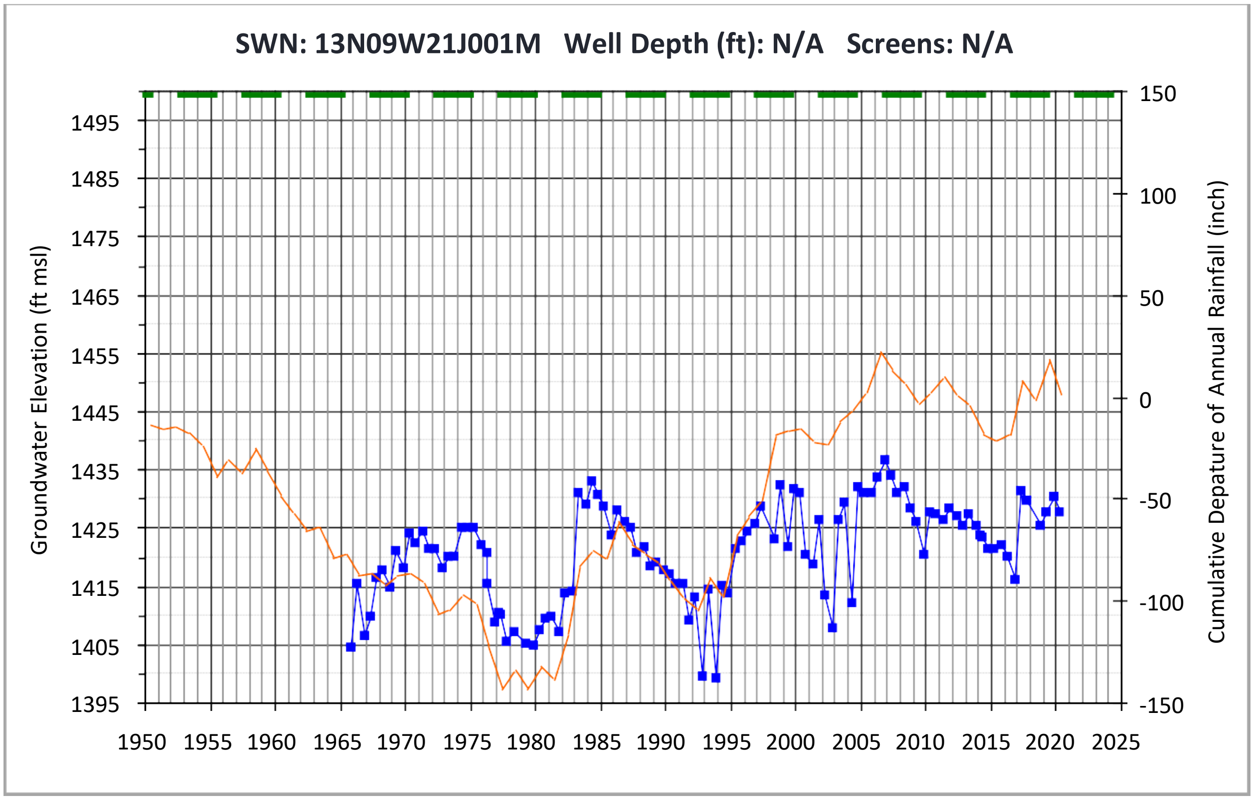




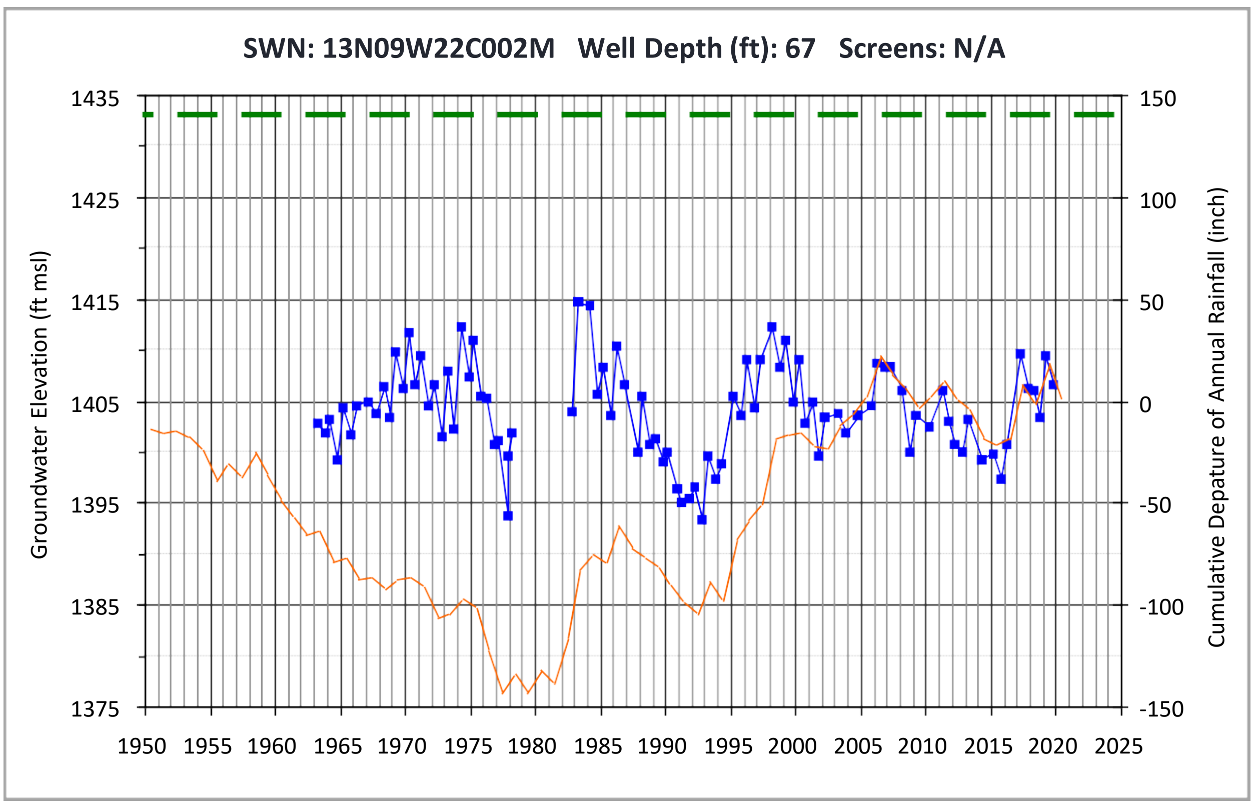
Groundwater elevation

Ground Surface elevation

Cumulative departure of annual rainfall from mean (based on water year)

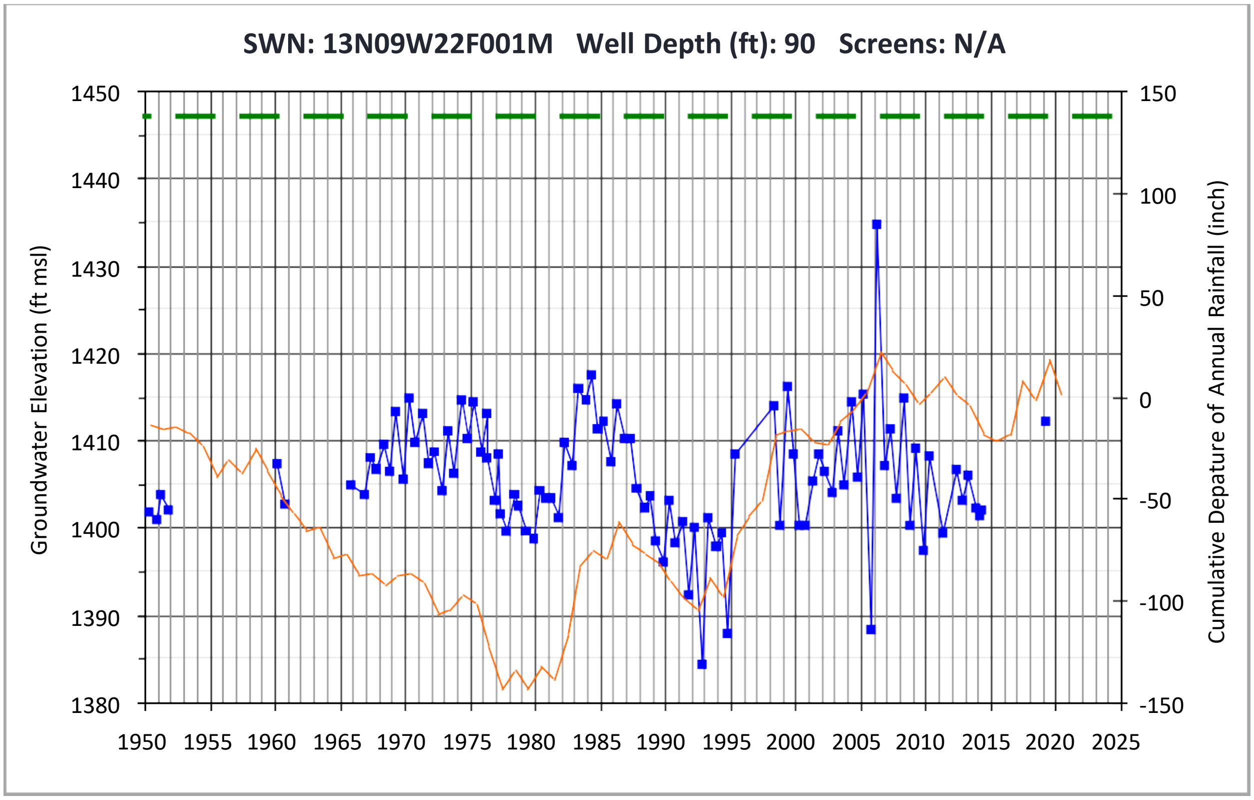


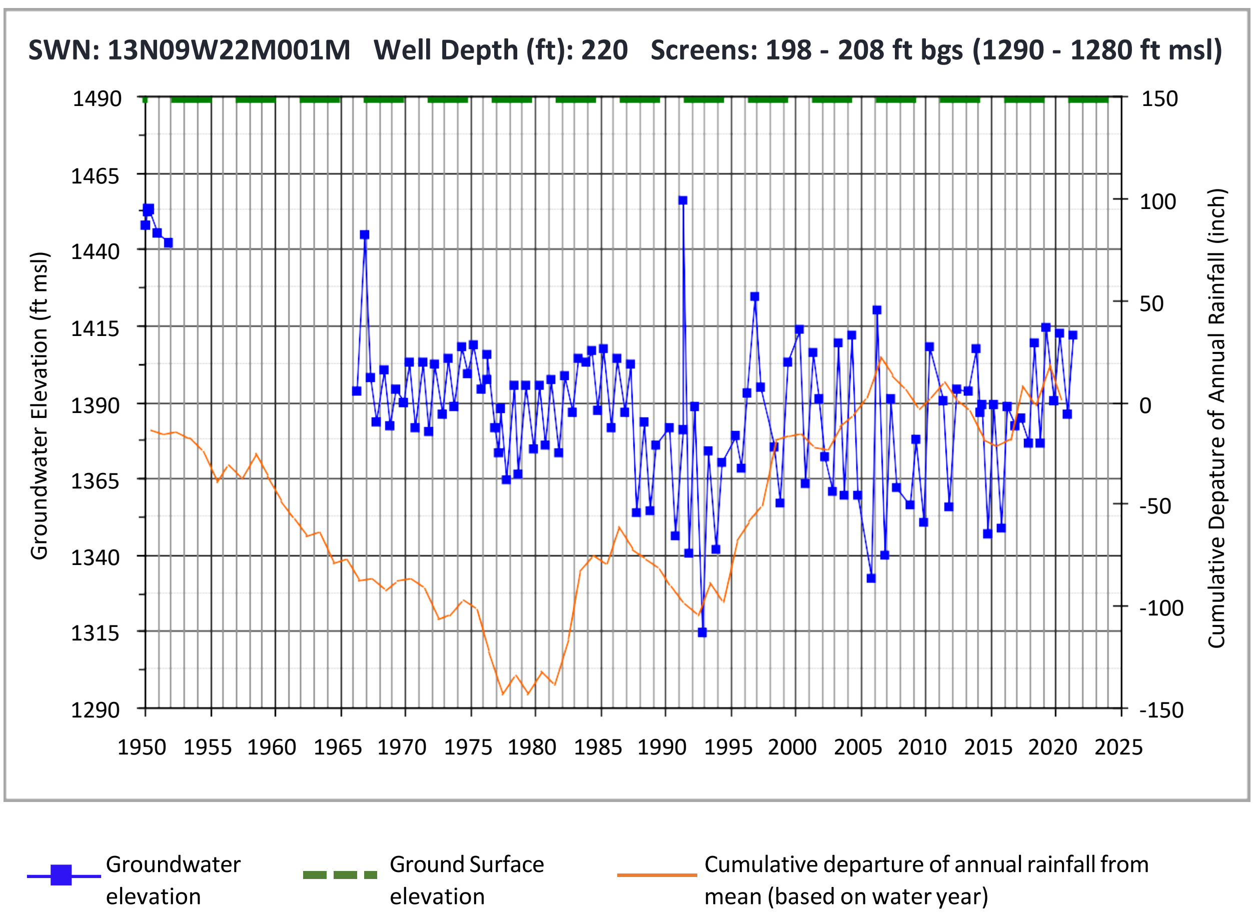
SWN: 13N09W21J001M Well Depth (ft): N/A Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1495
1485
1475
1465
1455
1445
1435
1425
1415
1405
1395
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025

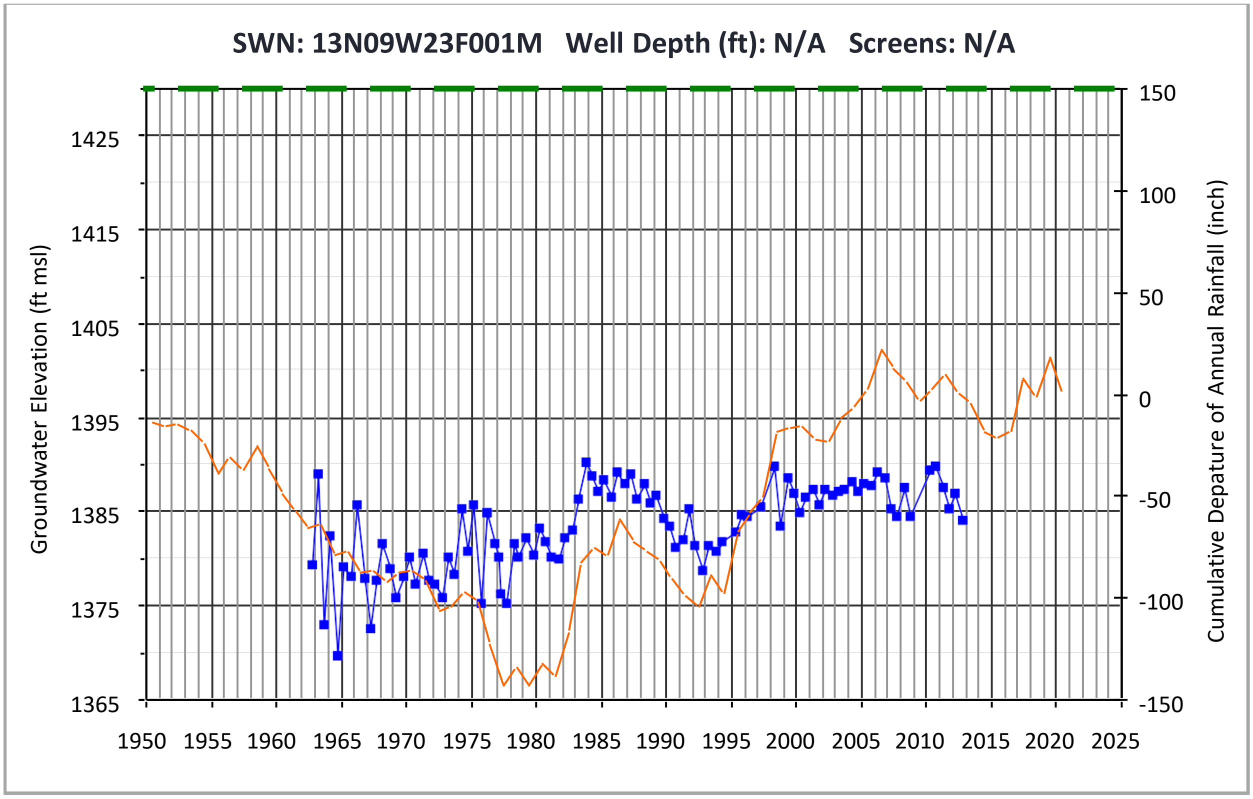


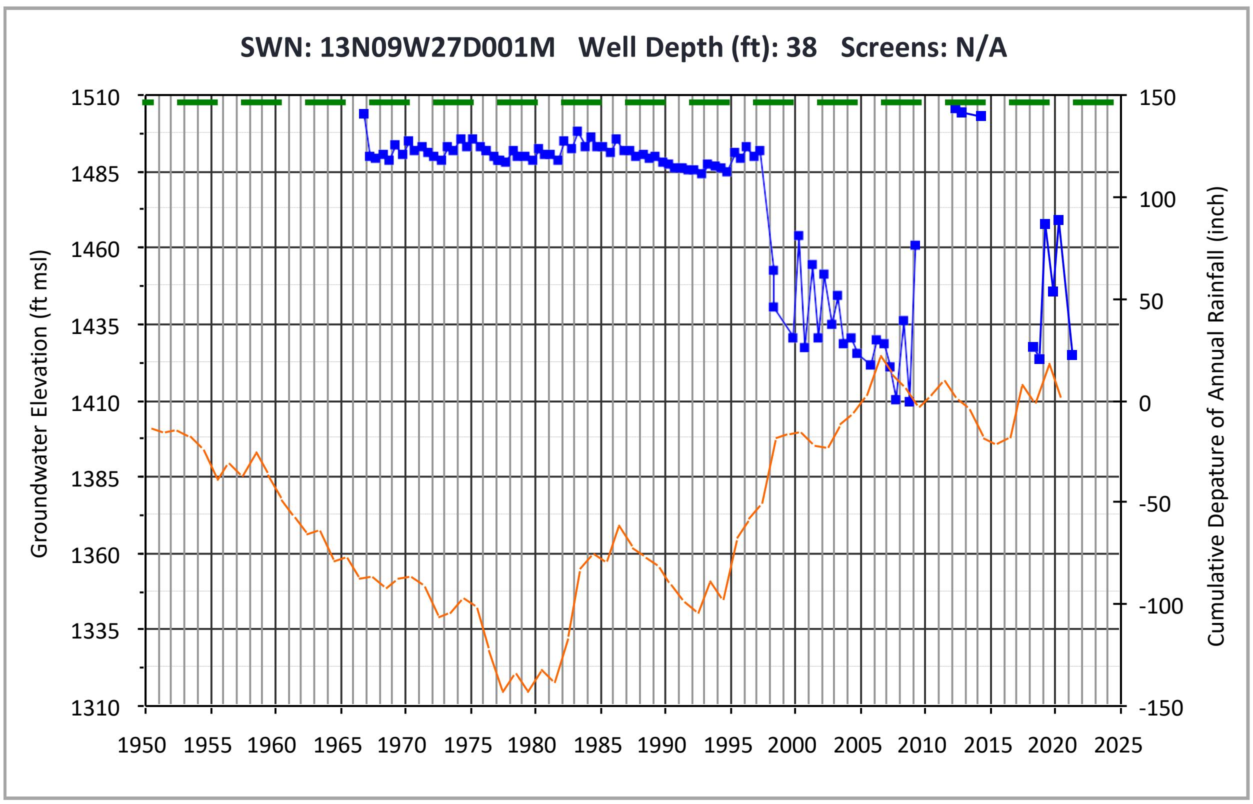
SWN: 13N09W22C002M Well Depth (ft): 67 Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1435
1425
1415
1405
1395
1385
1375
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025

Groundwater elevation
Ground Surface elevation
Cumulative departure of annual rainfall from mean (based on water year)

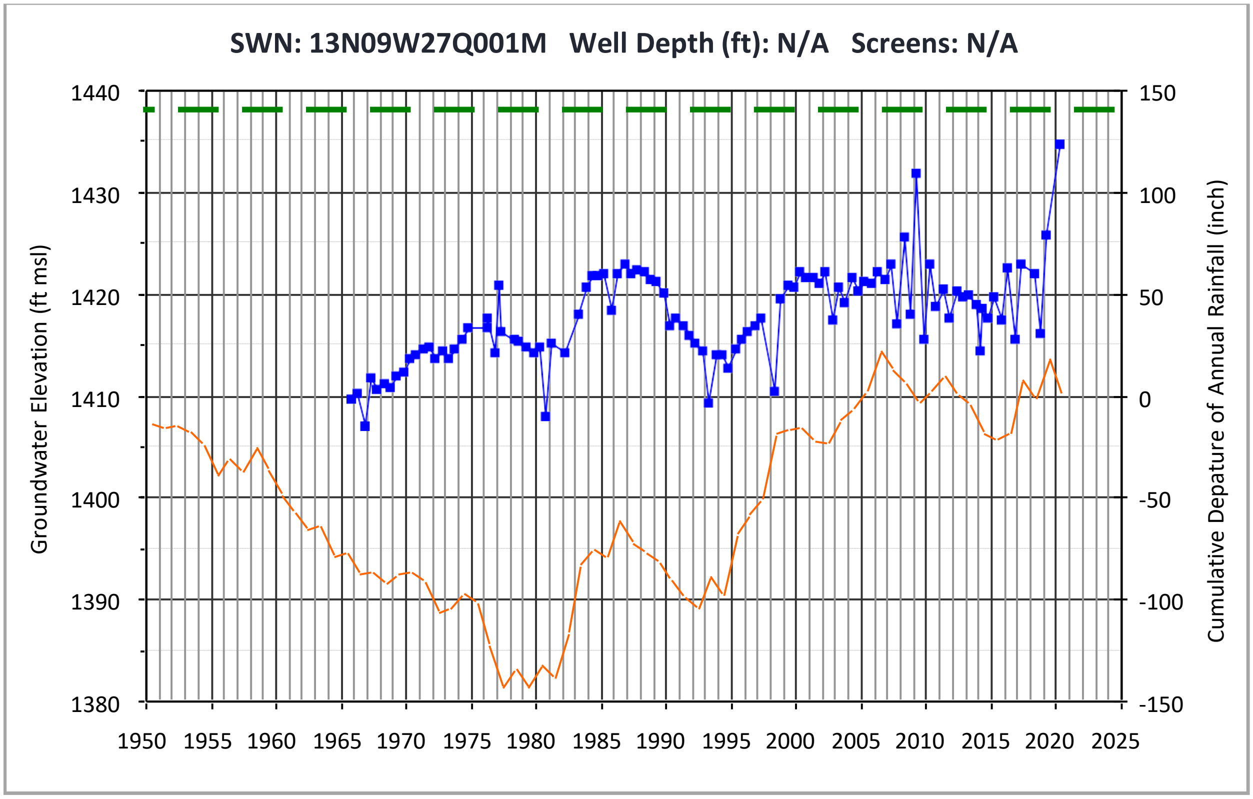

SWN: 13N09W22F001M Well Depth (ft): 90 Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1450
1440
1430
1420
1410
1400
1390
1380
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025

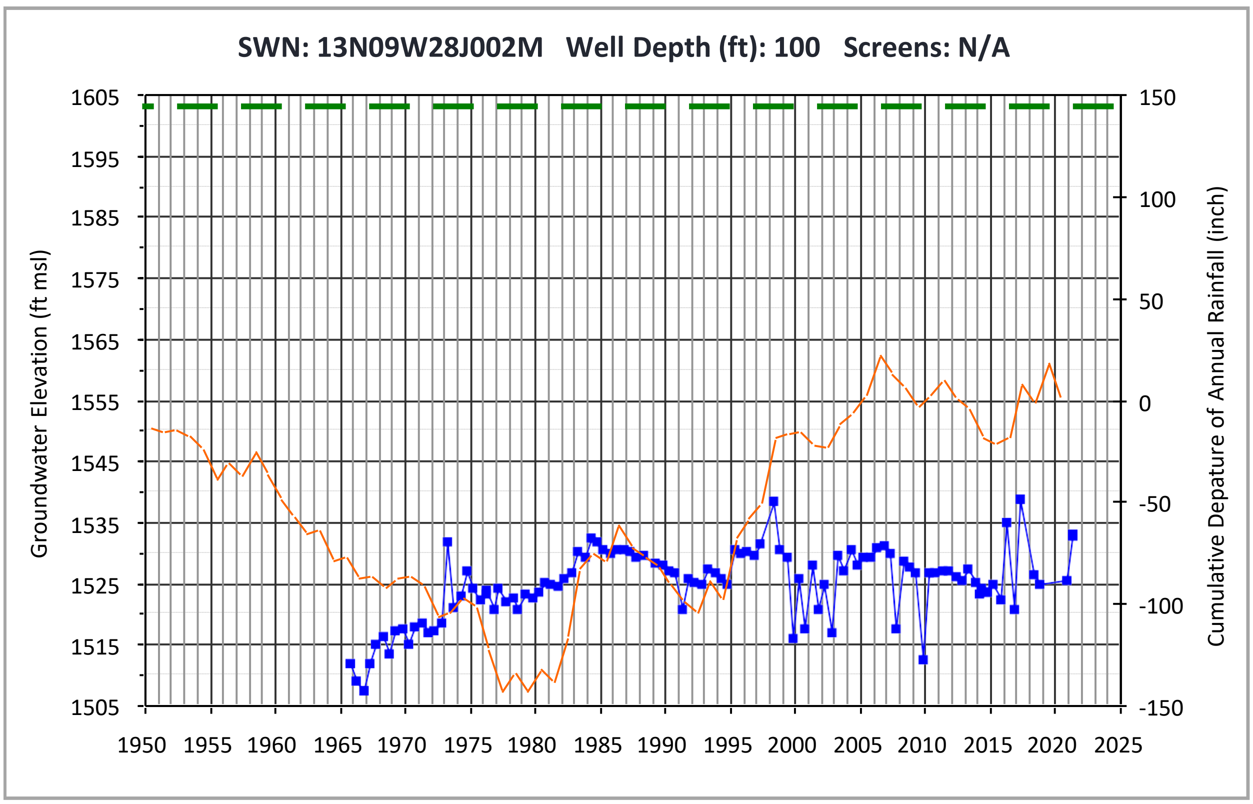

SWN: 13N09W22M001M Well Depth (ft): 220 Screens: 198 - 208 ft bgs (1290 - 1280 ft msl)
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1490
1465
1440
1415
1390
1365
1340
1315
1290
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025
Groundwater elevation
Ground Surface elevation
Cumulative departure of annual rainfall from mean (based on water year)



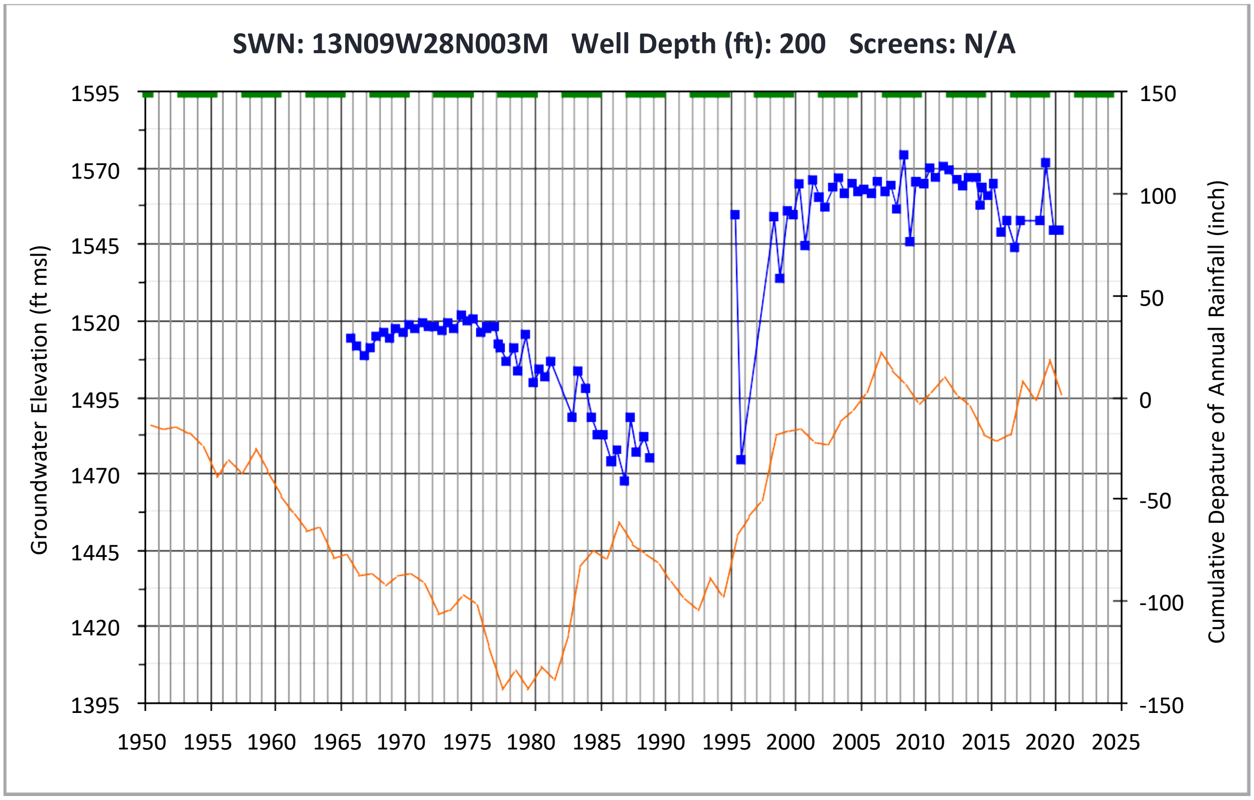


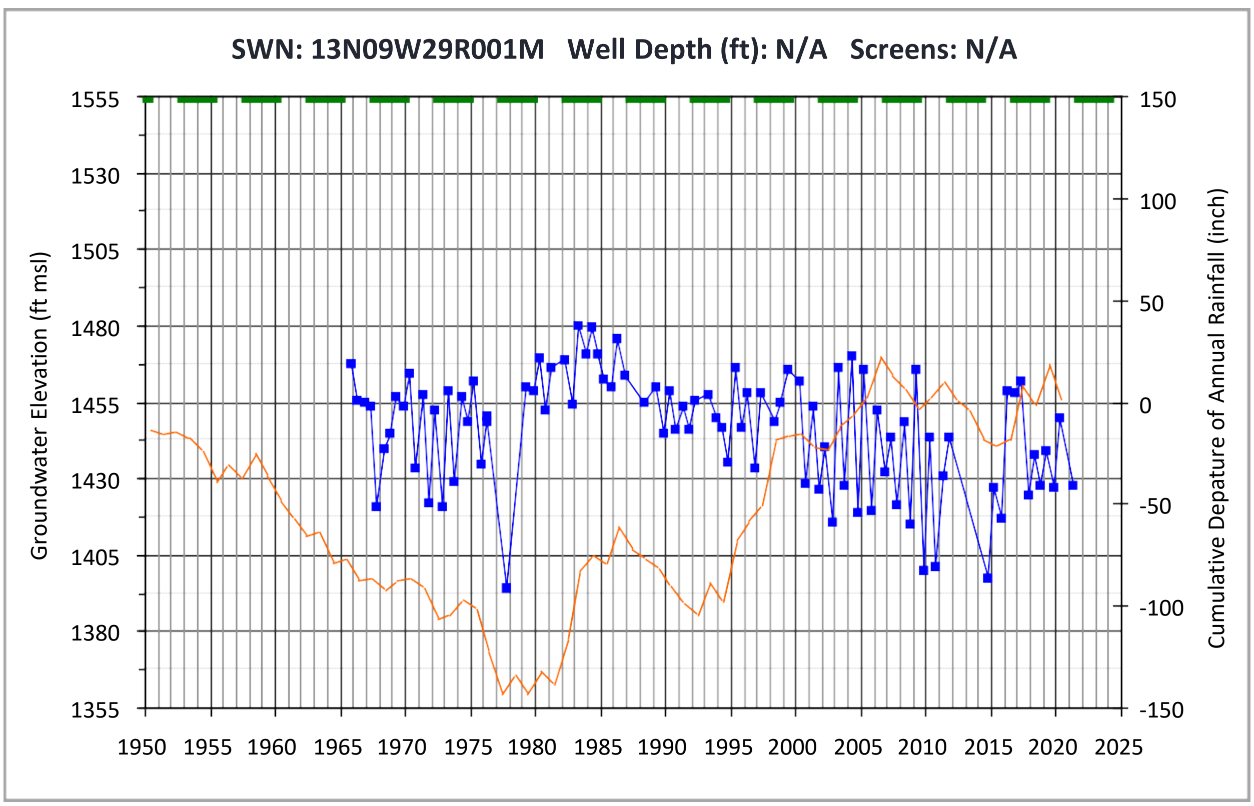
Groundwater elevation | Ground Surface elevation | Cumulative departure of annual rainfall from mean (based on water year)


SWN: 13N09W27Q001M Well Depth (ft): N/A Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1440
1430
1420
1410
1400
1390
1380
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025

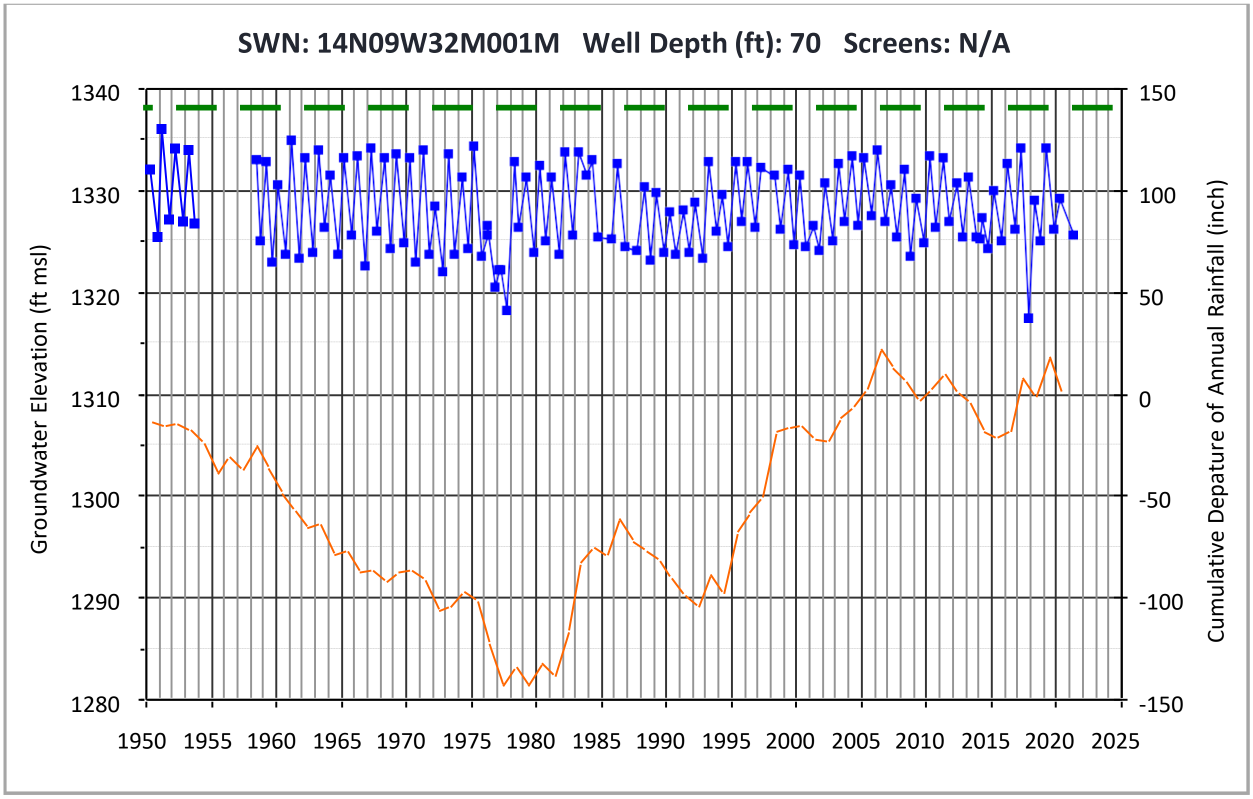

SWN: 13N09W28J002M Well Depth (ft): 100 Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1605
1595
1585
1575
1565
1555
1545
1535
1525
1515
1505
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025

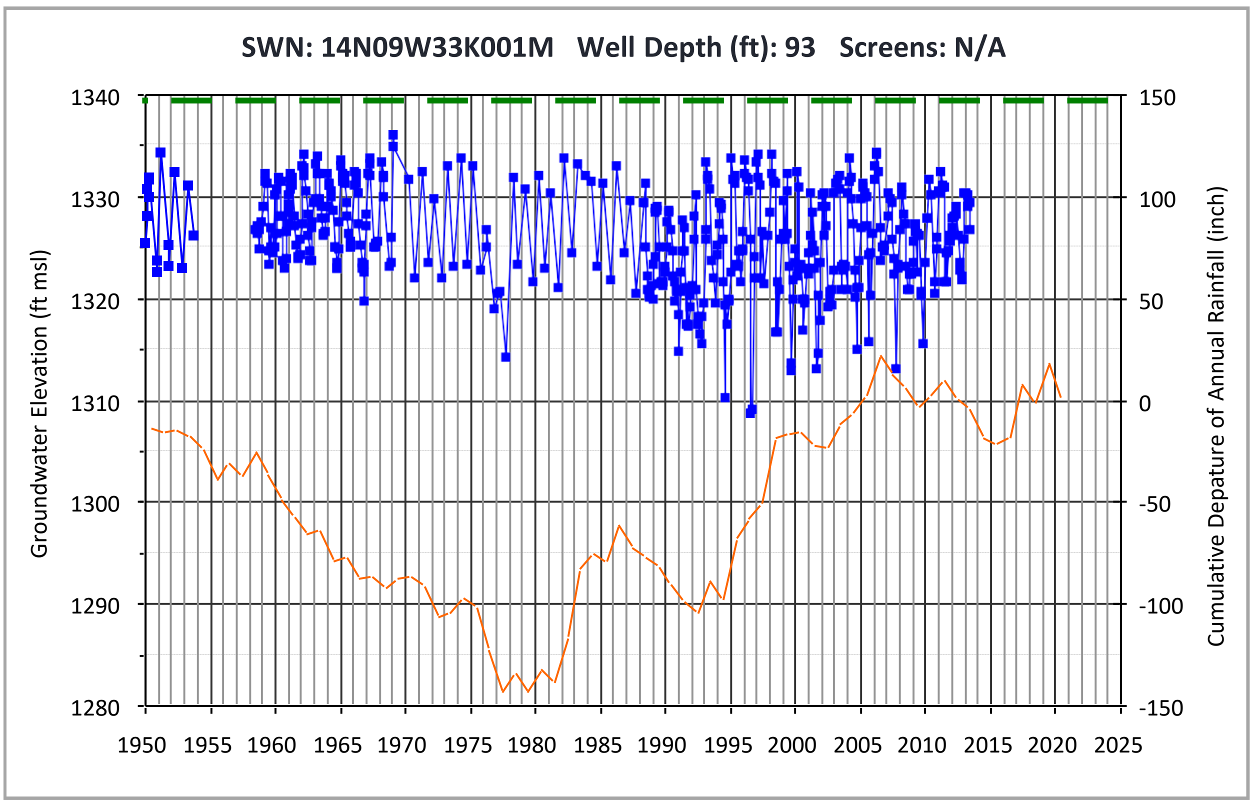

Groundwater elevation
Ground Surface elevation
Cumulative departure of annual rainfall from mean (based on water year)


SWN: 13N09W28N003M Well Depth (ft): 200 Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1595
1570
1545
1520
1495
1470
1445
1420
1395
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025

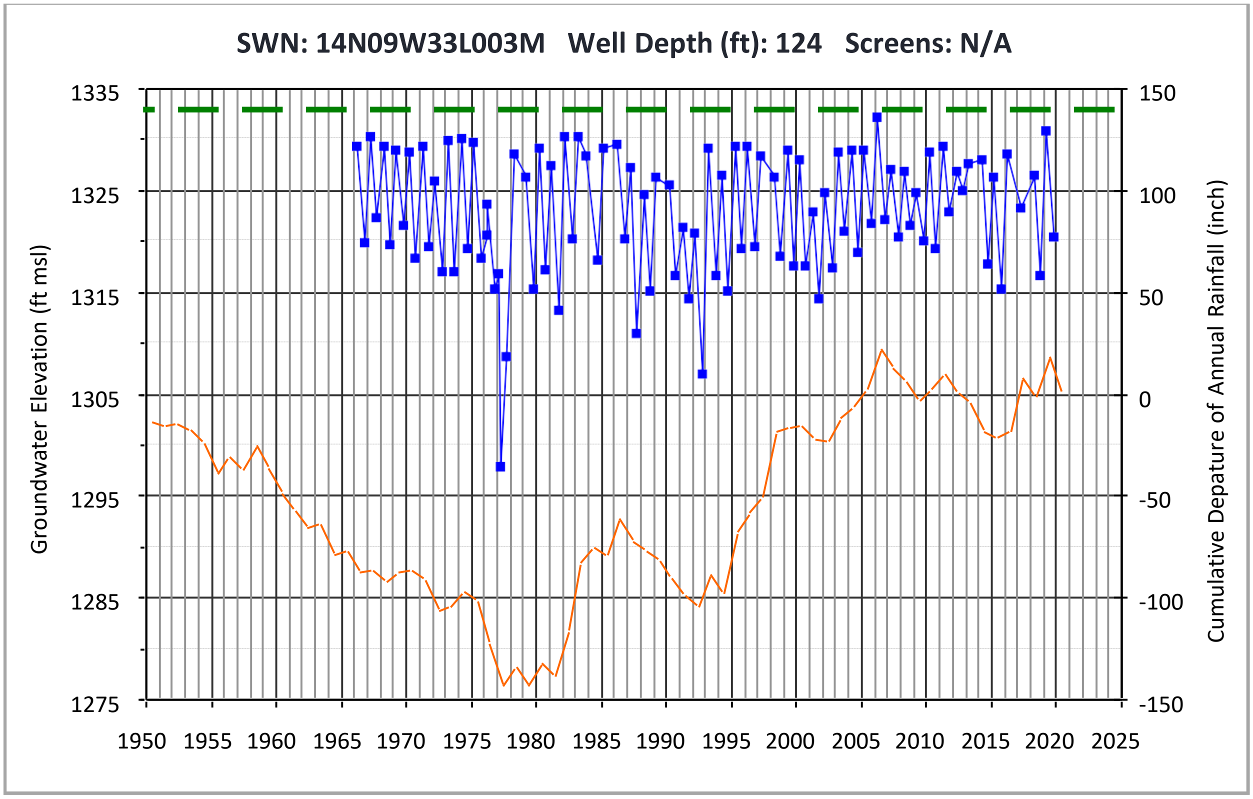

SWN: 13N09W29R001M Well Depth (ft): N/A Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1555
1530
1505
1480
1455
1430
1405
1380
1355
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025

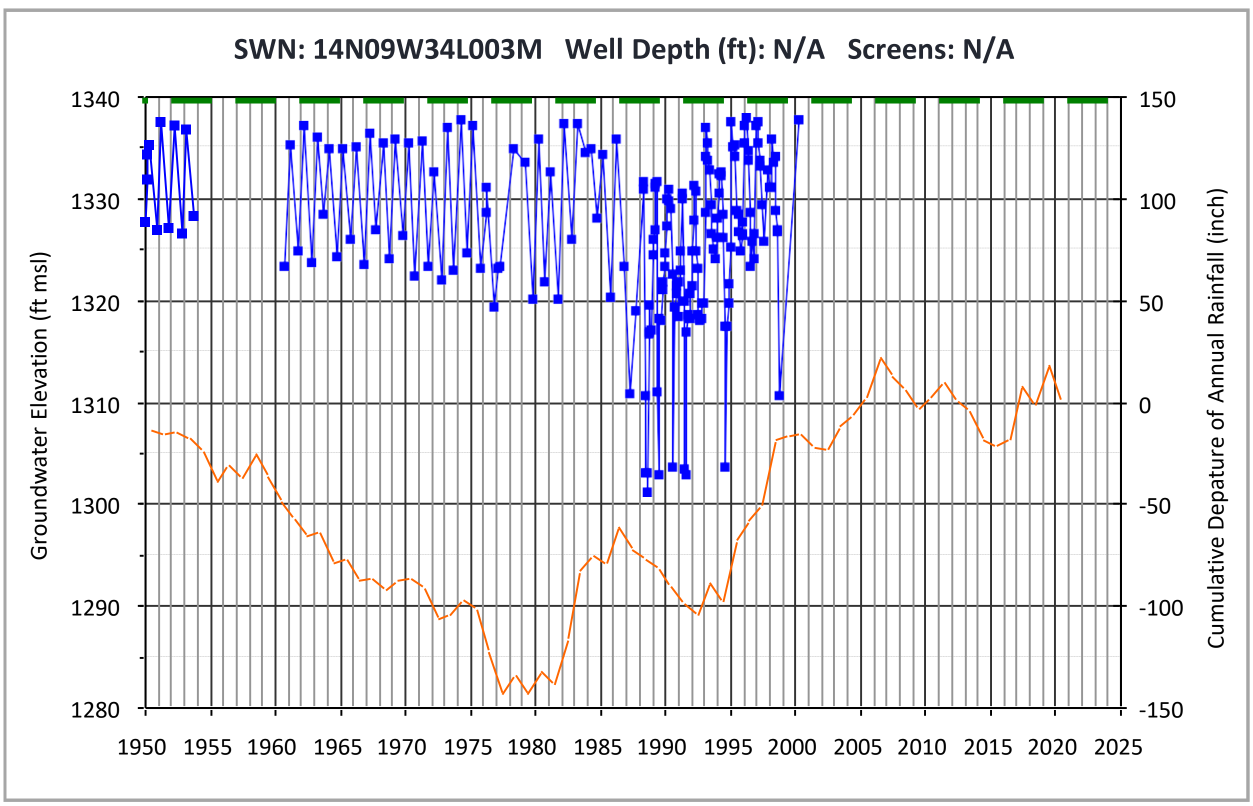

Groundwater elevation
Ground Surface elevation
Cumulative departure of annual rainfall from mean (based on water year)


SWN: 14N09W32M001M Well Depth (ft): 70 Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1340
1330
1320
1310
1300
1290
1280
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025


SWN: 14N09W33K001M Well Depth (ft): 93 Screens: N/A
Groundwater Elevation (ft msl)
Cumulative Depature of Annual Rainfall (inch)
1340
1330
1320
1310
1300
1290
1280
150
100
50
0
-50
-100
-150
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025


Groundwater elevation
Ground Surface elevation
Cumulative departure of annual rainfall from mean (based on water year)





Groundwater elevation | Ground Surface elevation | Cumulative departure of annual rainfall from mean (based on water year)

APPENDIX 2B-1

Timeseries Graphs of TDS, Nitrate, Boron and Arsenic

(Wells were selected based on duration and count of available water quality records.)

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Timeseries Graphs of TDS Concentrations

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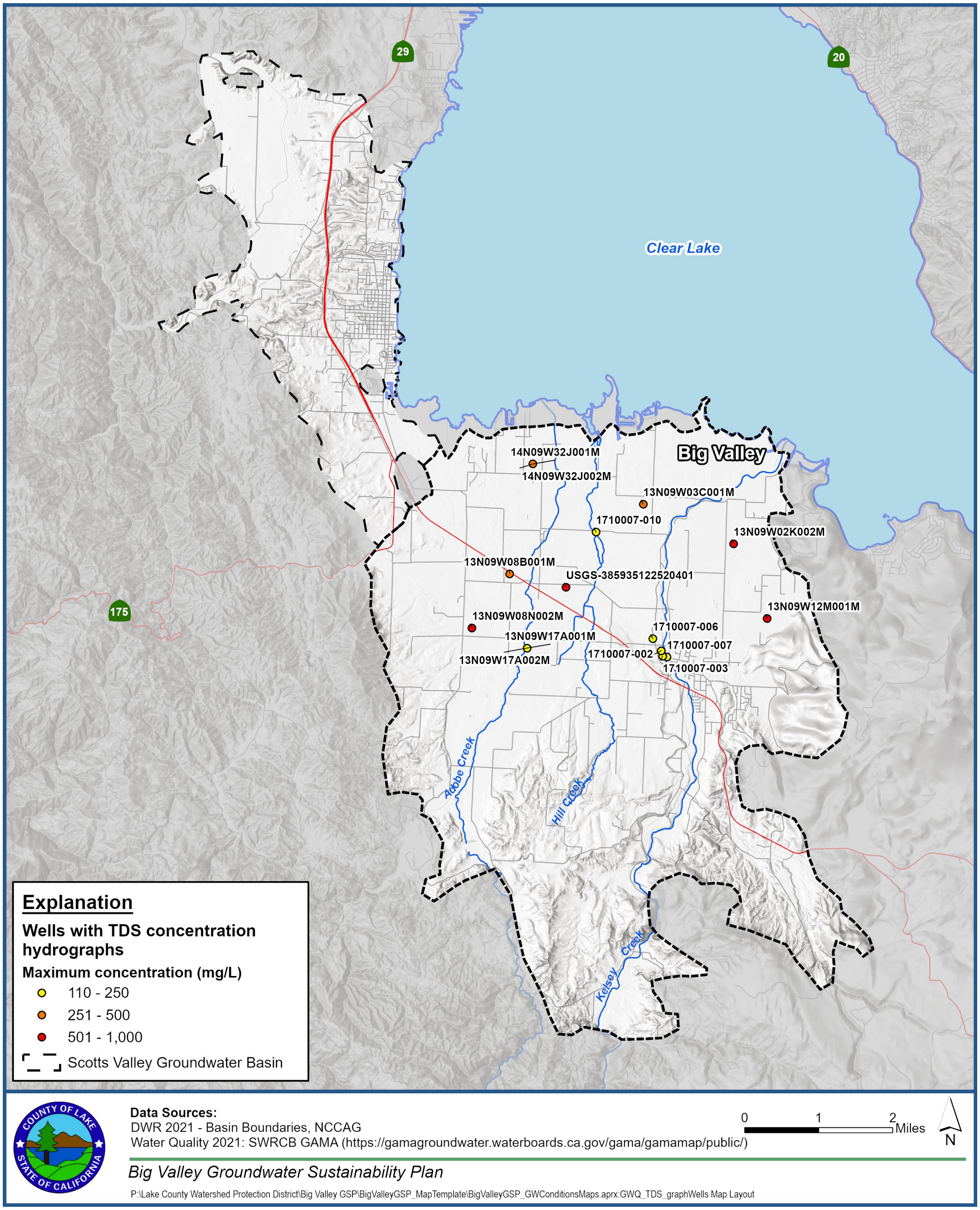
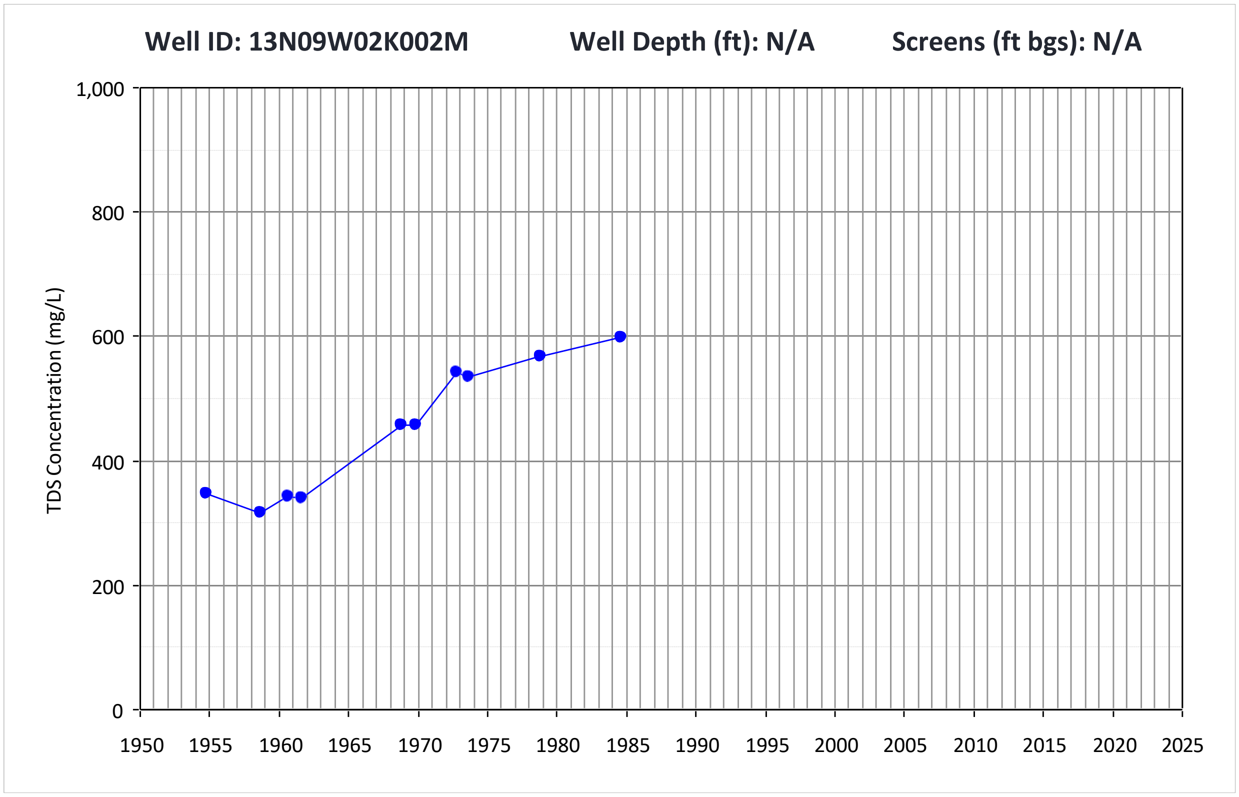
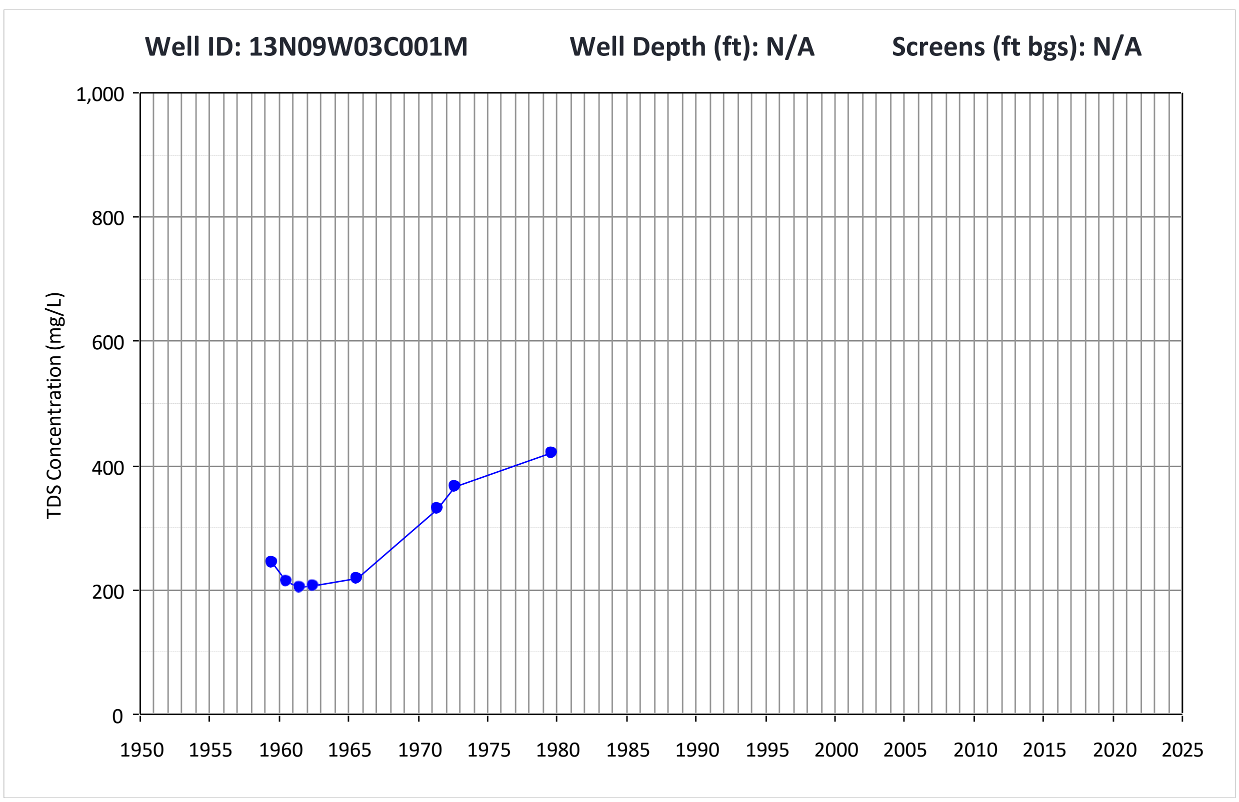
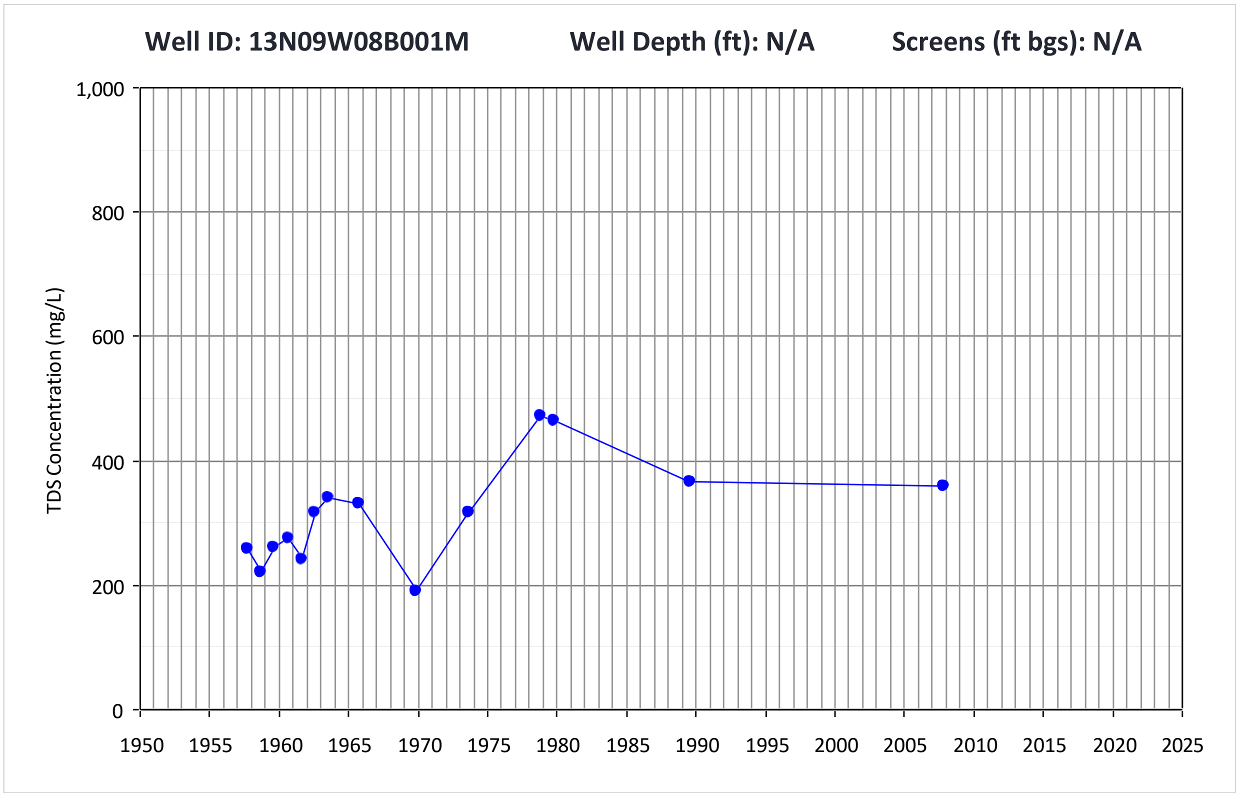
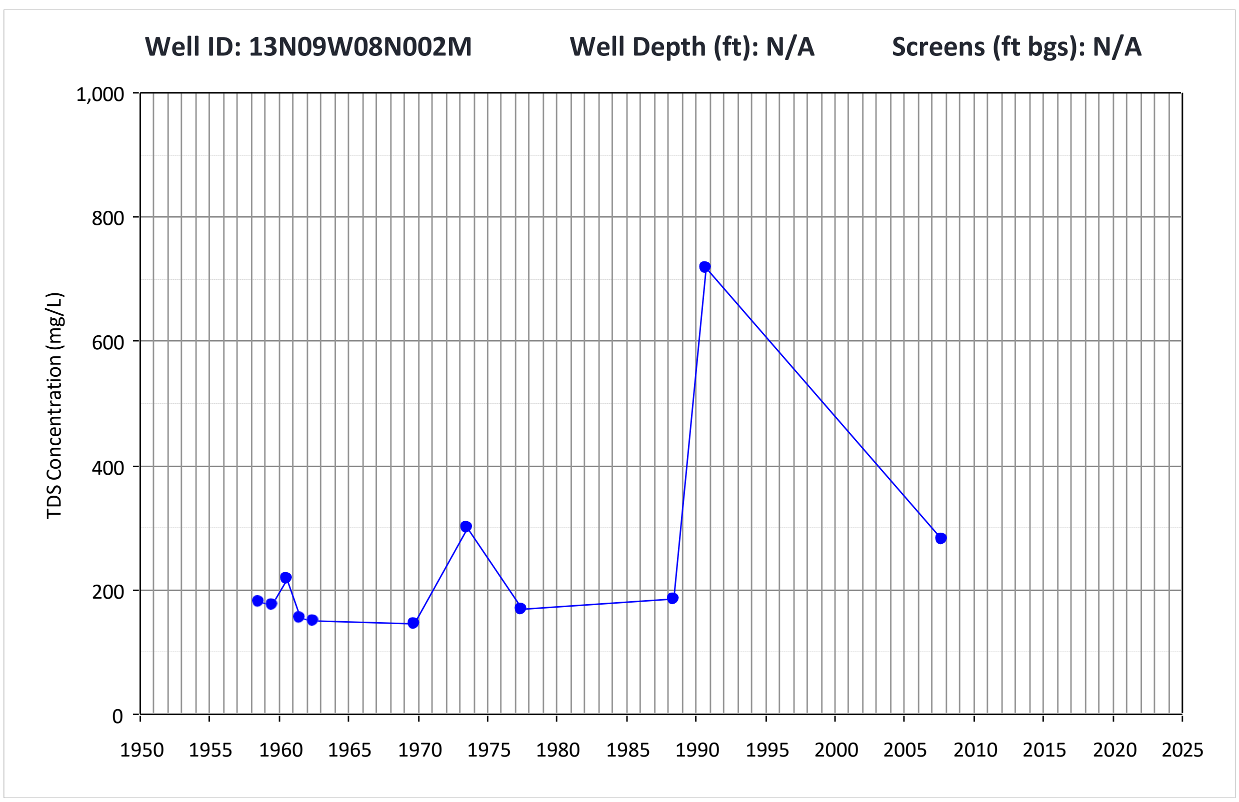


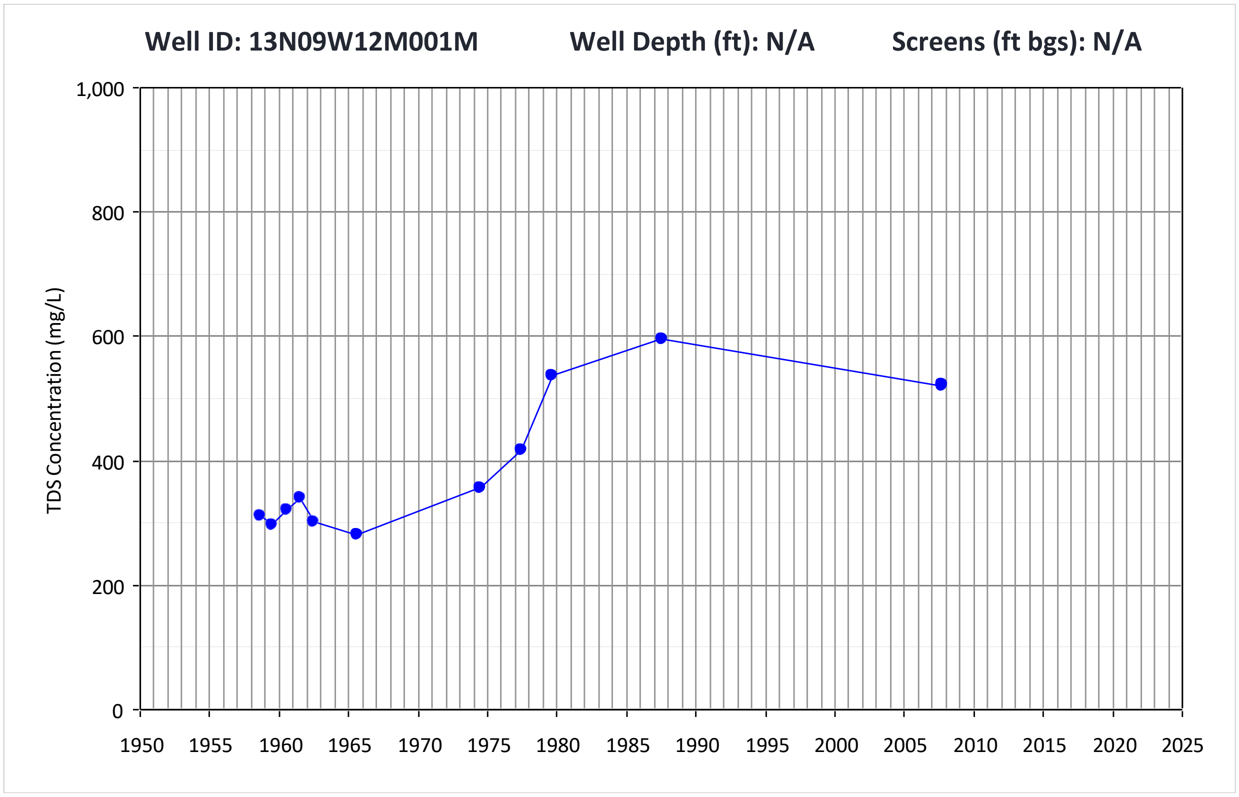
Figure 1. Locations of Wells with TDS Concentration Timeseries Graphs

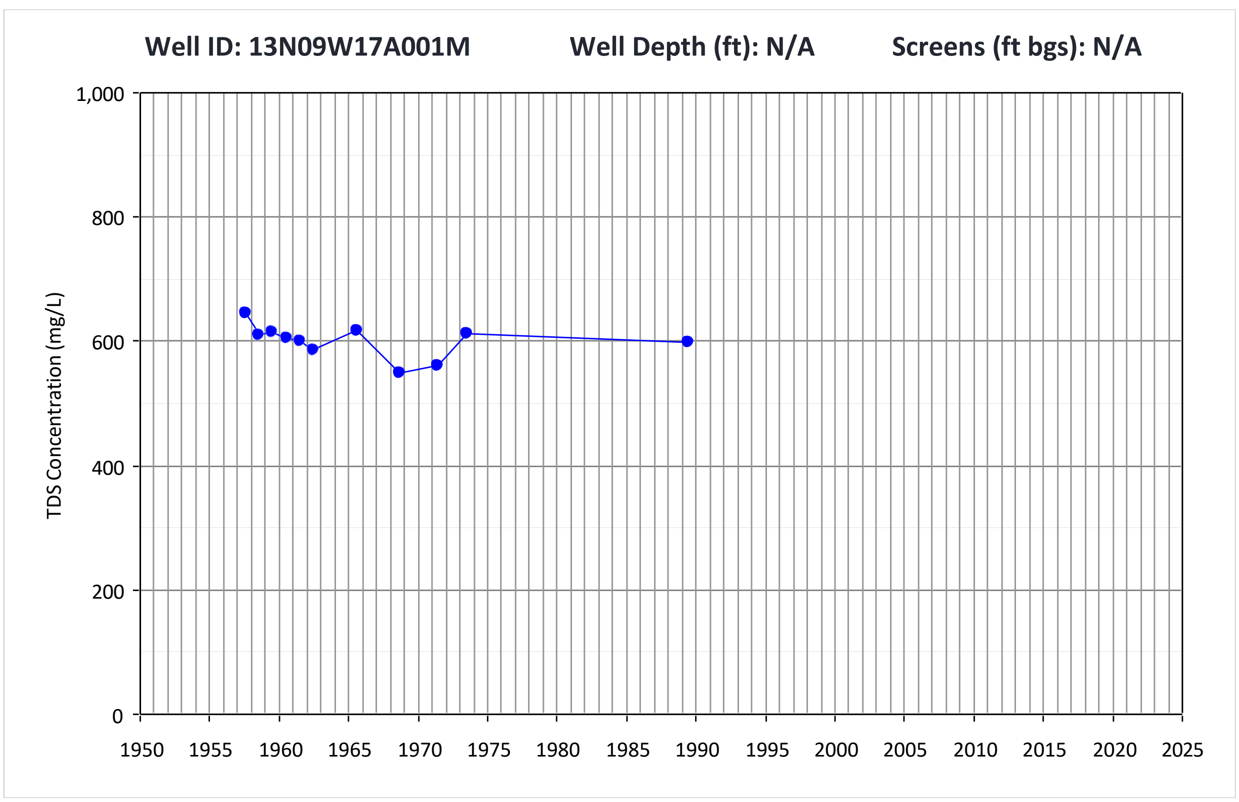

Well ID: 13N09W02K002M
Well Depth (ft): N/A
Screens (ft bgs): N/A
TDS Concentration (mg/L)
1,000
800
600
400
200
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025

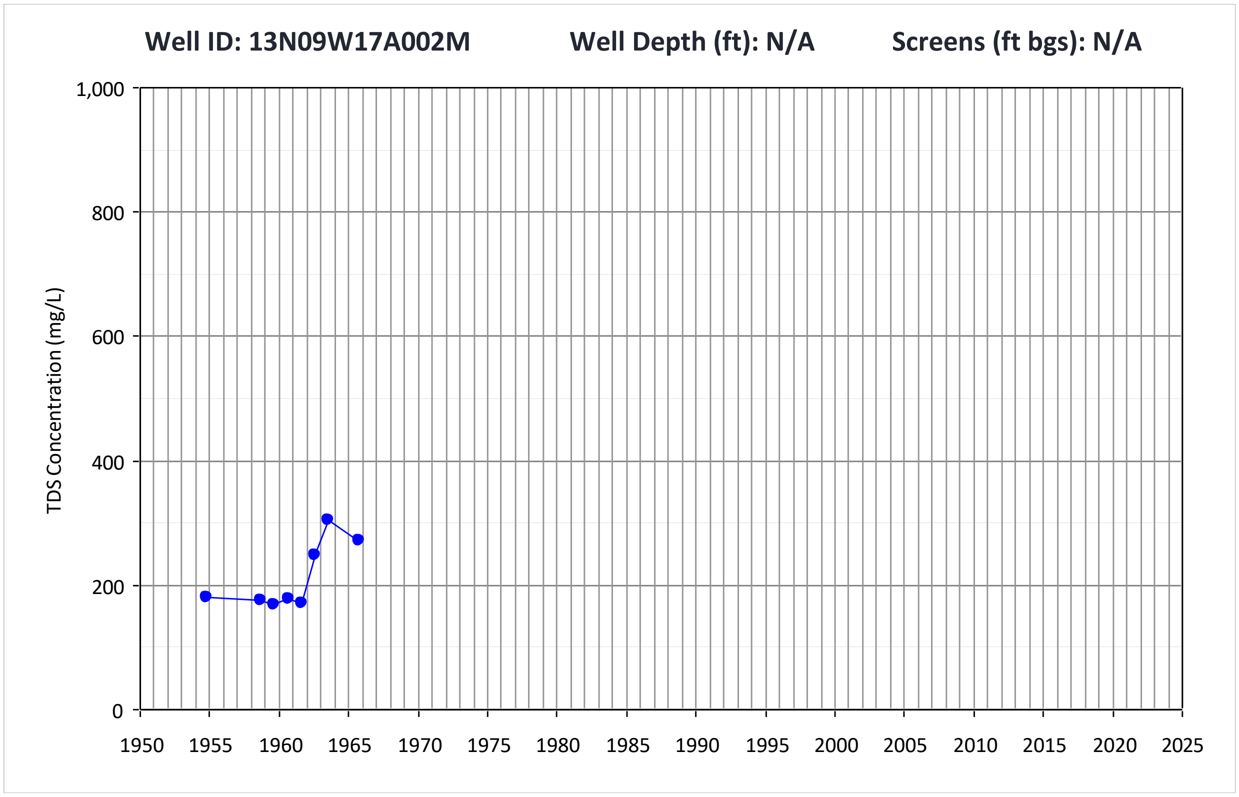

Well ID: 13N09W03C001M
Well Depth (ft): N/A
Screens (ft bgs): N/A
TDS Concentration (mg/L)
1,000
800
600
400
200
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025

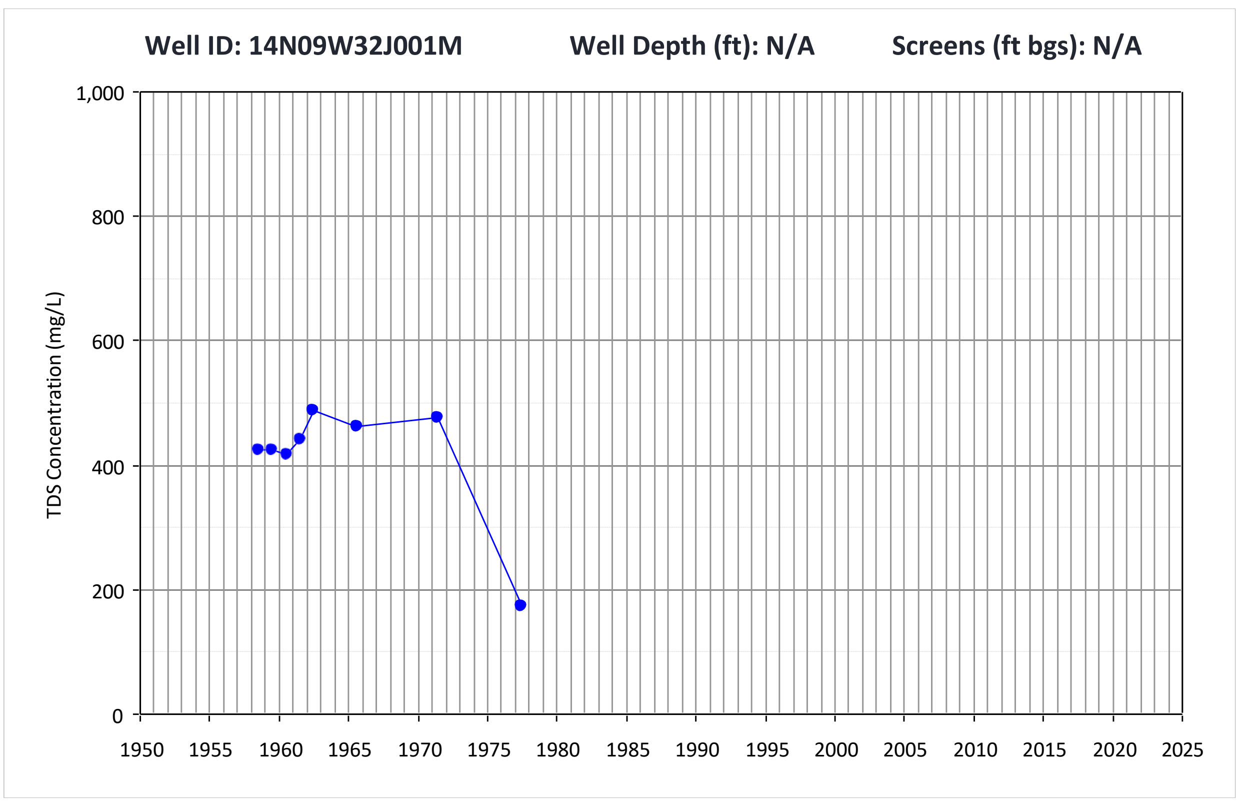

Well ID: 13N09W08B001M
Well Depth (ft): N/A
Screens (ft bgs): N/A
TDS Concentration (mg/L)
1,000
800
600
400
200
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025

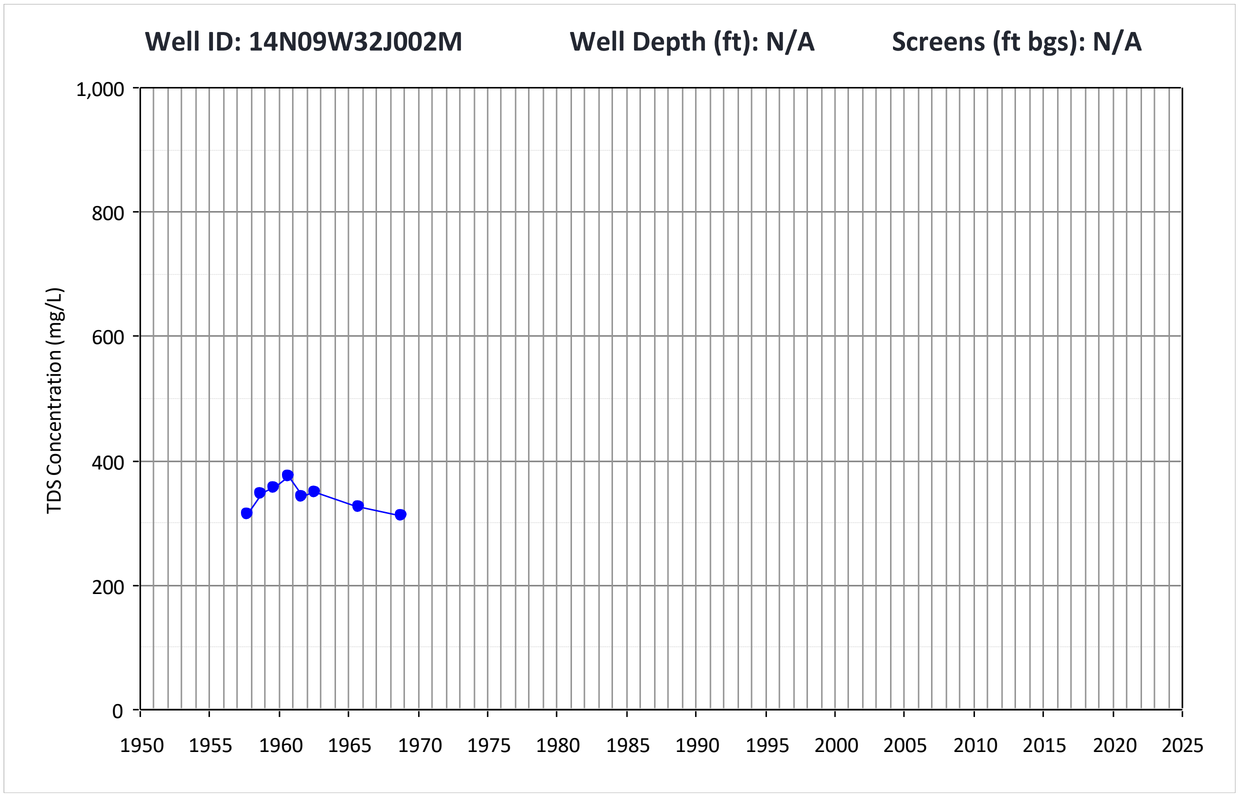

Well ID: 13N09W08N002M
Well Depth (ft): N/A
Screens (ft bgs): N/A
TDS Concentration (mg/L)
1,000
800
600
400
200
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025

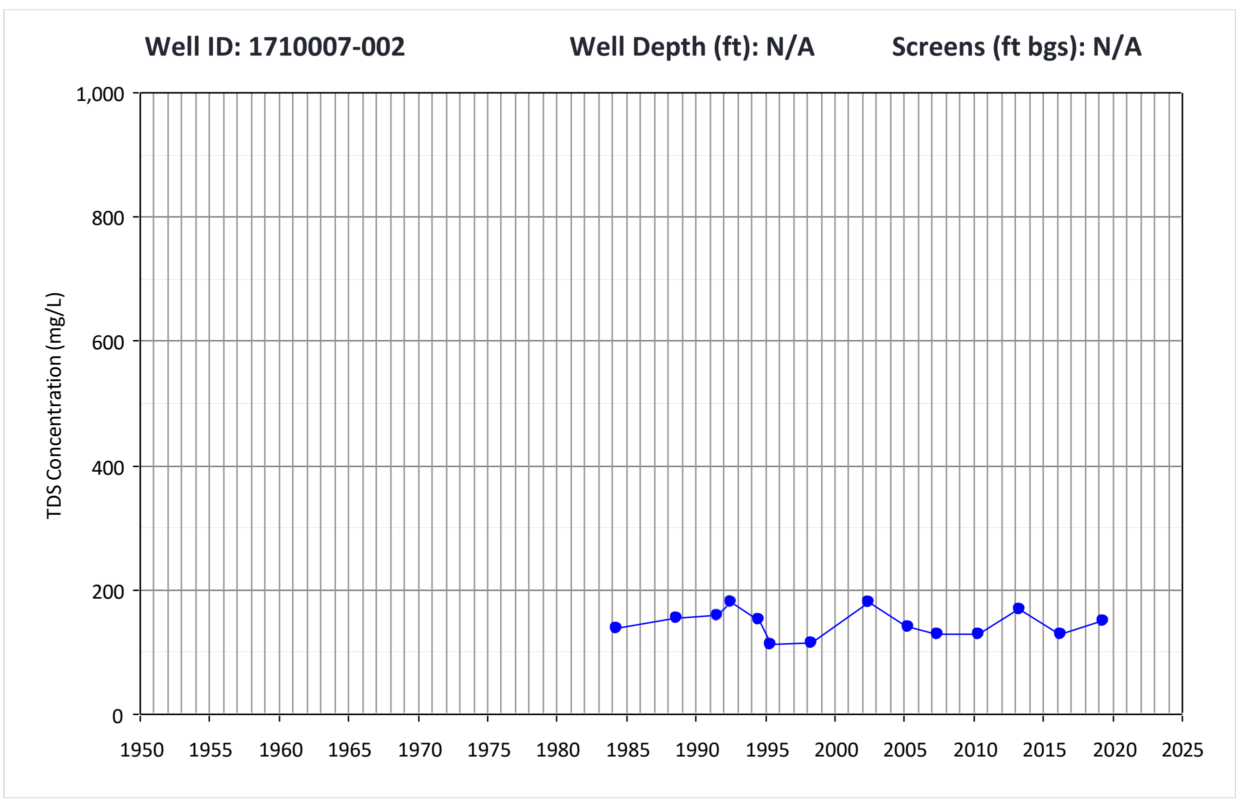

Well ID: 13N09W12M001M
Well Depth (ft): N/A
Screens (ft bgs): N/A
TDS Concentration (mg/L)
1,000
800
600
400
200
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025

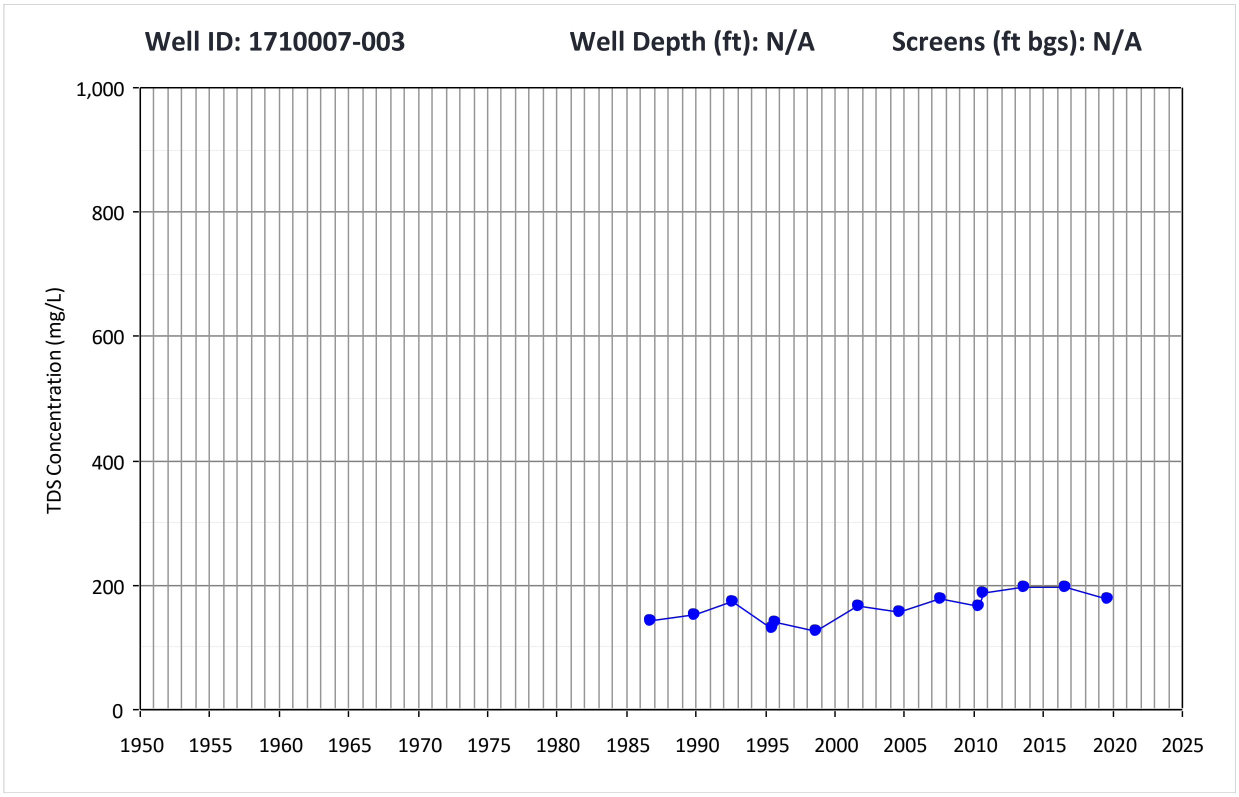

Well ID: 13N09W17A001M
Well Depth (ft): N/A
Screens (ft bgs): N/A
TDS Concentration (mg/L)
1,000
800
600
400
200
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025

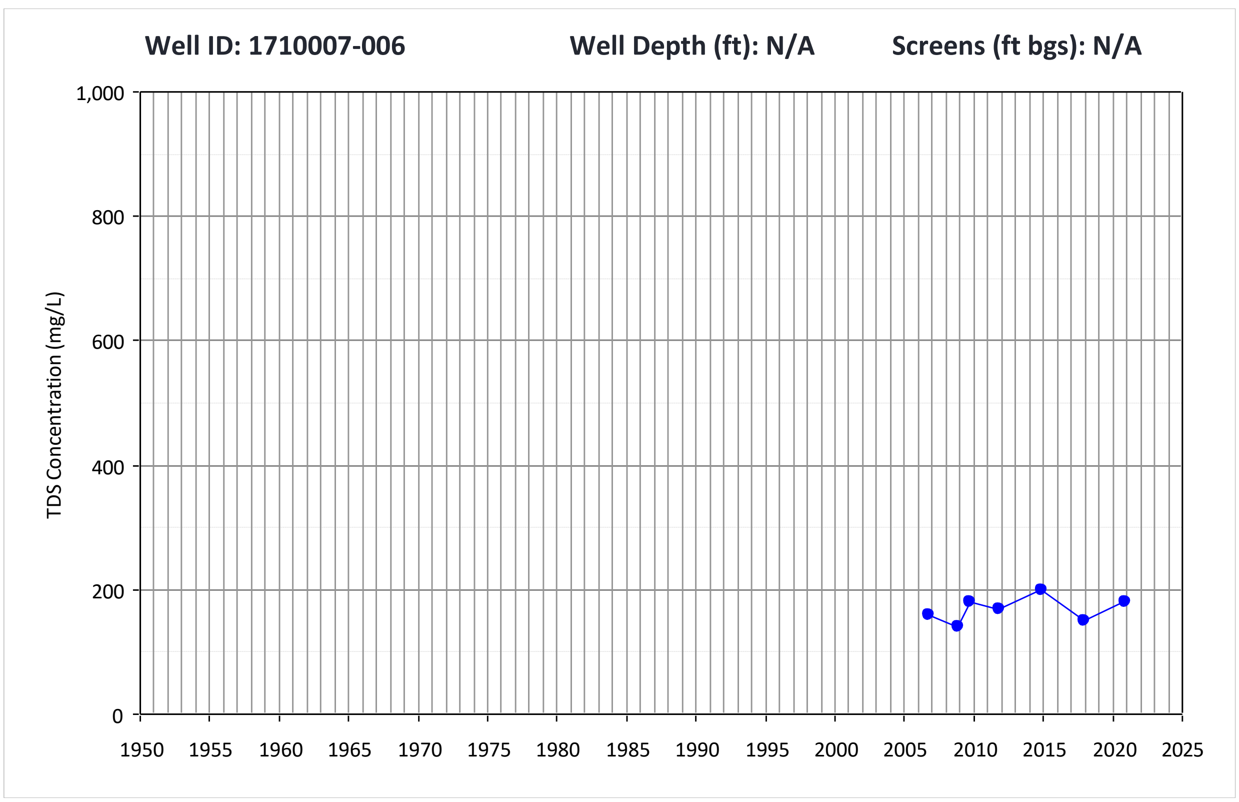

Well ID: 13N09W17A002M
Well Depth (ft): N/A
Screens (ft bgs): N/A
TDS Concentration (mg/L)
1,000
800
600
400
200
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025

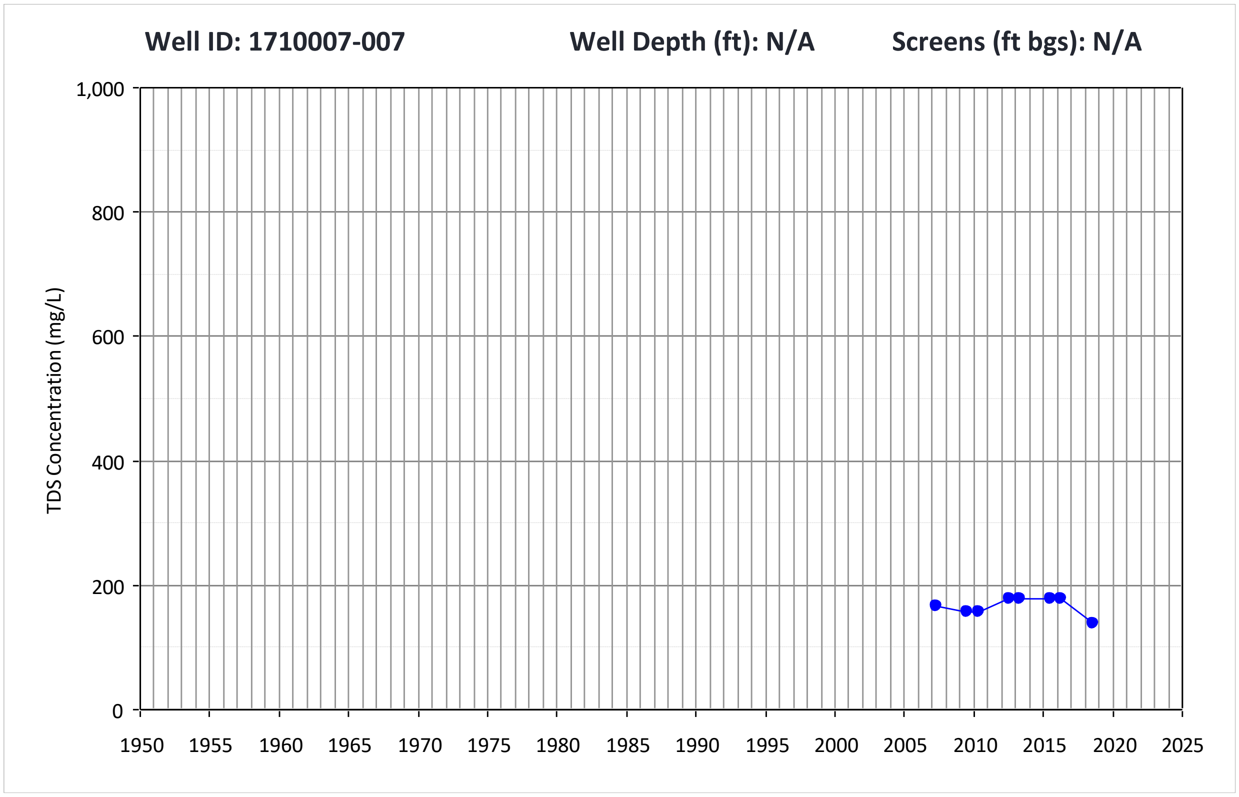

Well ID: 14N09W32J001M
Well Depth (ft): N/A
Screens (ft bgs): N/A
TDS Concentration (mg/L)
1,000
800
600
400
200
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025

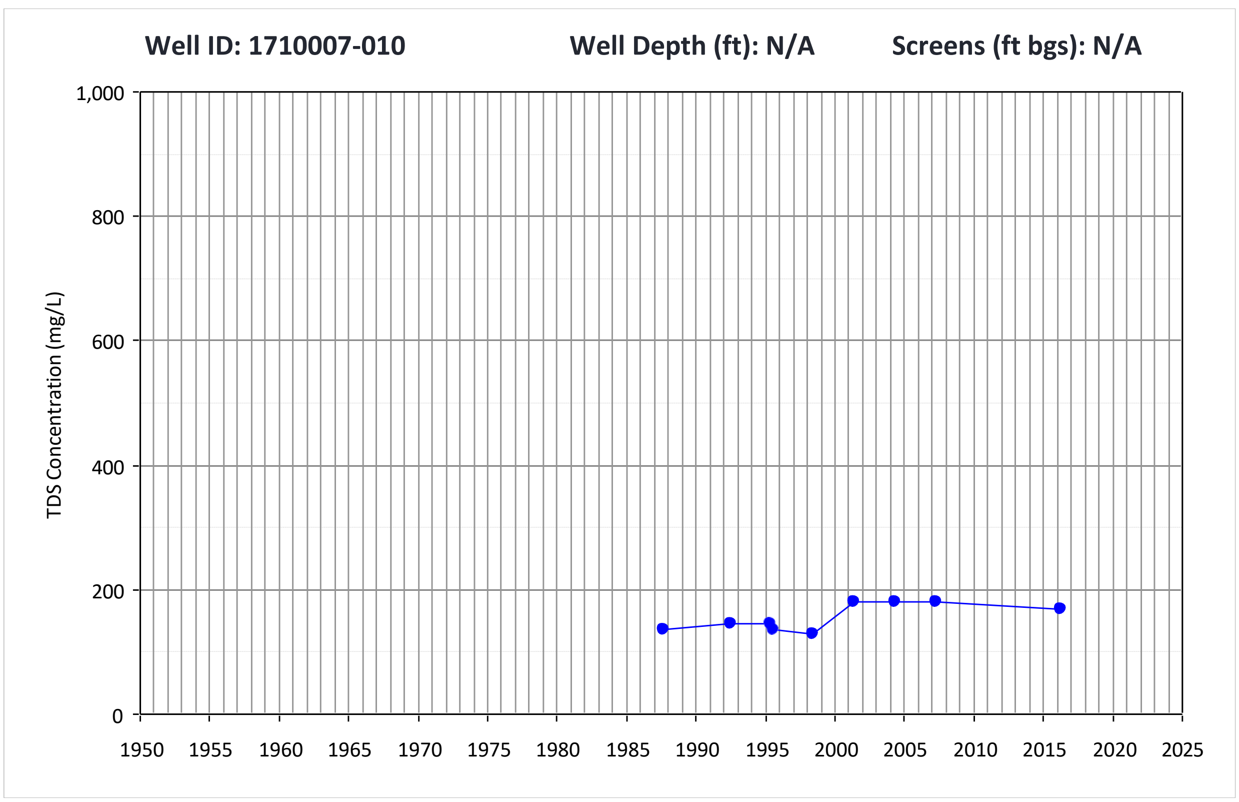

Well ID: 14N09W32J002M
Well Depth (ft): N/A
Screens (ft bgs): N/A
TDS Concentration (mg/L)
1,000
800
600
400
200
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025

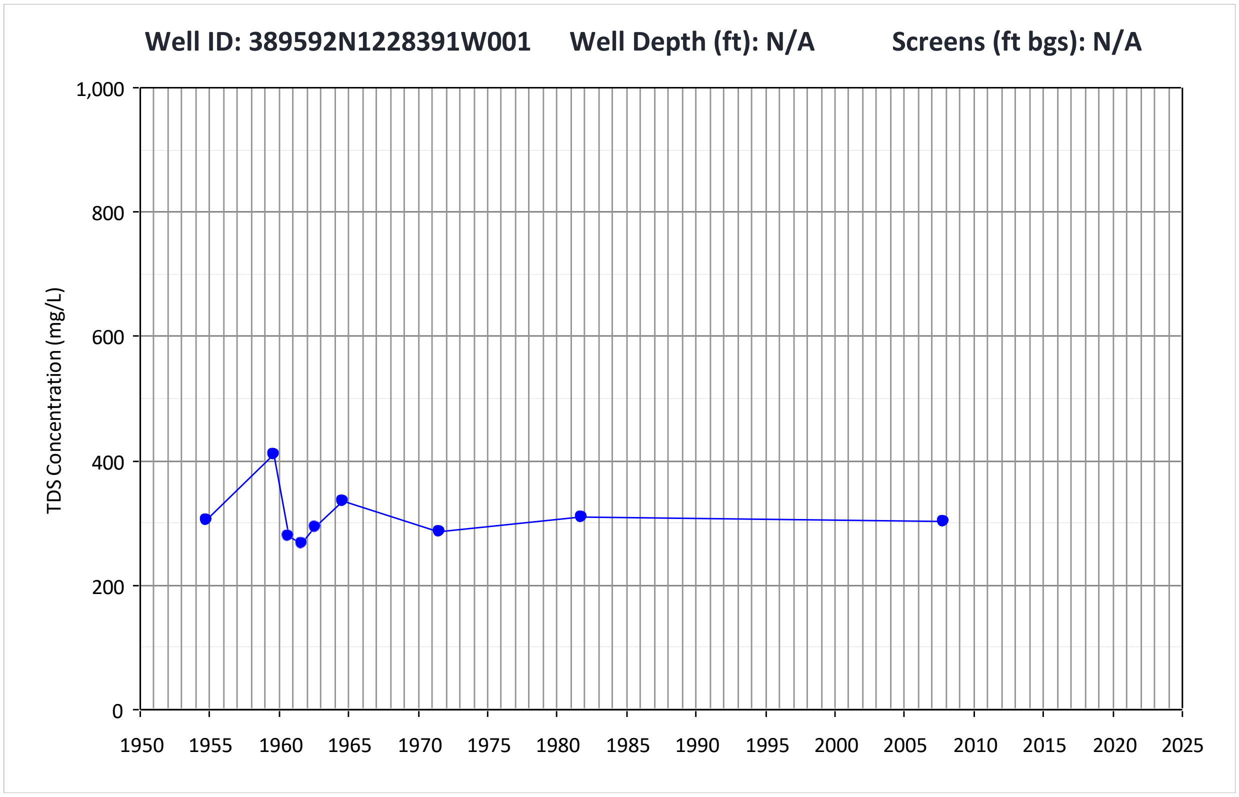

Well ID: 1710007-002
Well Depth (ft): N/A
Screens (ft bgs): N/A
TDS Concentration (mg/L)
1,000
800
600
400
200
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025

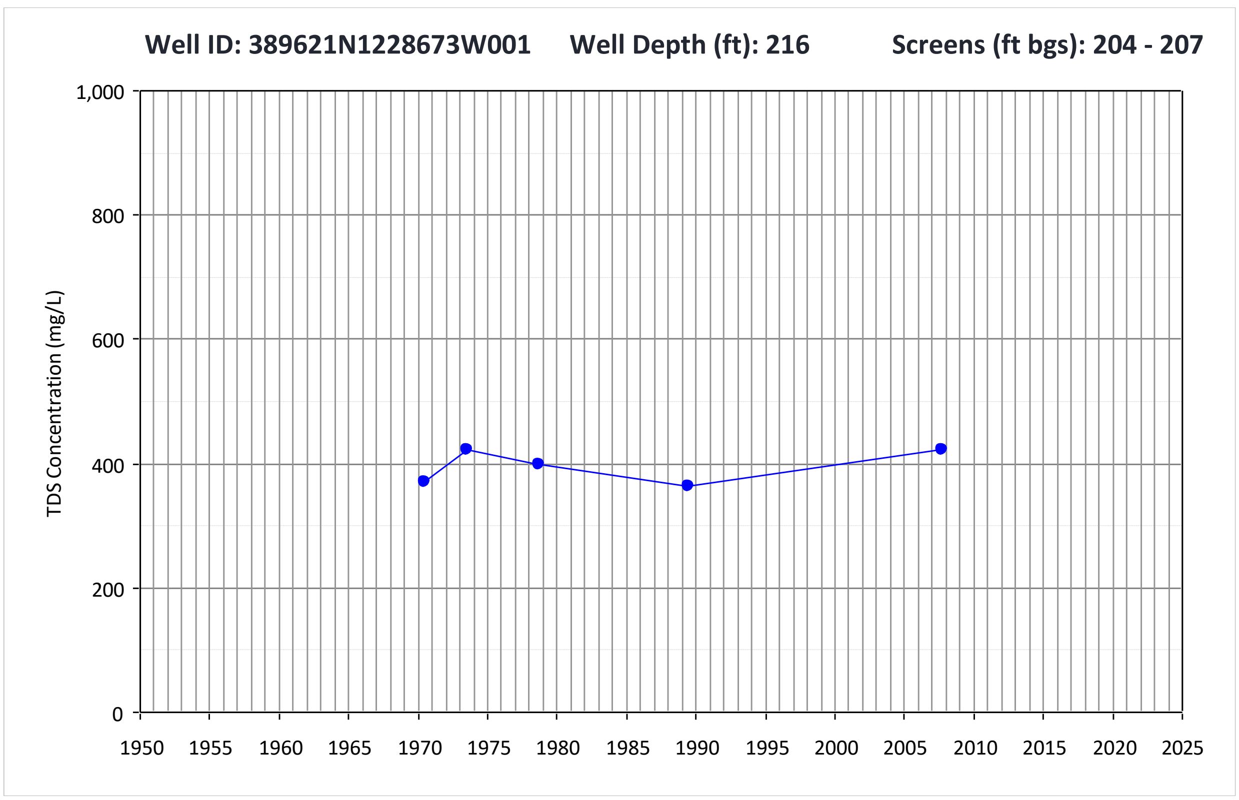

Well ID: 1710007-003
Well Depth (ft): N/A
Screens (ft bgs): N/A
TDS Concentration (mg/L)
1,000
800
600
400
200
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025

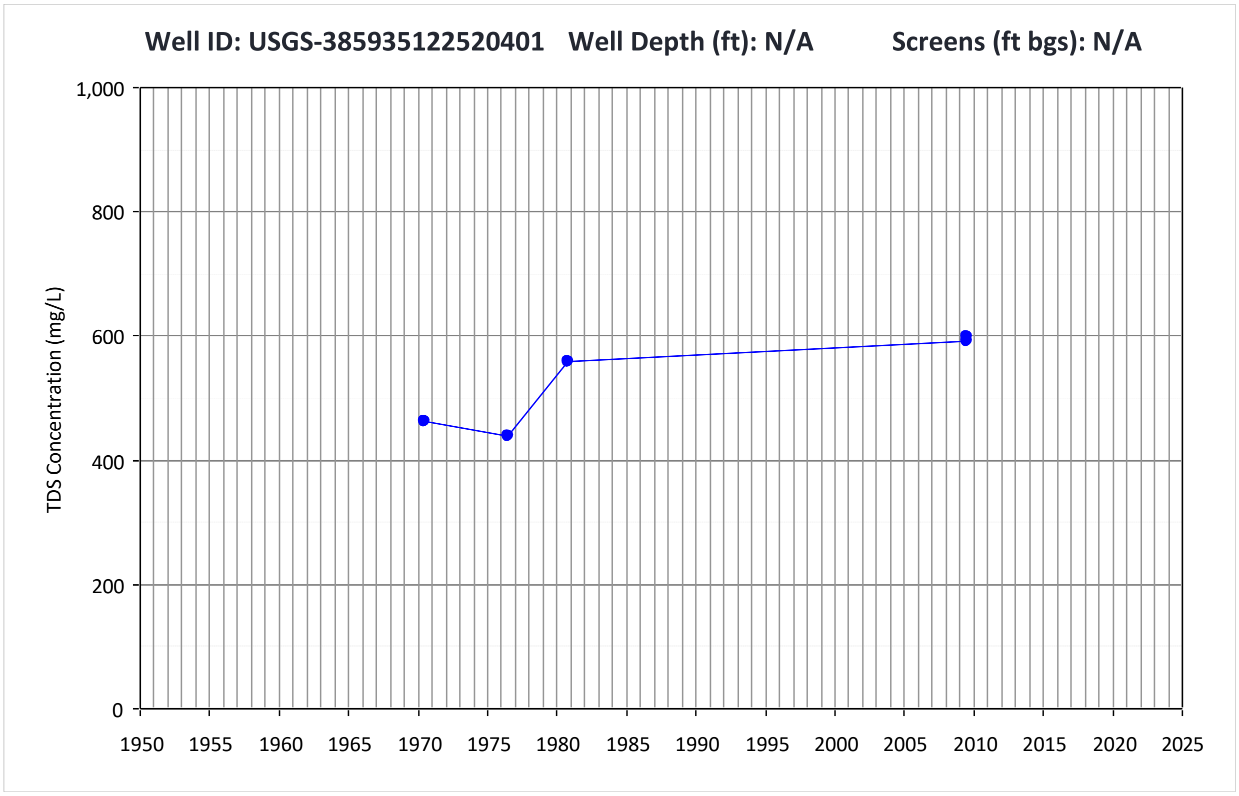

Well ID: 1710007-006
Well Depth (ft): N/A
Screens (ft bgs): N/A
TDS Concentration (mg/L)
1,000
800
600
400
200
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025


Well ID: 1710007-007
Well Depth (ft): N/A
Screens (ft bgs): N/A
TDS Concentration (mg/L)
1,000
800
600
400
200
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025


Well ID: 1710007-010
Well Depth (ft): N/A
Screens (ft bgs): N/A
TDS Concentration (mg/L)
1,000
800
600
400
200
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025


Well ID: 389592N1228391W001 Well Depth (ft): N/A Screens (ft bgs): N/A
TDS Concentration (mg/L)
1,000
800
600
400
200
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025


Well ID: 389621N1228673W001 Well Depth (ft): 216 Screens (ft bgs): 204 - 207
TDS Concentration (mg/L)
1,000
800
600
400
200
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025


Well ID: USGS-385935122520401 Well Depth (ft): N/A Screens (ft bgs): N/A
TDS Concentration (mg/L)
1,000
800
600
400
200
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025

Timeseries Graphs of Nitrate Concentrations

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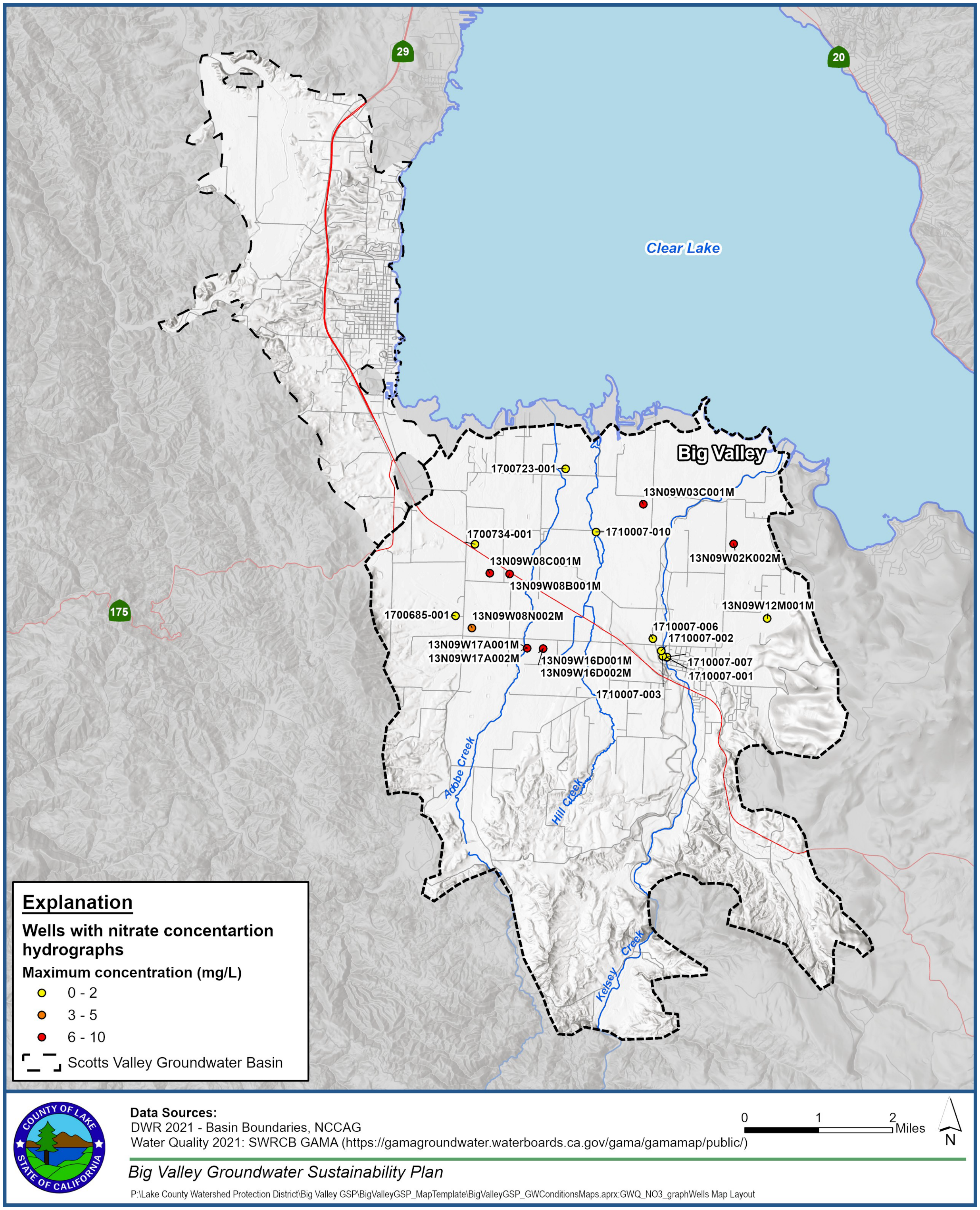
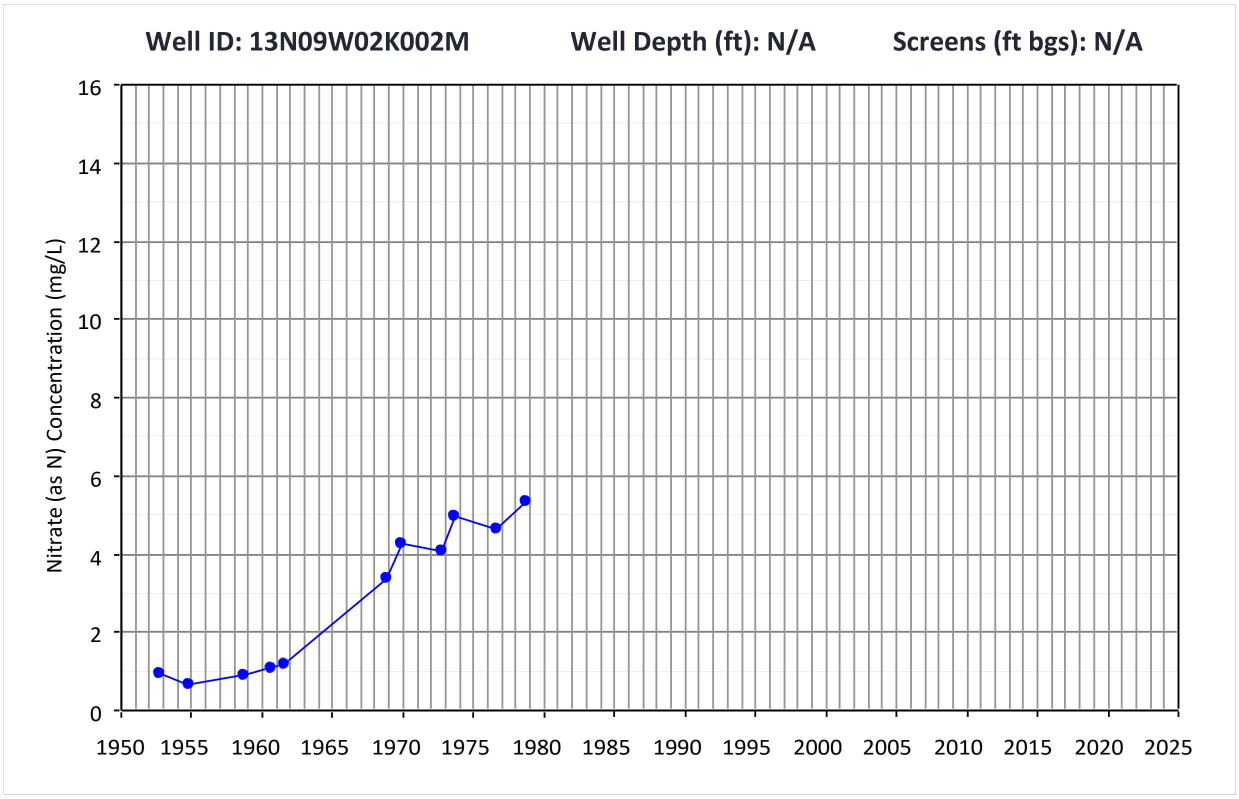
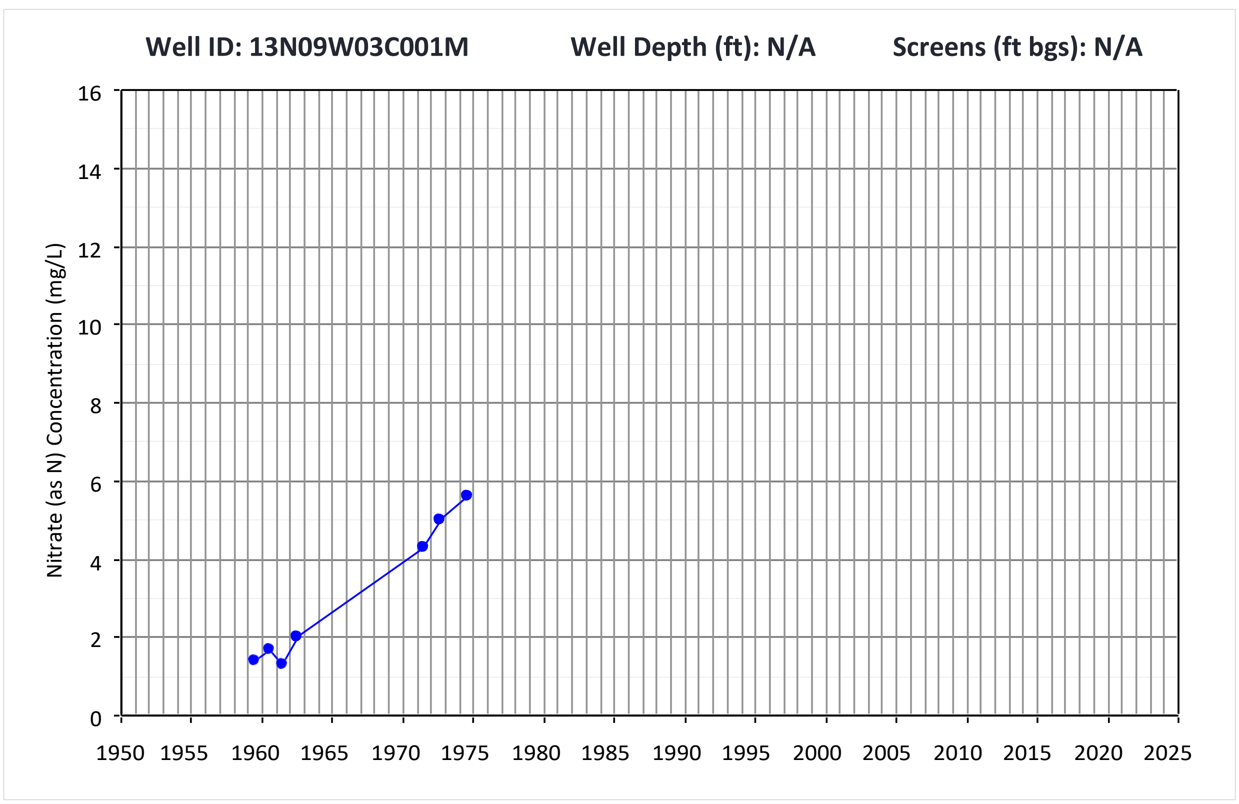
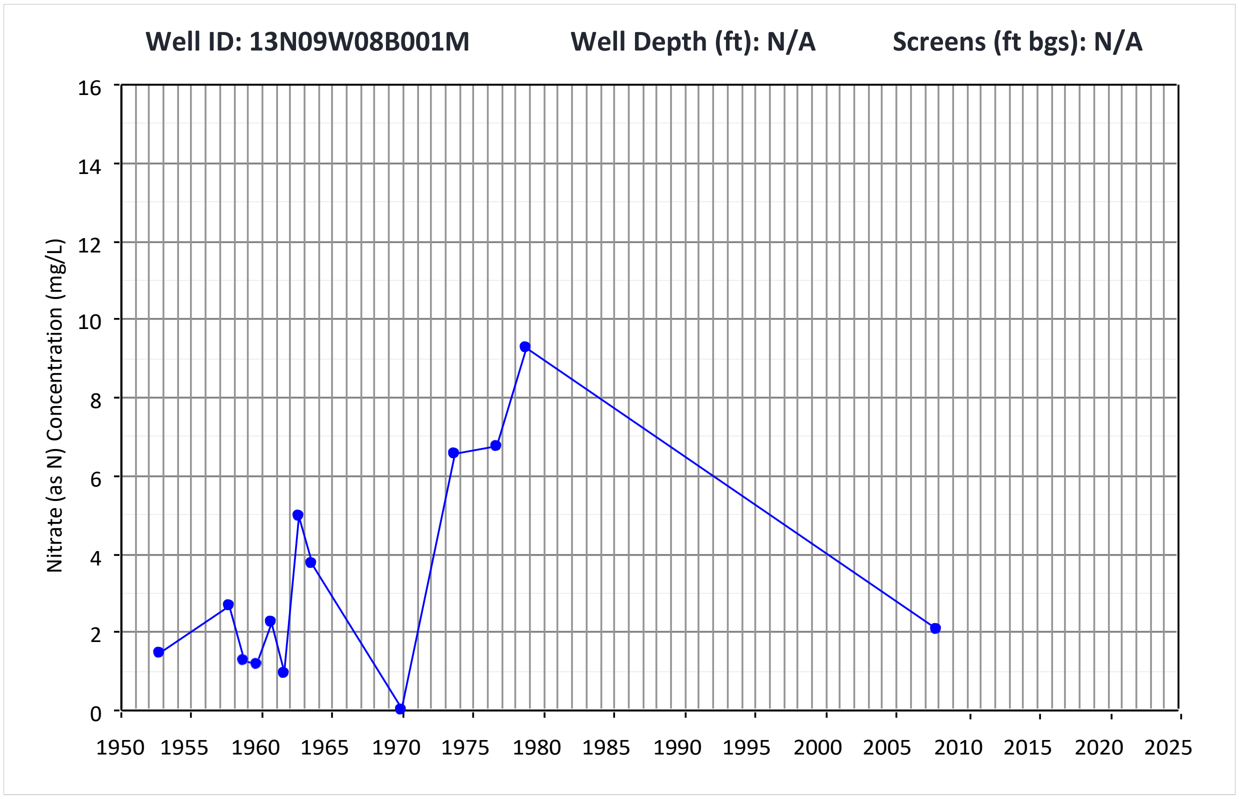
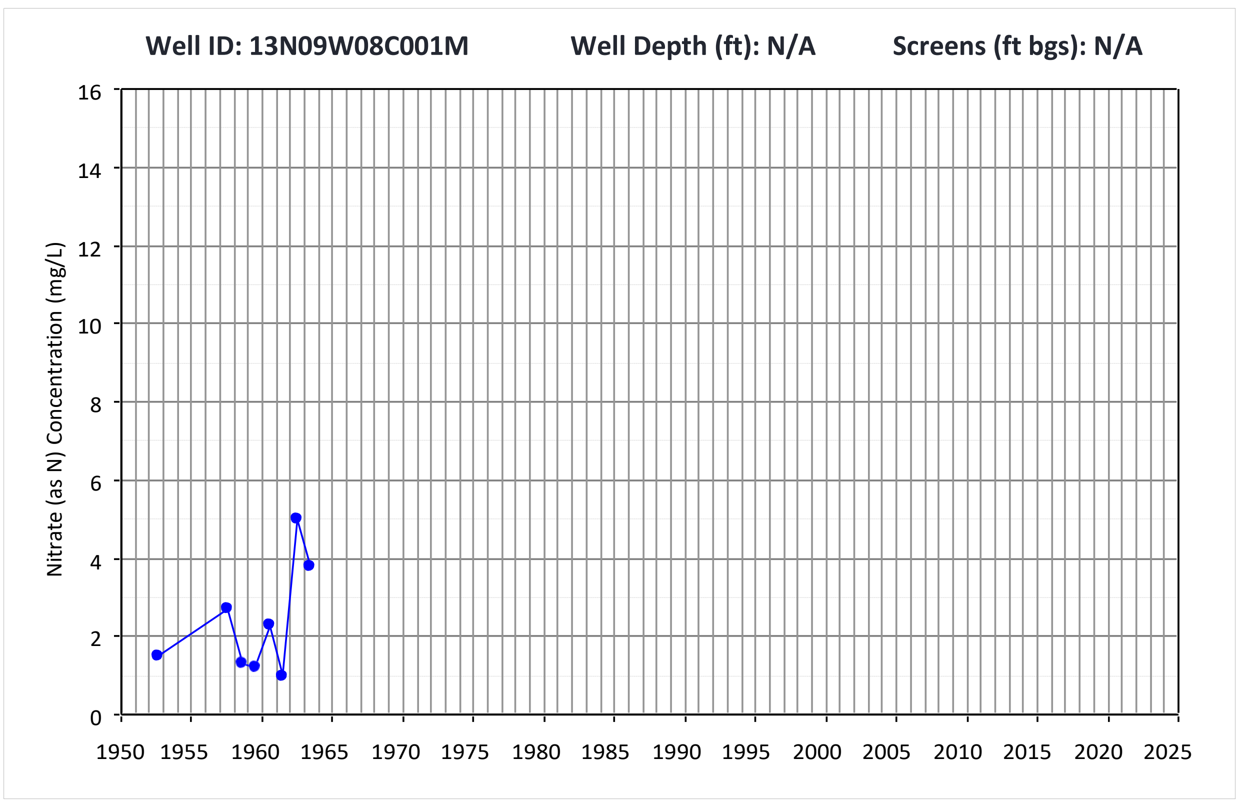


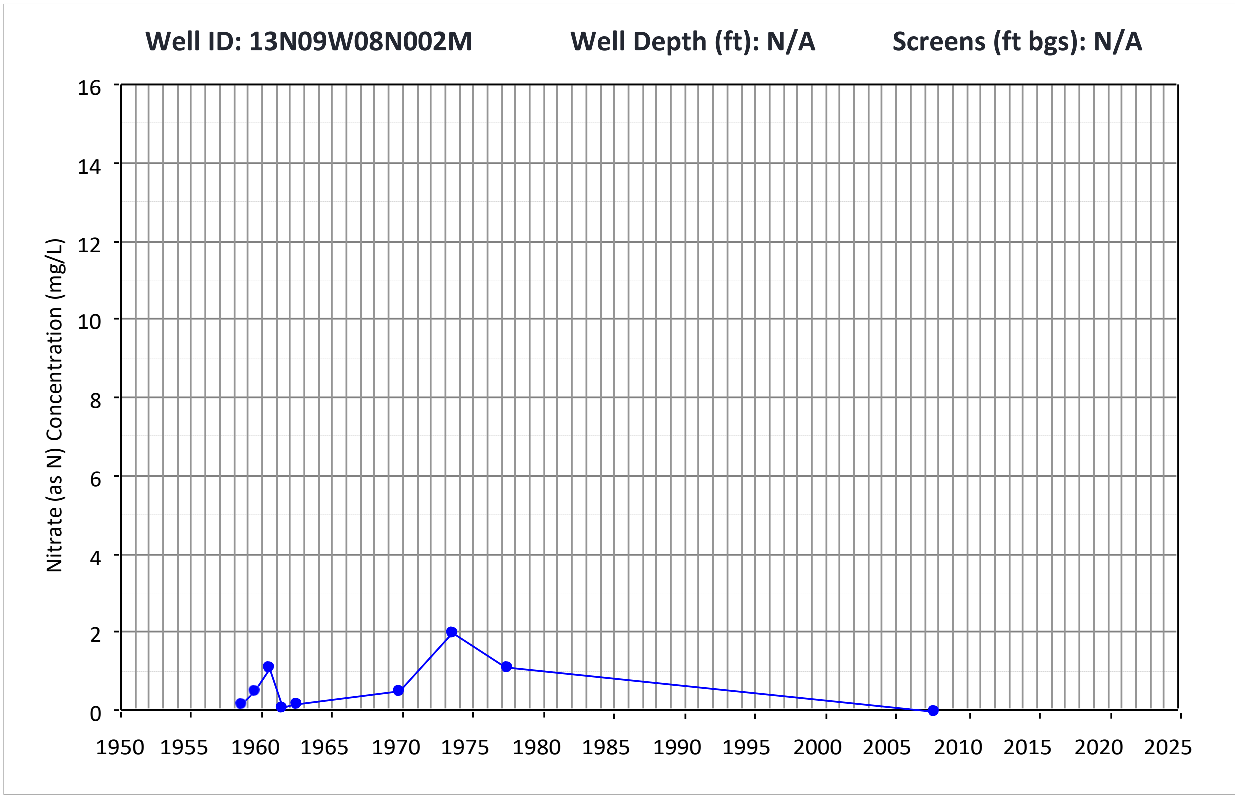
Figure 2. Locations of Wells with Nitrate Concentration Timeseries Graphs

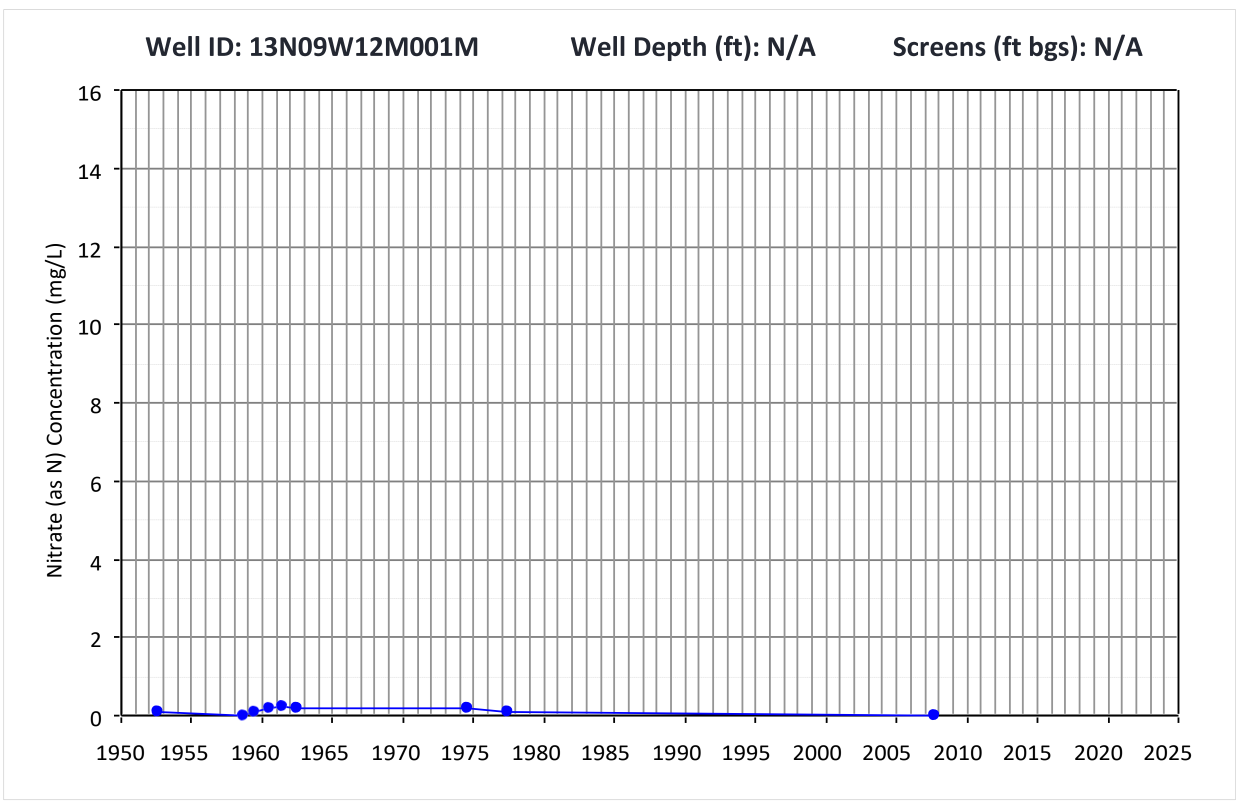

Well ID: 13N09W02K002M
Well Depth (ft): N/A
Screens (ft bgs): N/A
Nitrate (as N) Concentration (mg/L)
0
2
4
6
8
10
12
14
16
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025

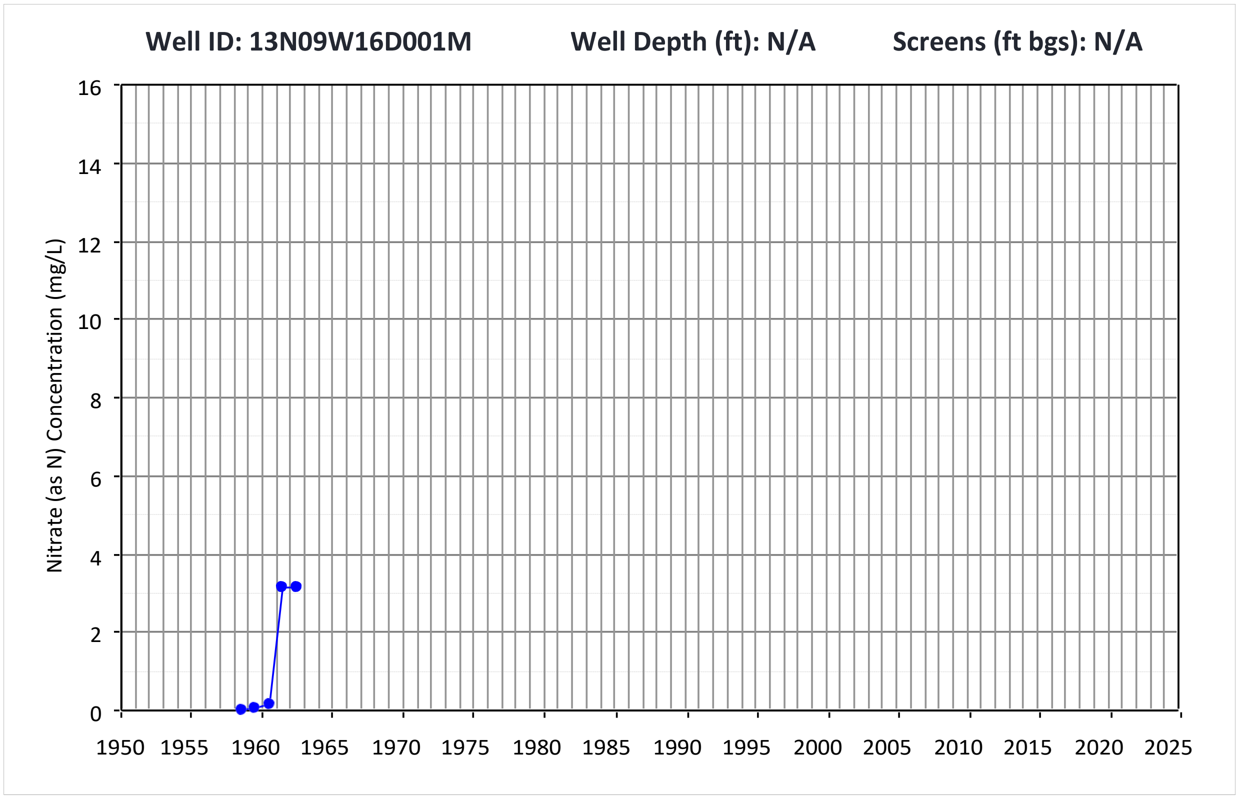

Well ID: 13N09W03C001M
Well Depth (ft): N/A
Screens (ft bgs): N/A
Nitrate (as N) Concentration (mg/L)
0
2
4
6
8
10
12
14
16
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025

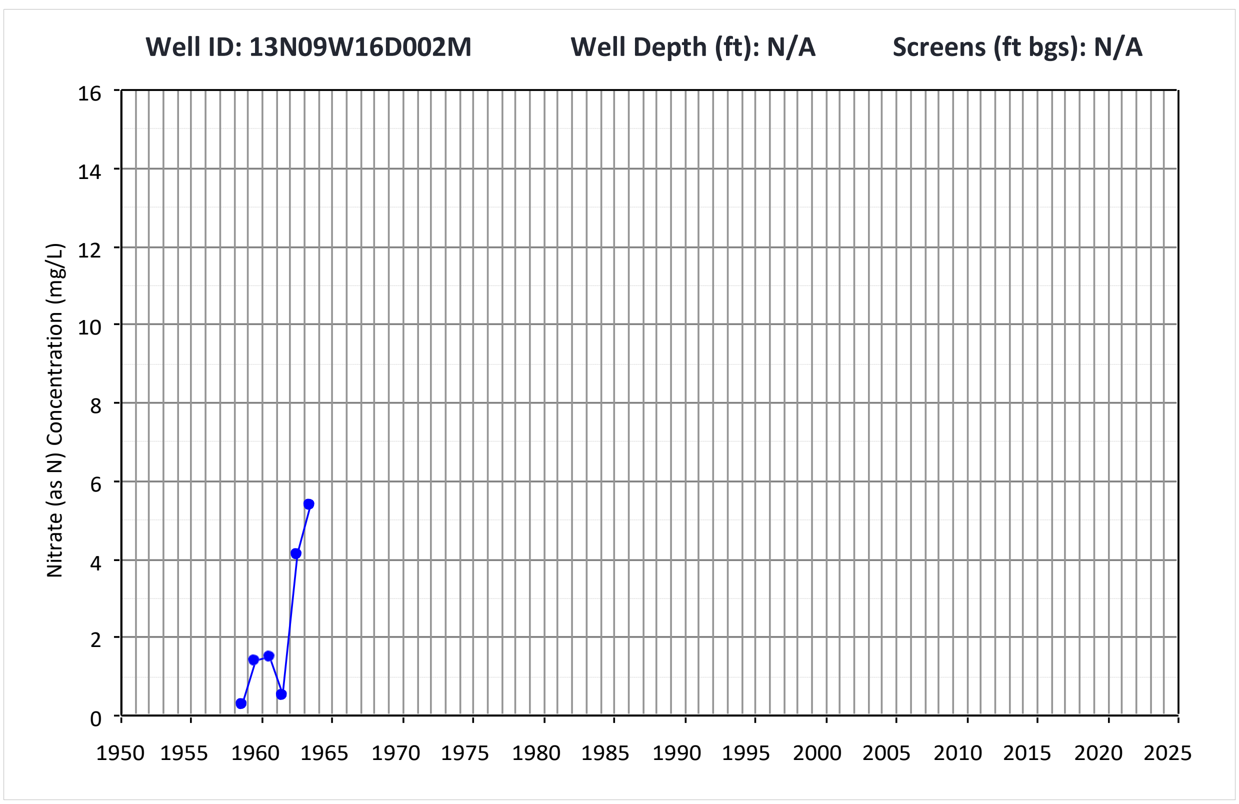

Well ID: 13N09W08B001M
Well Depth (ft): N/A
Screens (ft bgs): N/A
Nitrate (as N) Concentration (mg/L)
0
2
4
6
8
10
12
14
16
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025

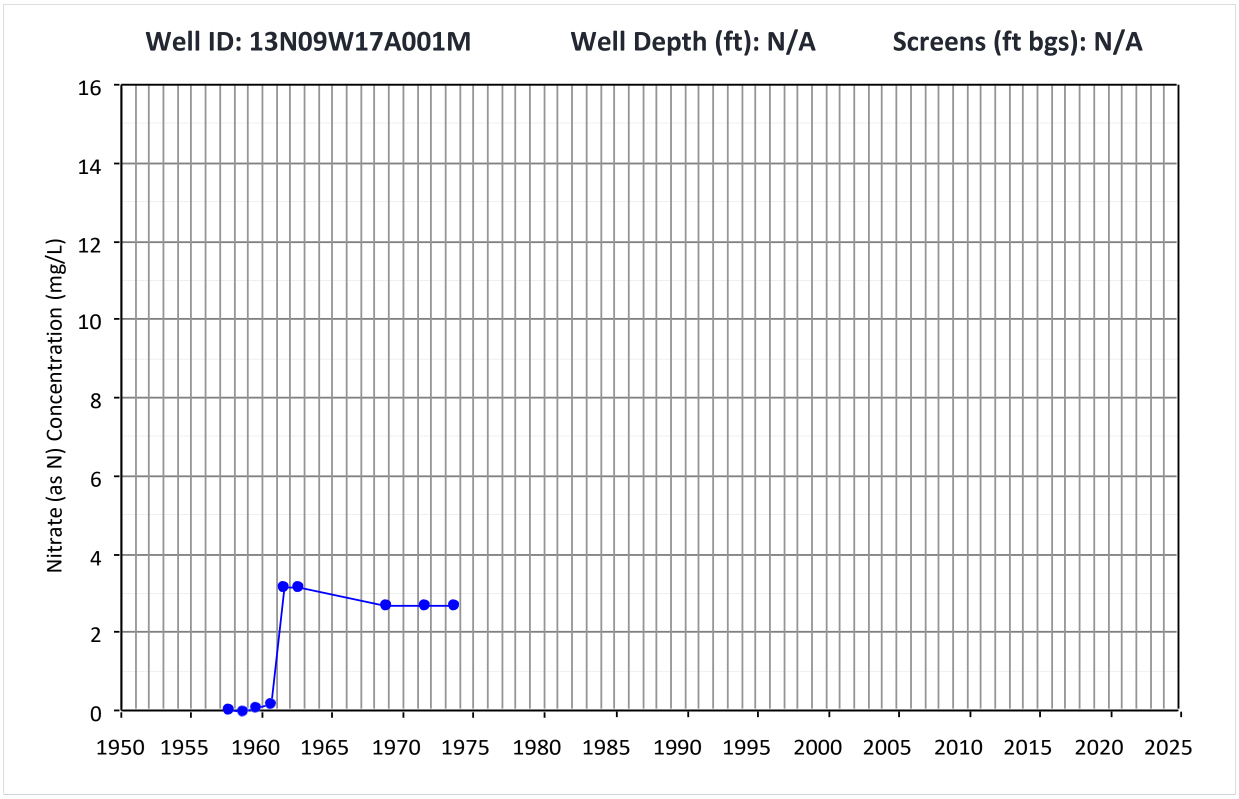

Well ID: 13N09W08C001M
Well Depth (ft): N/A
Screens (ft bgs): N/A
Nitrate (as N) Concentration (mg/L)
0
2
4
6
8
10
12
14
16
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025

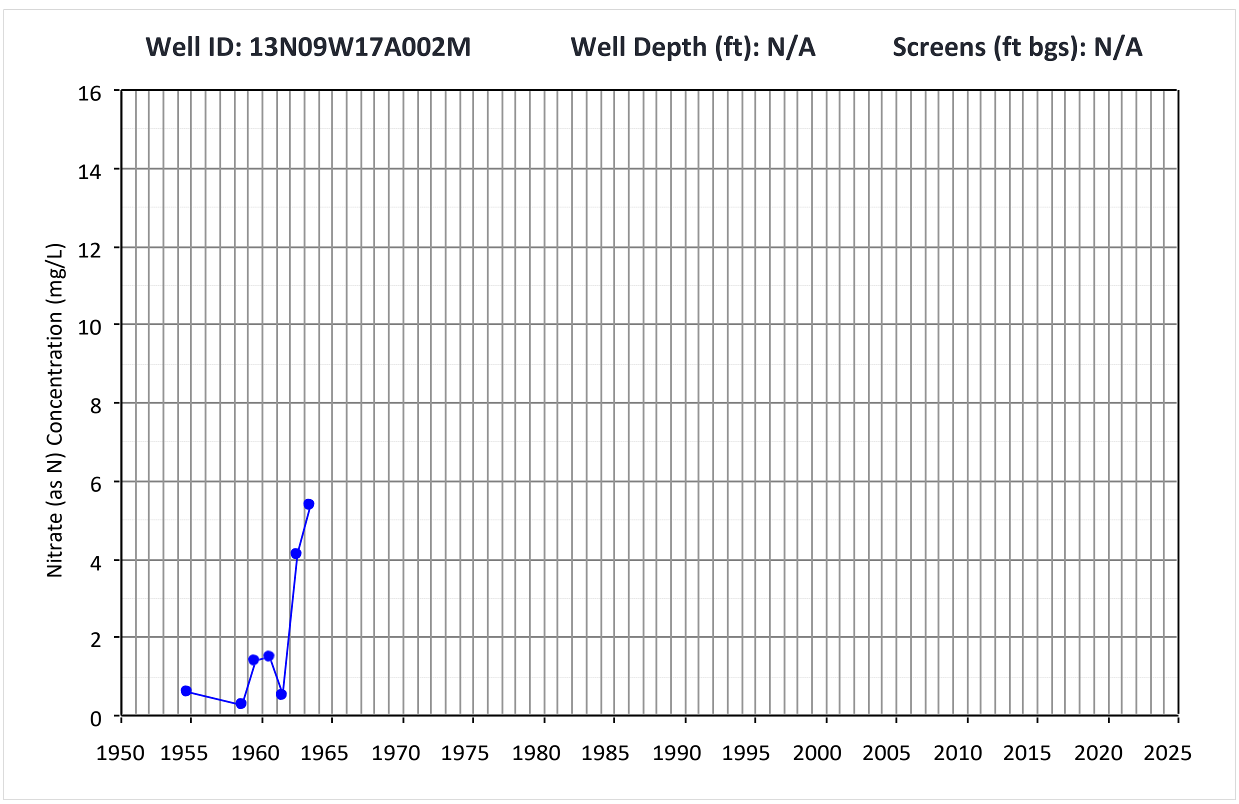

Well ID: 13N09W08N002M
Well Depth (ft): N/A
Screens (ft bgs): N/A
Nitrate (as N) Concentration (mg/L)
0
2
4
6
8
10
12
14
16
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025


Well ID: 13N09W12M001M
Well Depth (ft): N/A
Screens (ft bgs): N/A
Nitrate (as N) Concentration (mg/L)
0
2
4
6
8
10
12
14
16
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025


Well ID: 13N09W16D001M
Well Depth (ft): N/A
Screens (ft bgs): N/A
Nitrate (as N) Concentration (mg/L)
0
2
4
6
8
10
12
14
16
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025


Well ID: 13N09W16D002M
Well Depth (ft): N/A
Screens (ft bgs): N/A
Nitrate (as N) Concentration (mg/L)
0
2
4
6
8
10
12
14
16
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025


Well ID: 13N09W17A001M
Well Depth (ft): N/A
Screens (ft bgs): N/A
Nitrate (as N) Concentration (mg/L)
0
2
4
6
8
10
12
14
16
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025


Well ID: 13N09W17A002M
Well Depth (ft): N/A
Screens (ft bgs): N/A
Nitrate (as N) Concentration (mg/L)
0
2
4
6
8
10
12
14
16
1950
1955
1960
1965
1970
1975
1980
1985
1990
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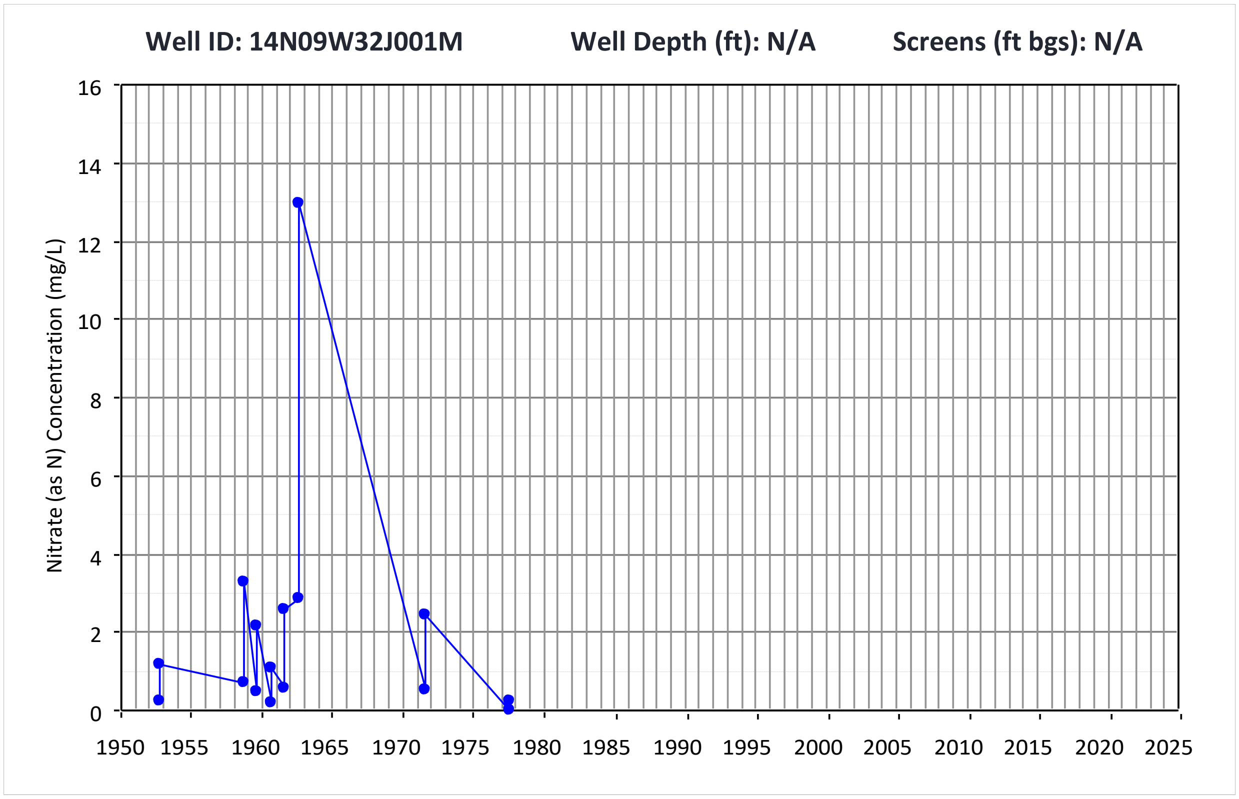
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Well Depth (ft): N/A
Screens (ft bgs): N/A
Nitrate (as N) Concentration (mg/L)
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2
4
6
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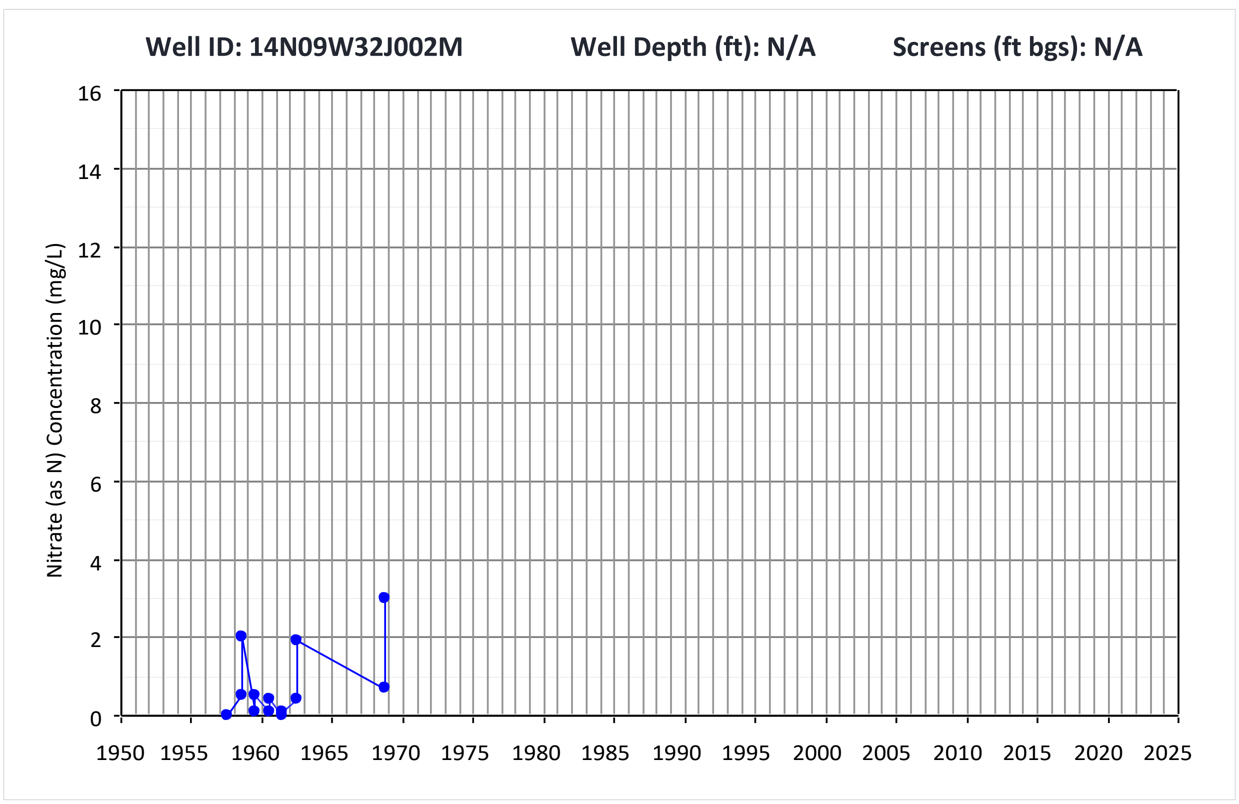
10
12
14
16
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025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Screens (ft bgs): N/A
Nitrate (as N) Concentration (mg/L)
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4
6
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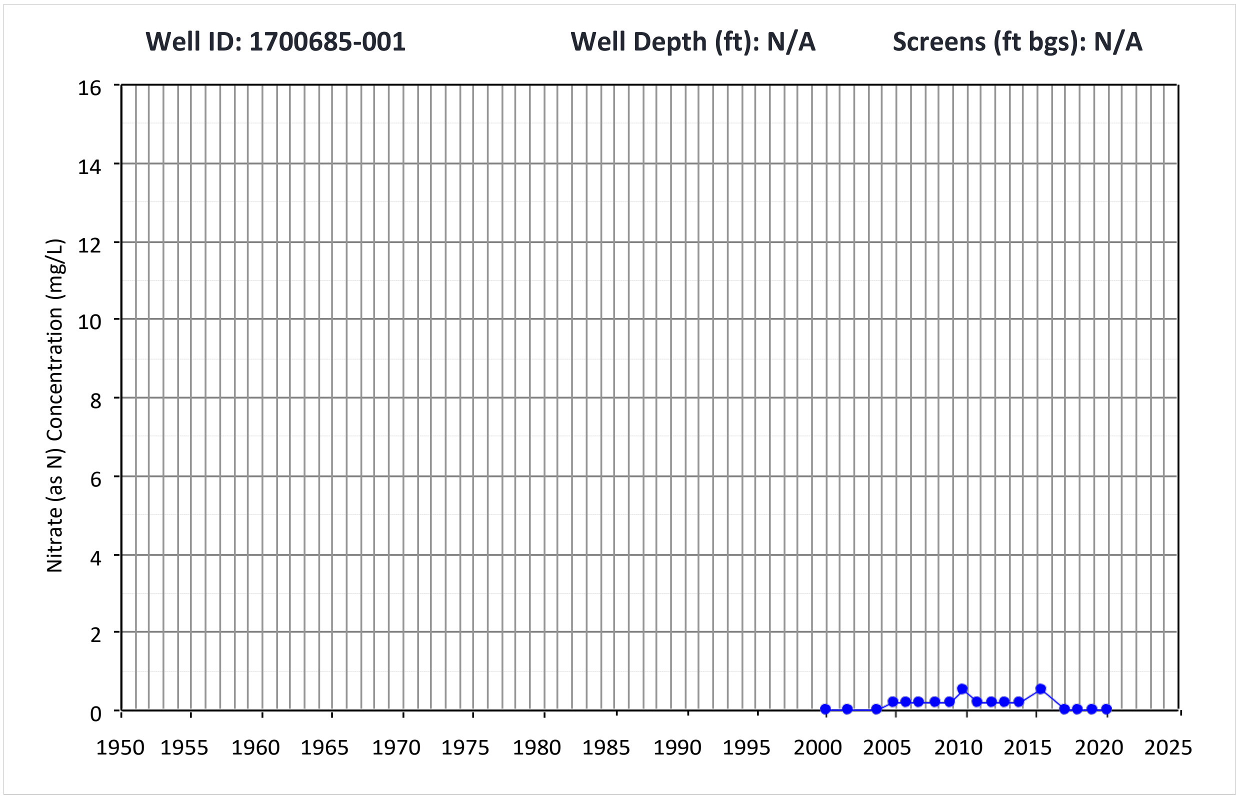
10
12
14
16
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025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Well Depth (ft): N/A
Screens (ft bgs): N/A
Nitrate (as N) Concentration (mg/L)
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1950
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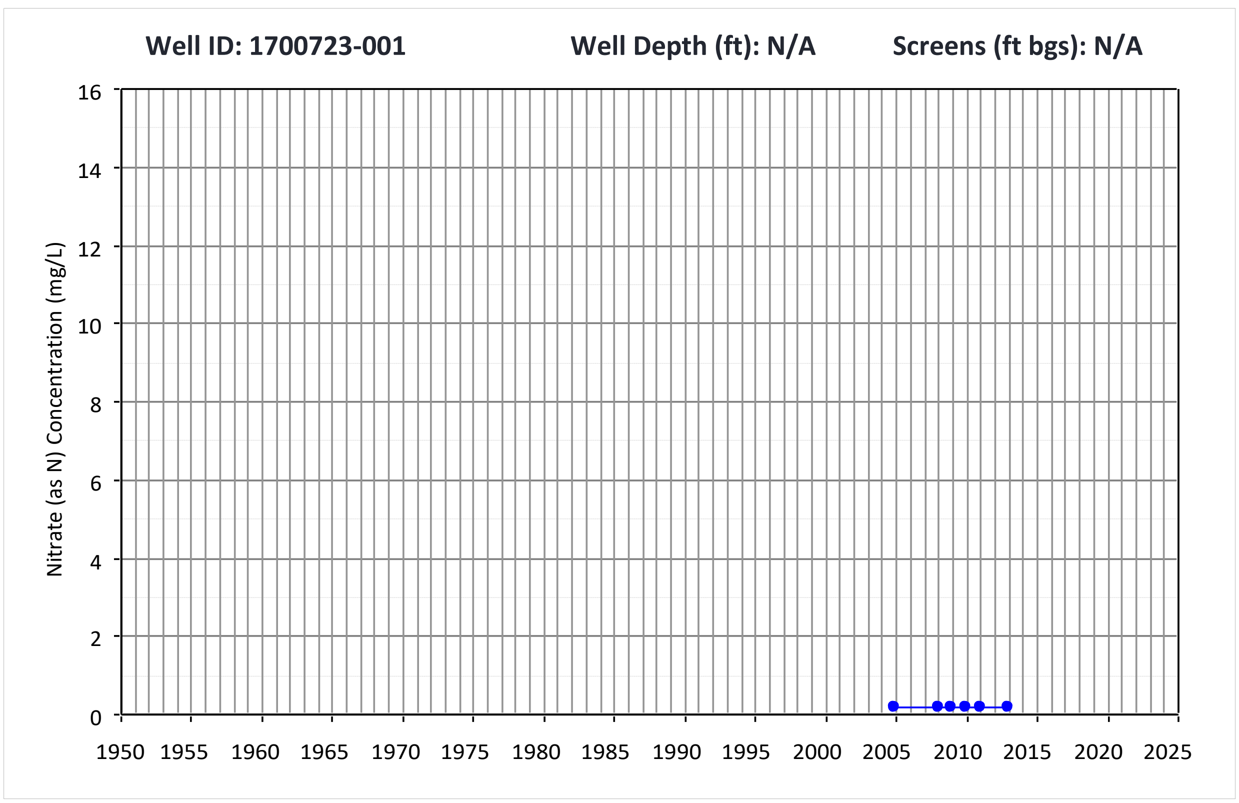
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Nitrate (as N) Concentration (mg/L)
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2
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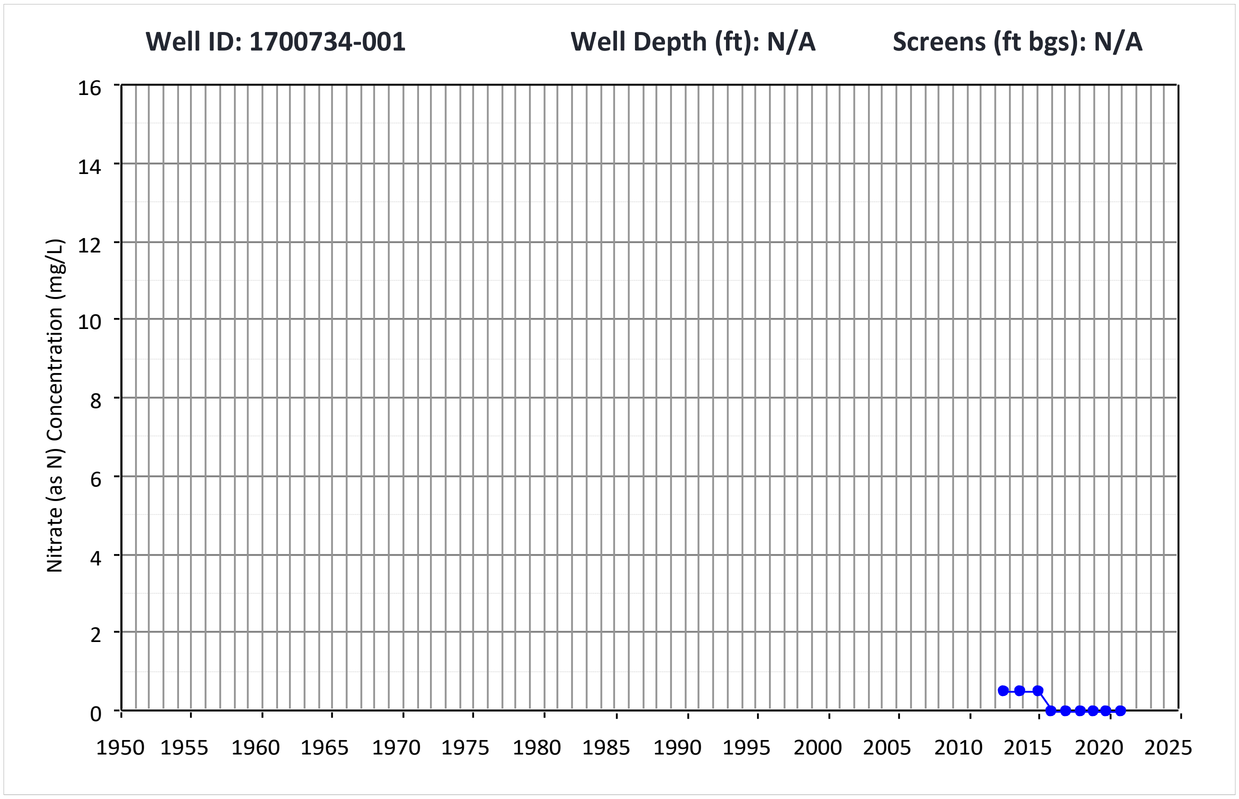
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2
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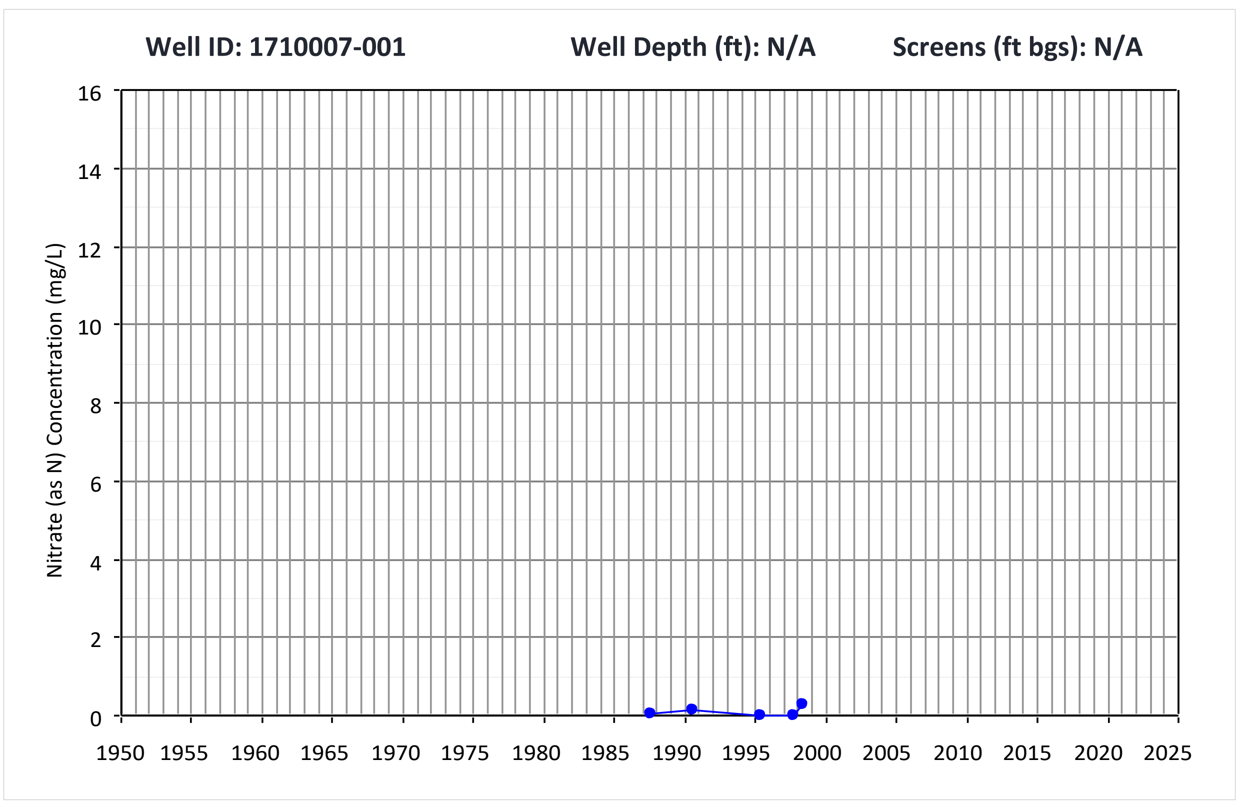
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Screens (ft bgs): N/A
Nitrate (as N) Concentration (mg/L)
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2
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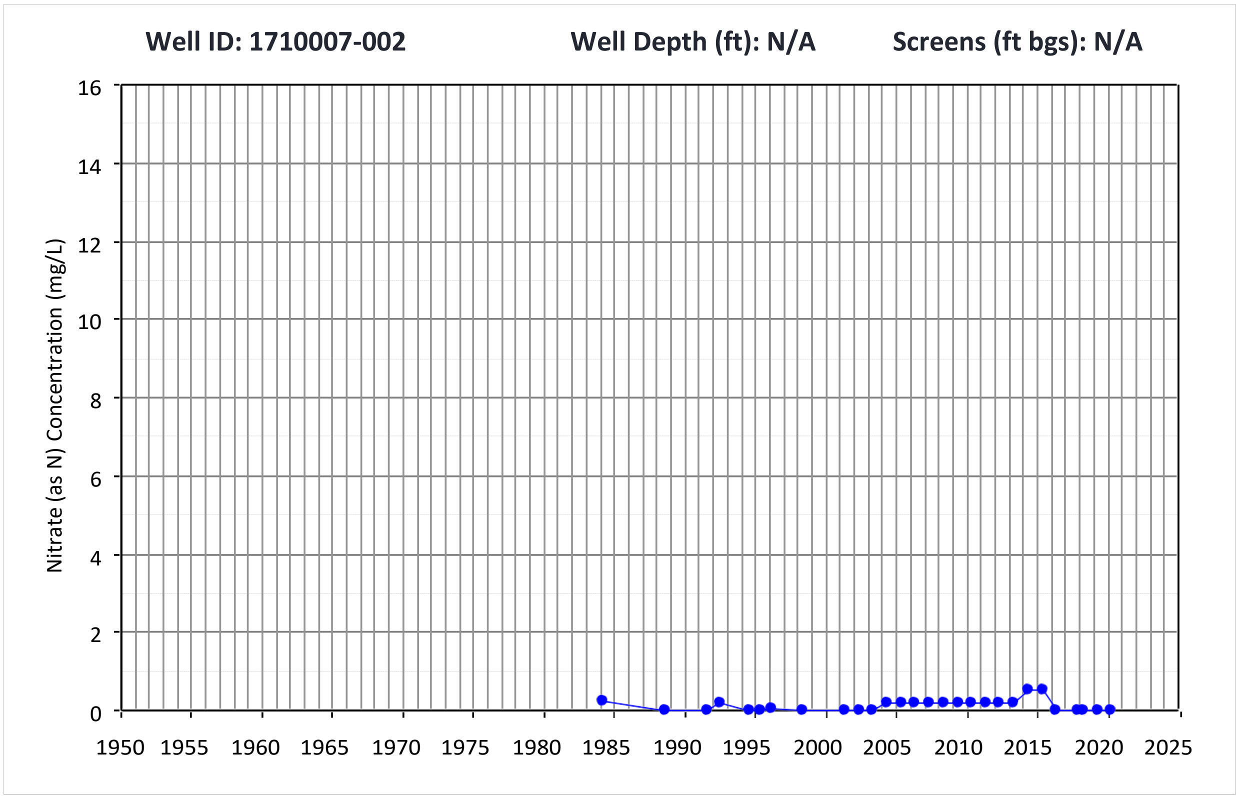
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Screens (ft bgs): N/A
Nitrate (as N) Concentration (mg/L)
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2
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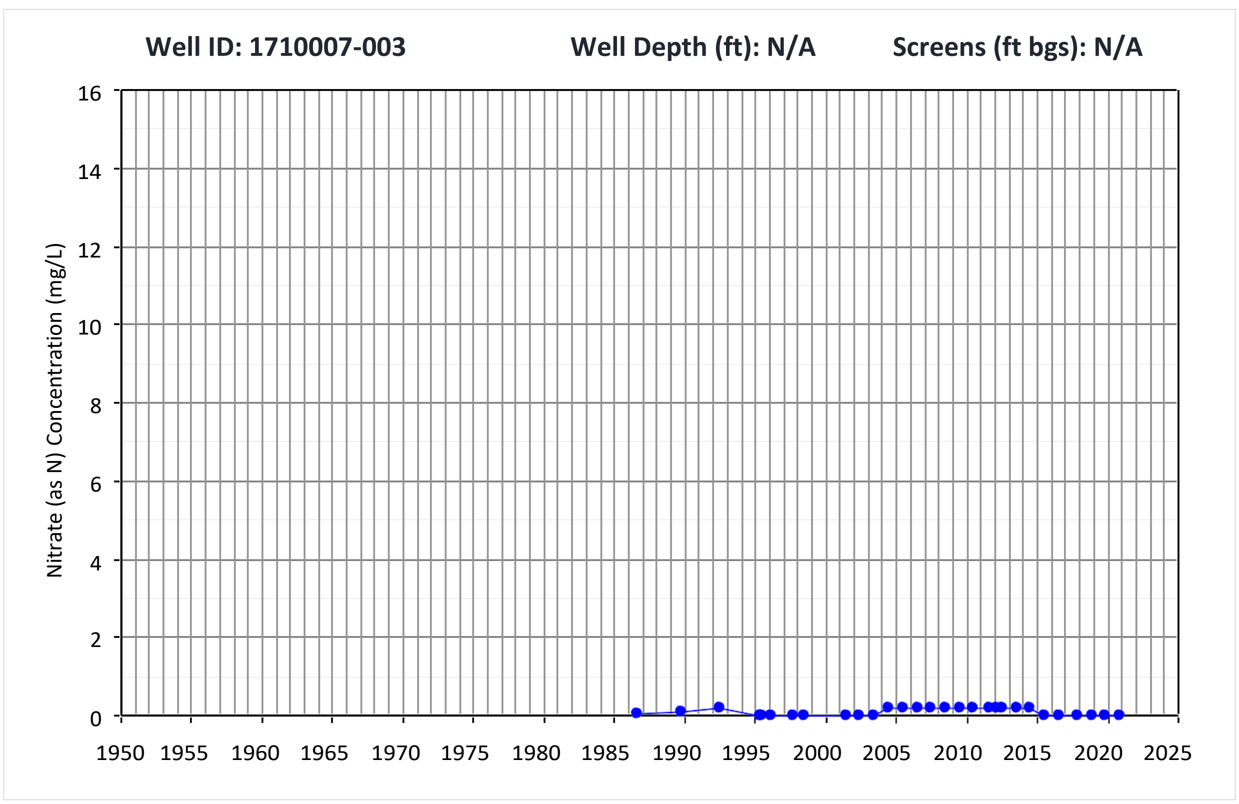
16
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025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Screens (ft bgs): N/A
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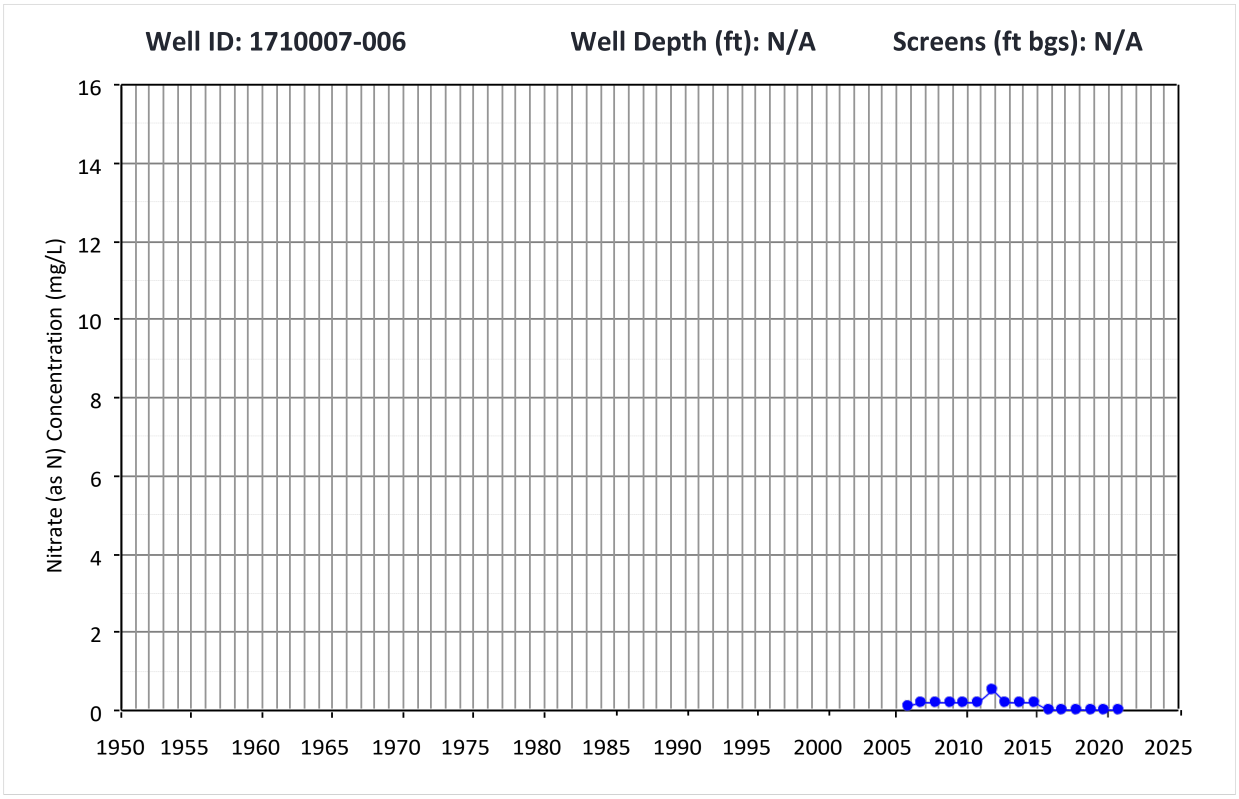
16
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025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Nitrate (as N) Concentration (mg/L)
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2
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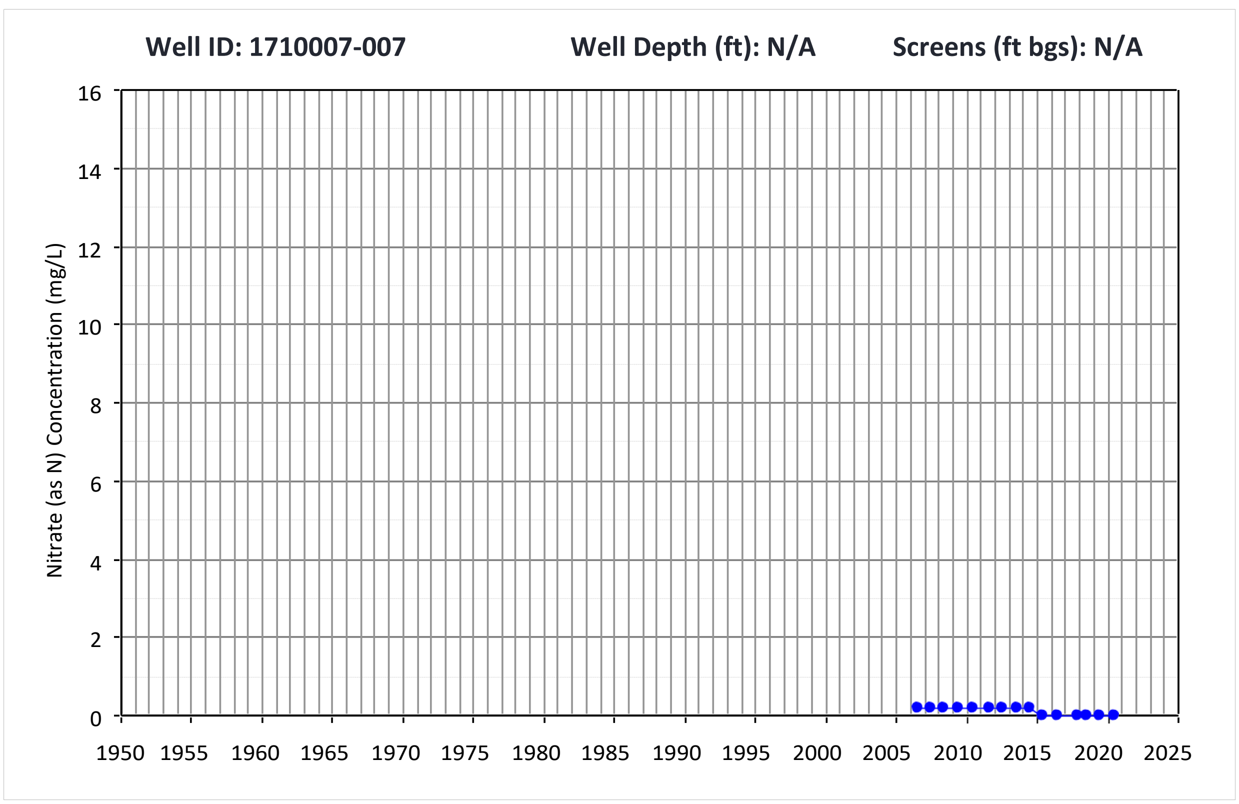
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Screens (ft bgs): N/A
Nitrate (as N) Concentration (mg/L)
0
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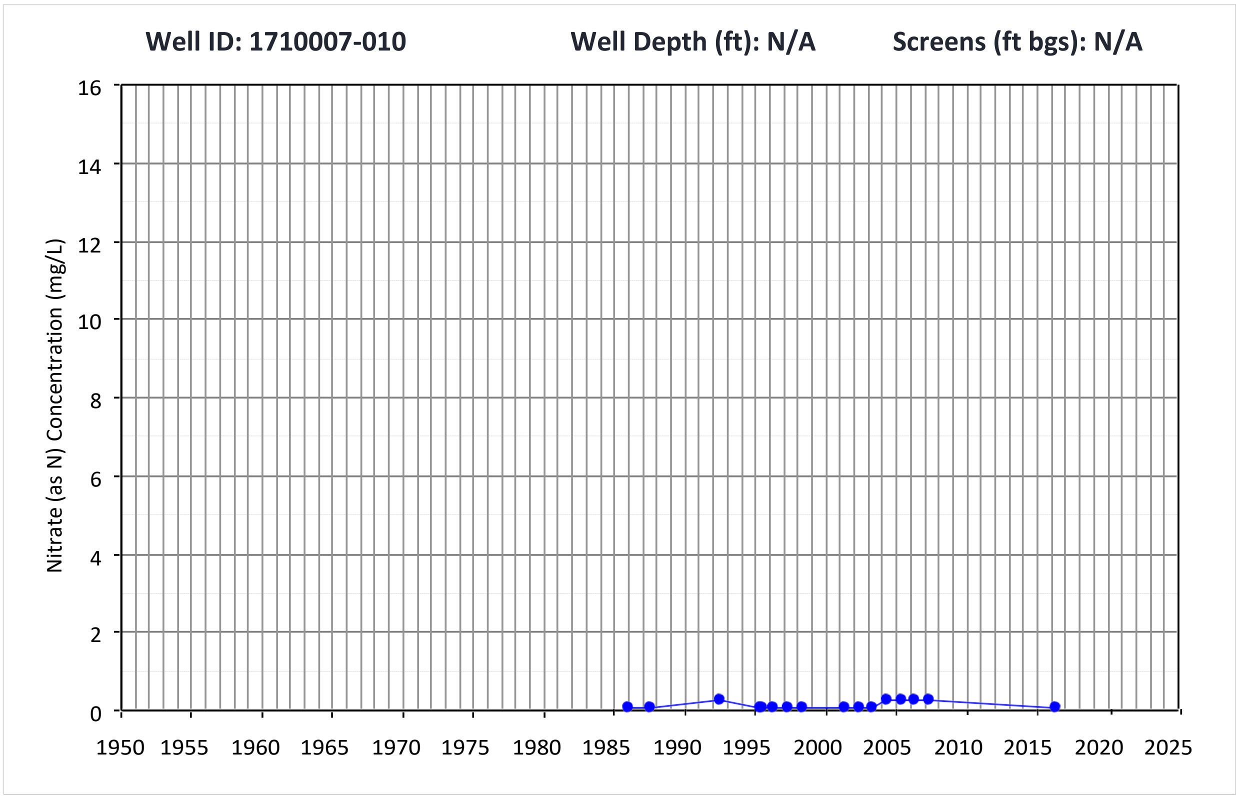
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Well Depth (ft): N/A
Screens (ft bgs): N/A
Nitrate (as N) Concentration (mg/L)
0
2
4
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1950
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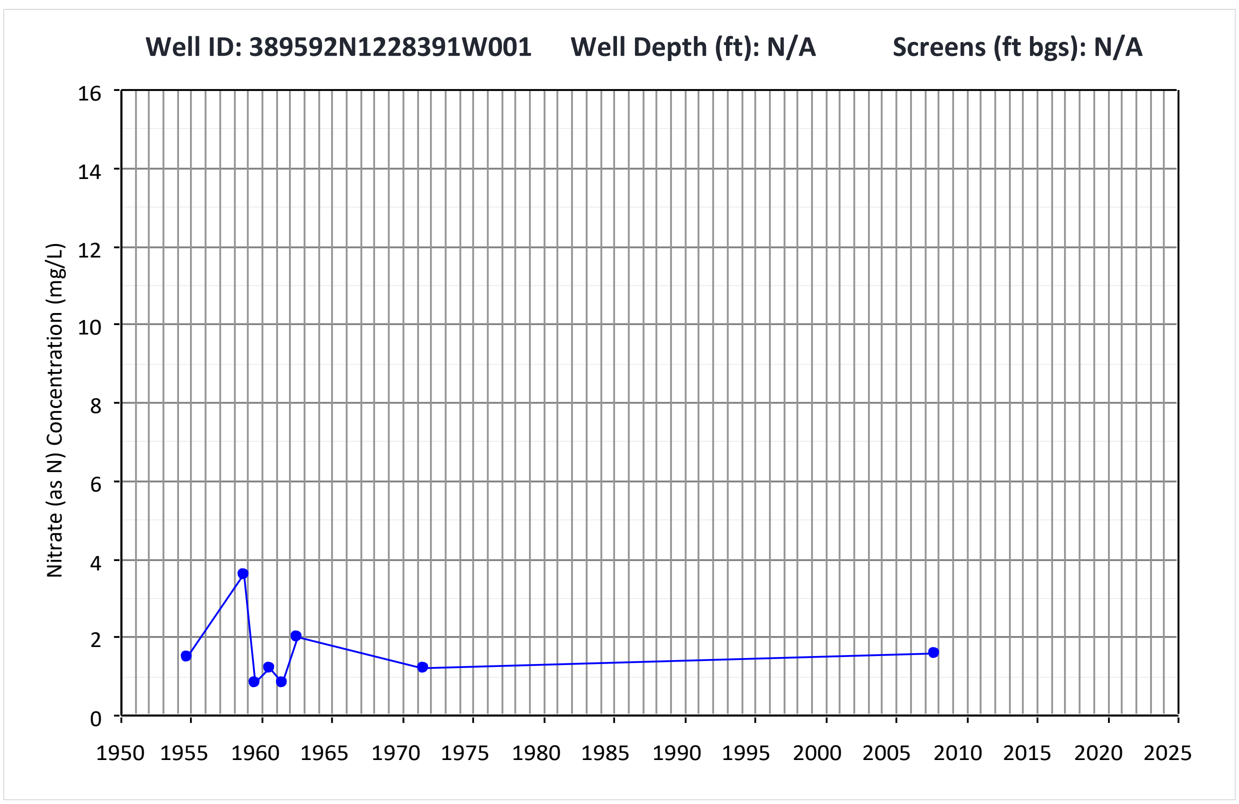
Well ID: 389592N1228391W001
Well Depth (ft): N/A
Screens (ft bgs): N/A
Nitrate (as N) Concentration (mg/L)
0
2
4
6
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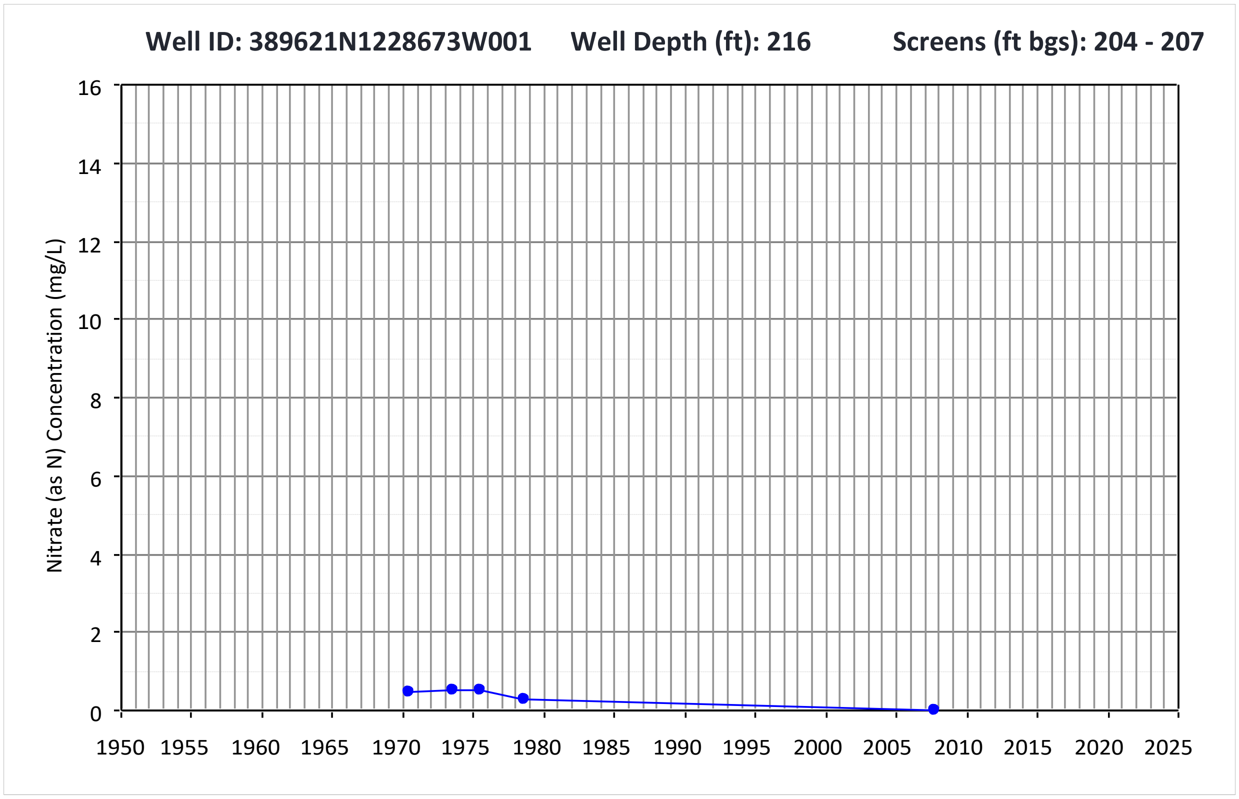
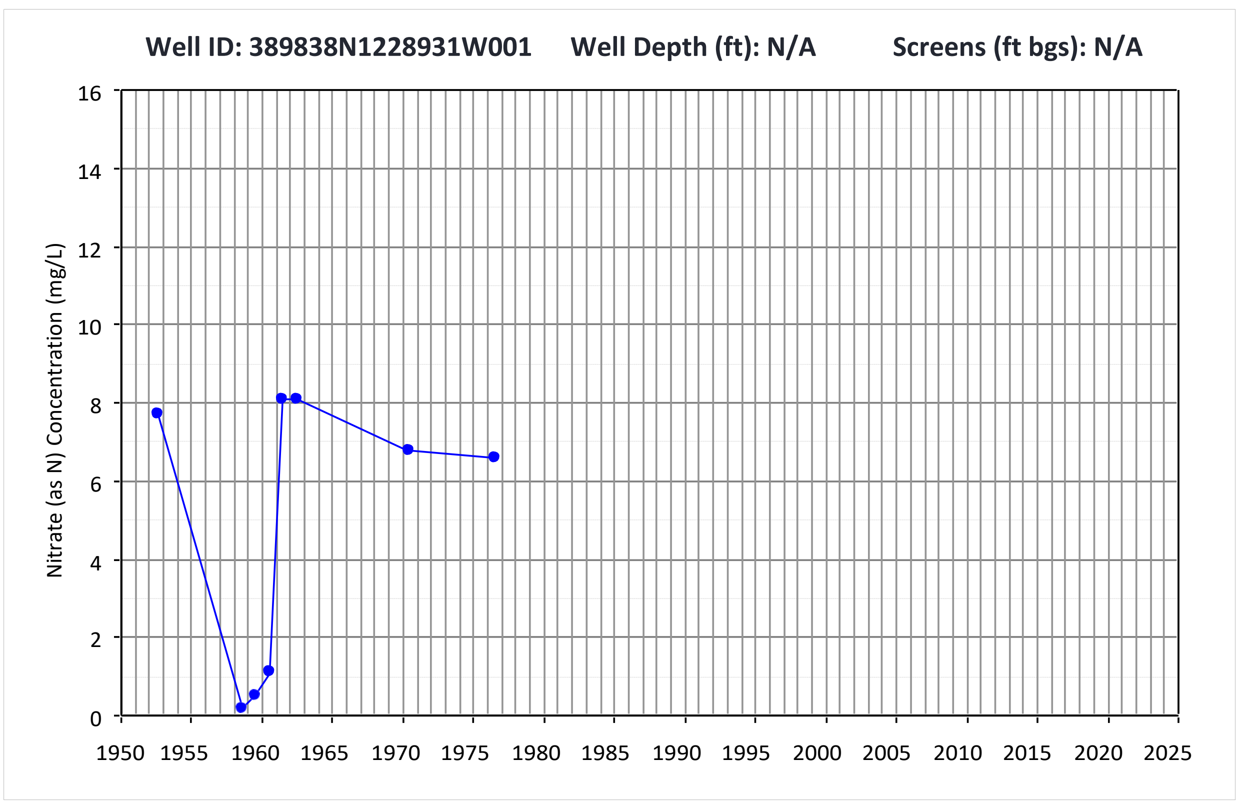

Well ID: 389621N1228673W001
Well Depth (ft): 216
Screens (ft bgs): 204 - 207
Nitrate (as N) Concentration (mg/L)
0
2
4
6
8
10
12
14
16
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025


Well ID: 389838N1228931W001
Well Depth (ft): N/A
Screens (ft bgs): N/A
Nitrate (as N) Concentration (mg/L)
0
2
4
6
8
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12
14
16
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025

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Timeseries Graphs of Boron Concentrations

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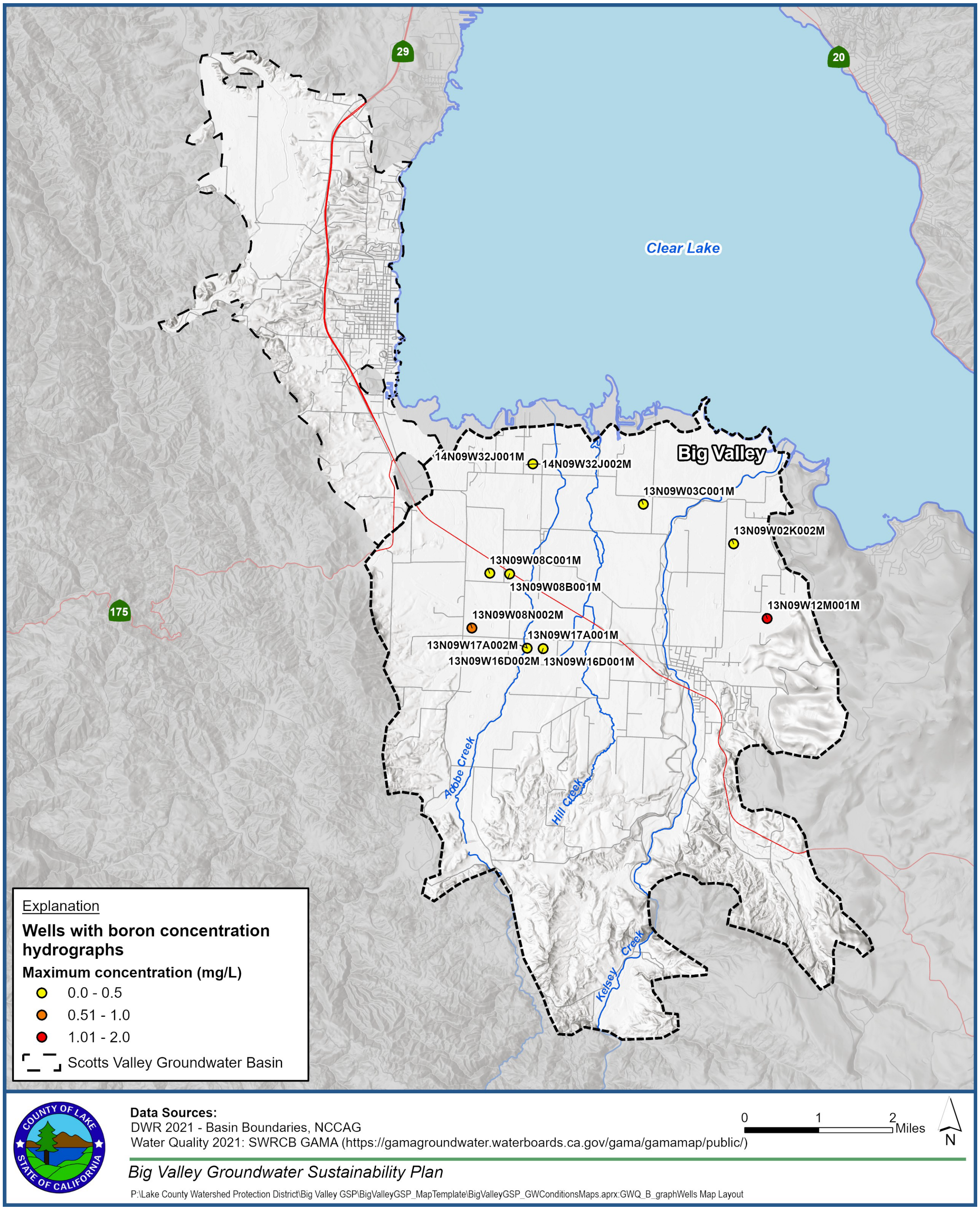
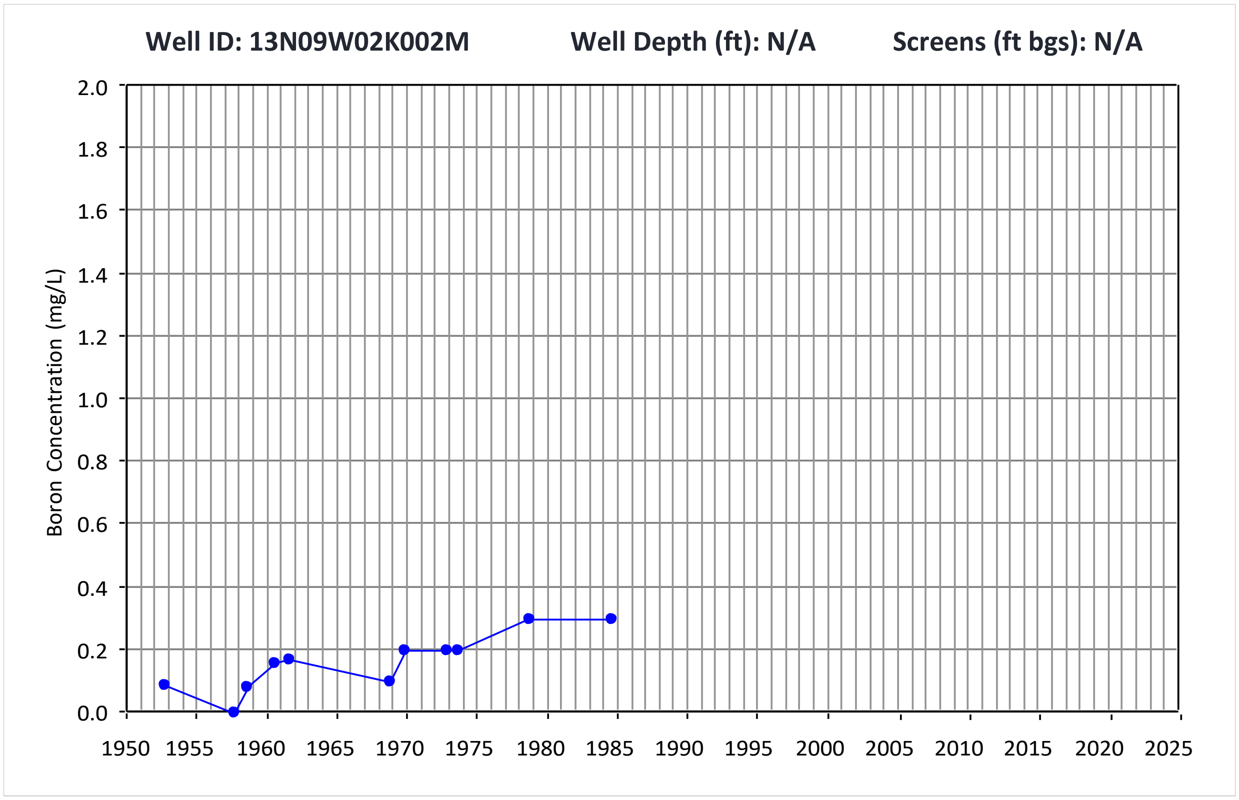


Figure 3. Locations of Wells with Boron Concentration Timeseries Graphs


Well ID: 13N09W02K002M
Well Depth (ft): N/A
Screens (ft bgs): N/A
Boron Concentration (mg/L)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1950
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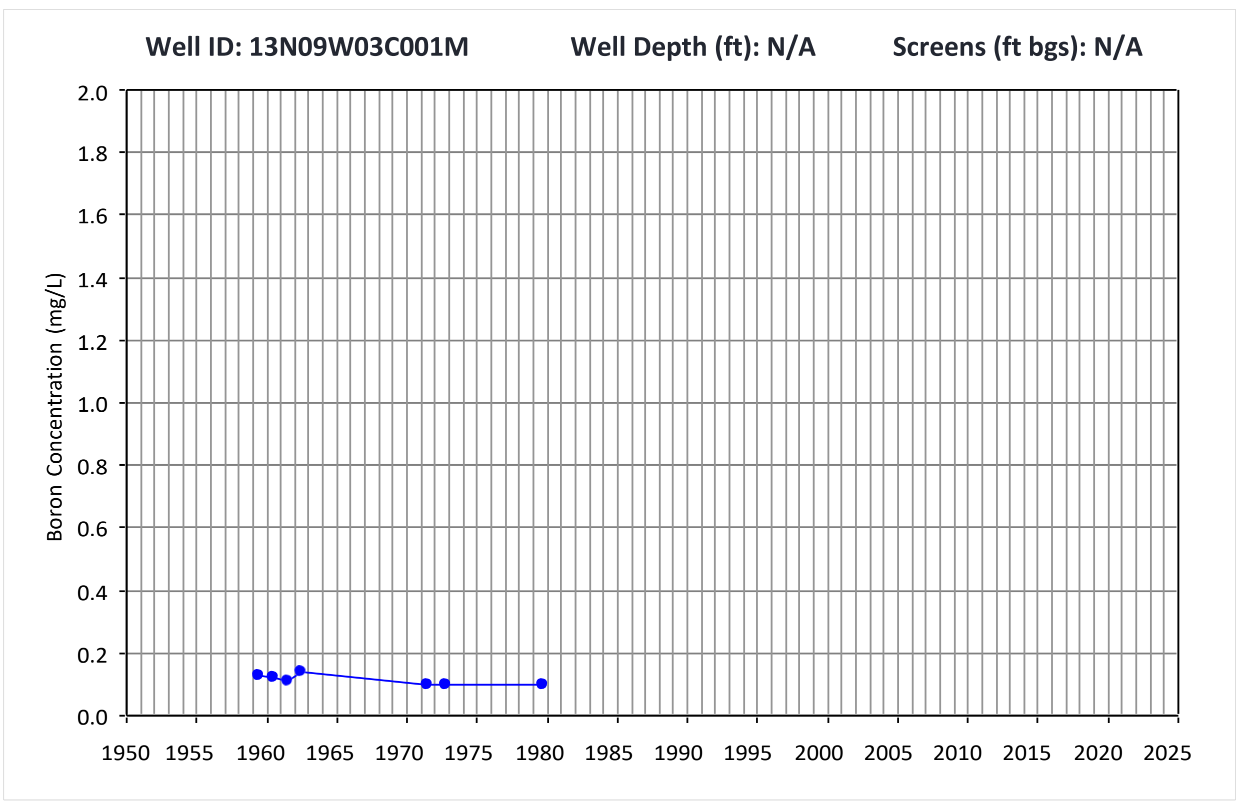
2025


Well ID: 13N09W03C001M
Well Depth (ft): N/A
Screens (ft bgs): N/A
Boron Concentration (mg/L)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1950
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1960
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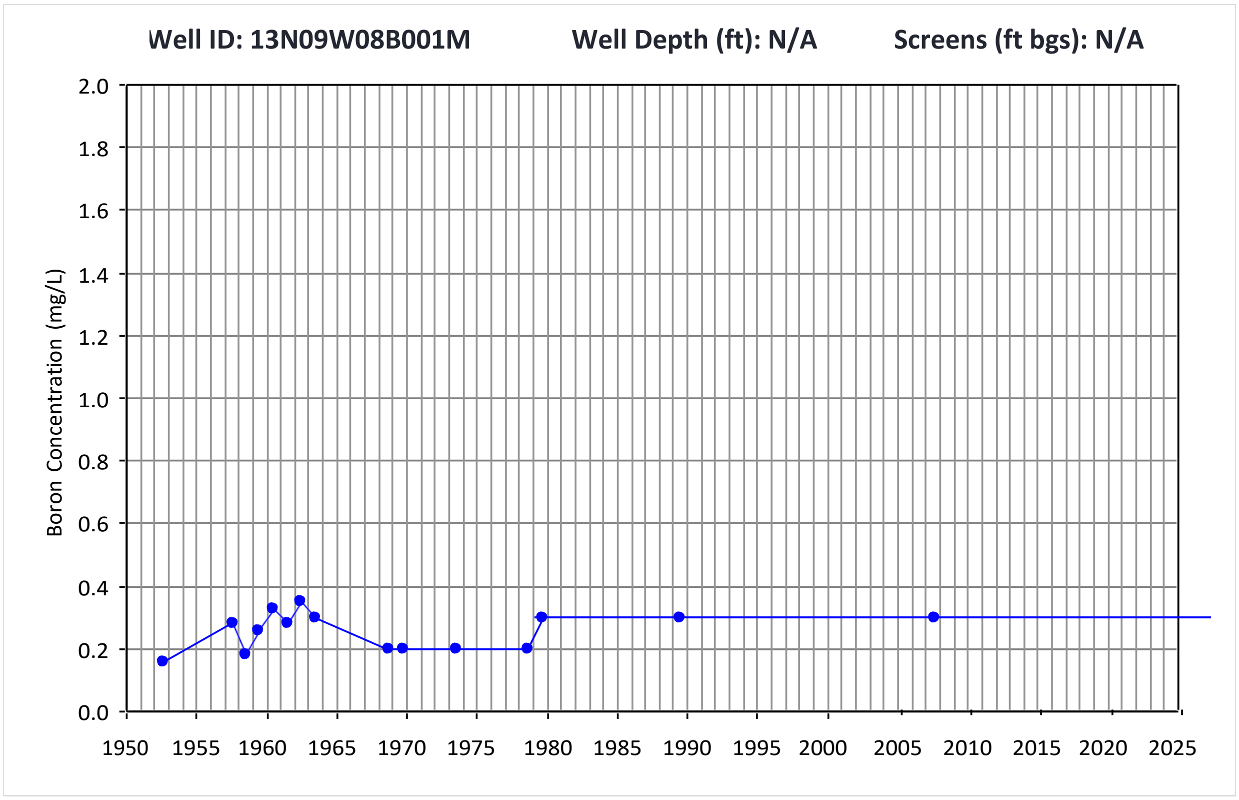
Well ID: 13N09W08B001M
Well Depth (ft): N/A
Screens (ft bgs): N/A
Boron Concentration (mg/L)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1950
1955
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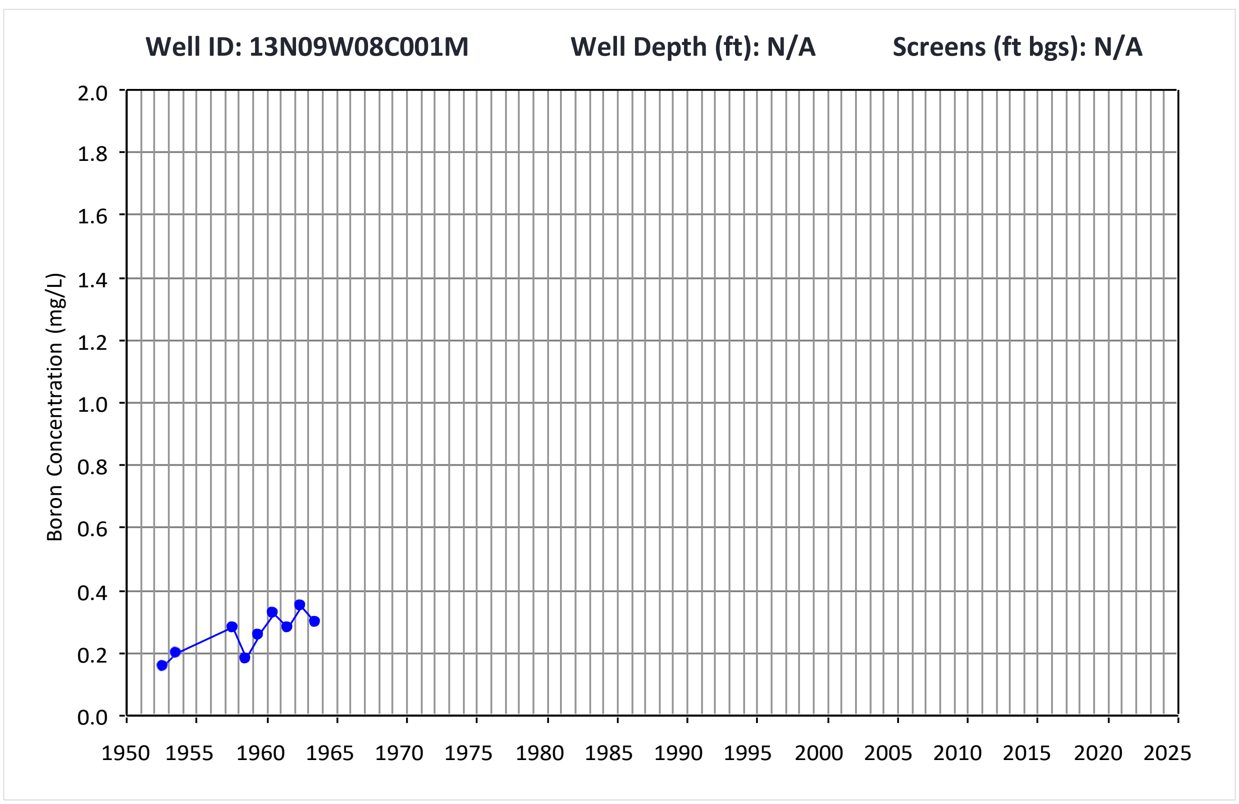
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Screens (ft bgs): N/A
Boron Concentration (mg/L)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1950
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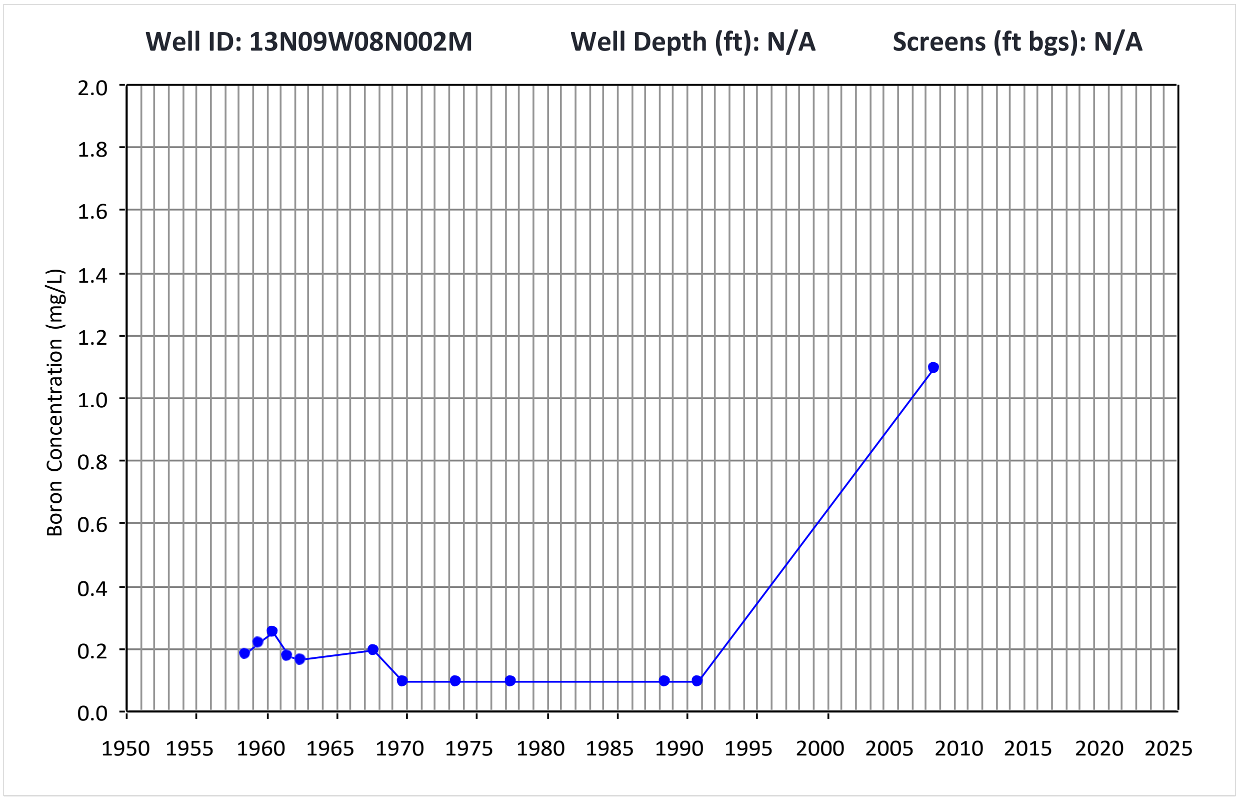
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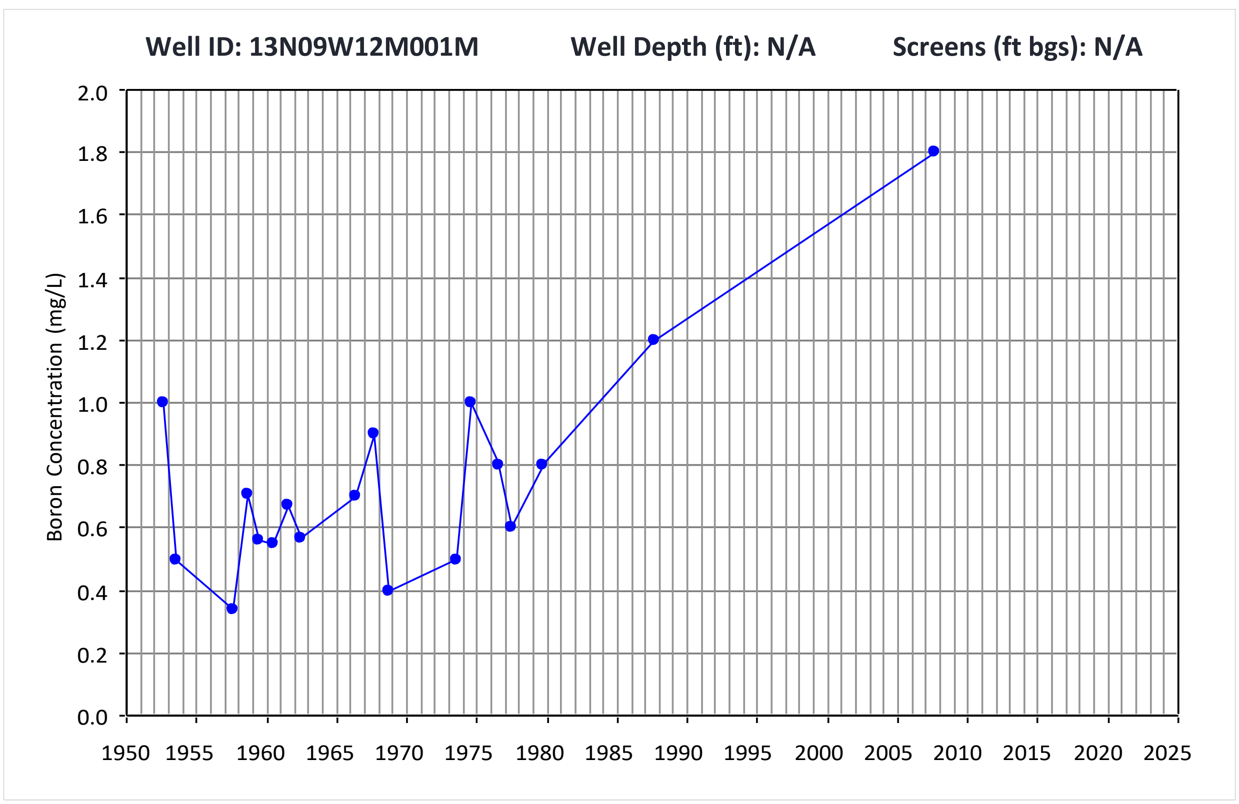
Well Depth (ft): N/A
Screens (ft bgs): N/A
Boron Concentration (mg/L)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025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Screens (ft bgs): N/A
Boron Concentration (mg/L)
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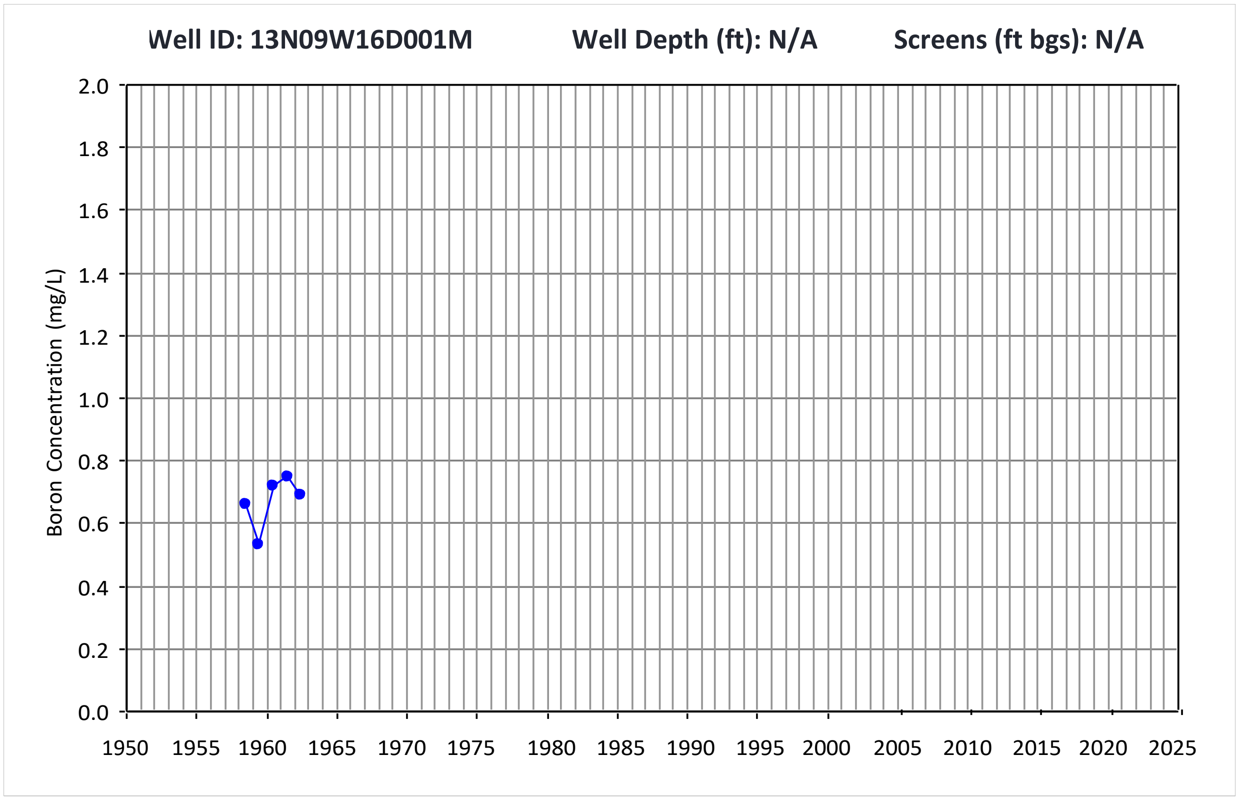
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025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Screens (ft bgs): N/A
Boron Concentration (mg/L)
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1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1950
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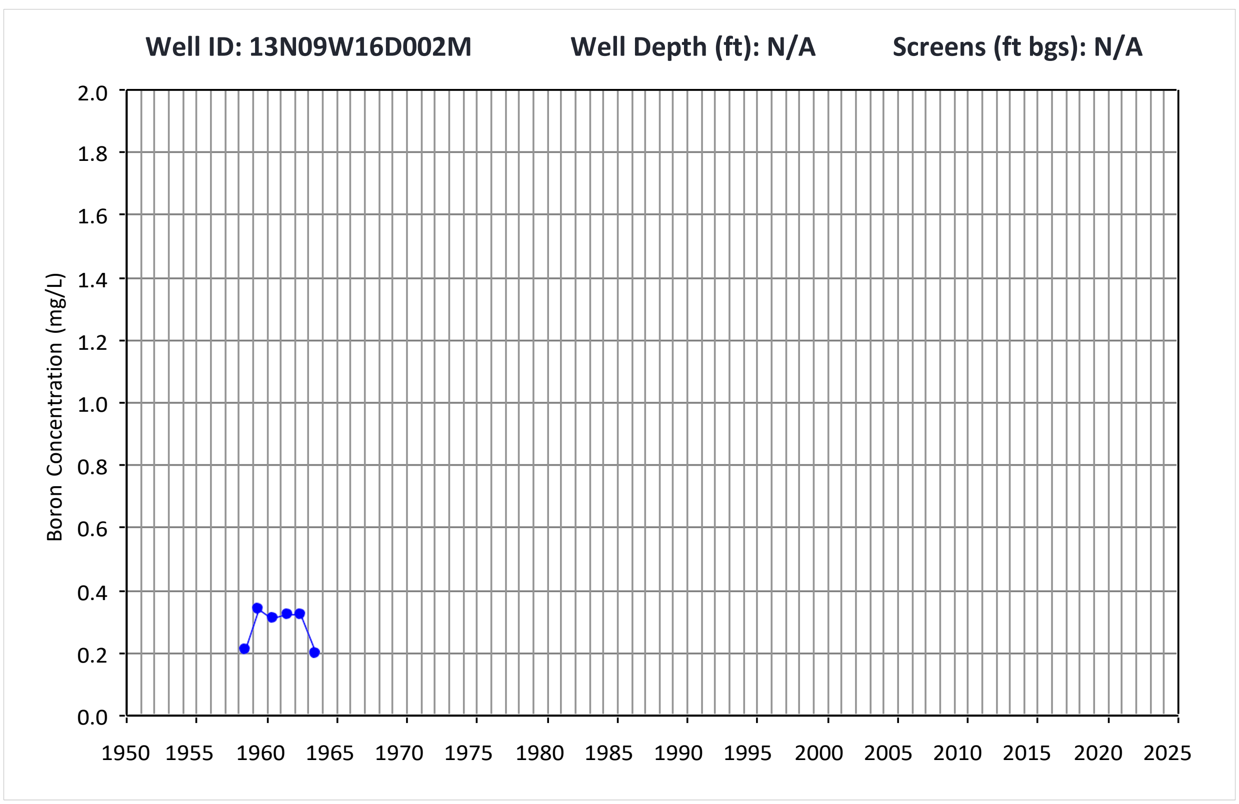
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1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1950
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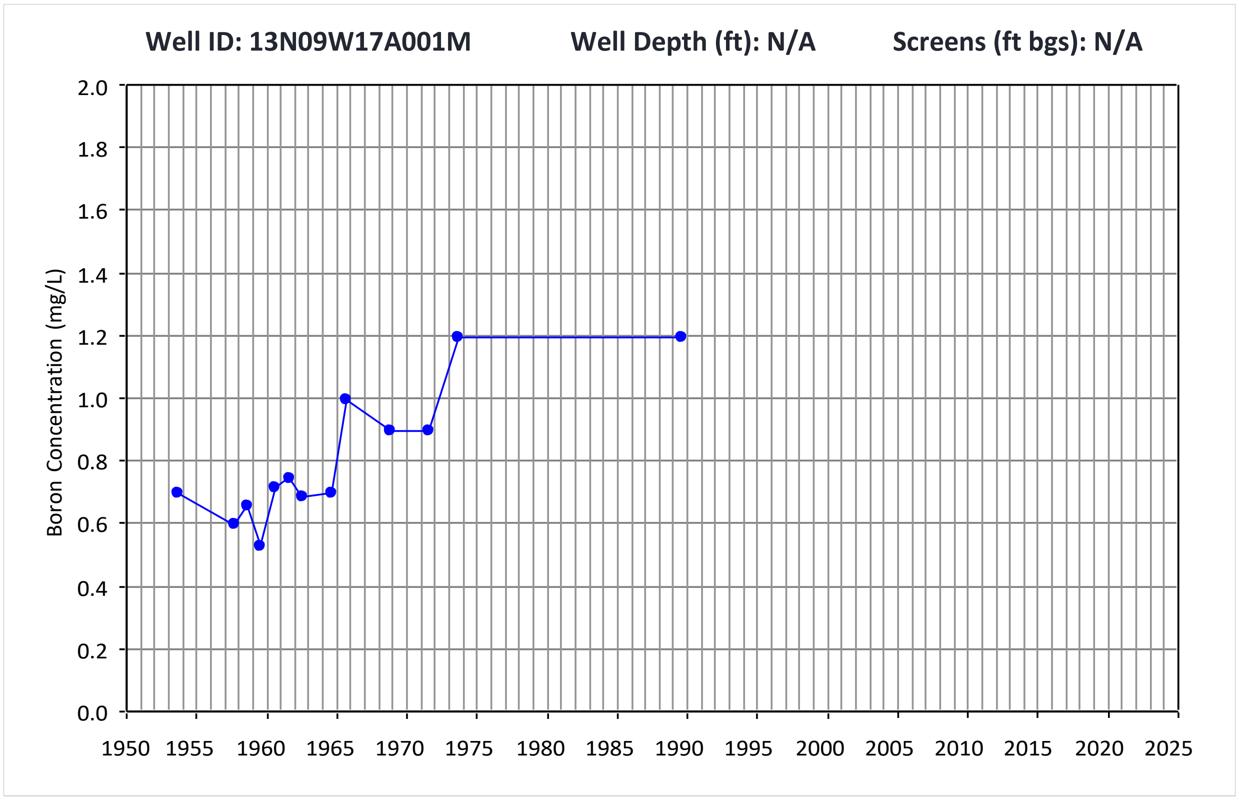
2020
2025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Screens (ft bgs): N/A
Boron Concentration (mg/L)
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1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
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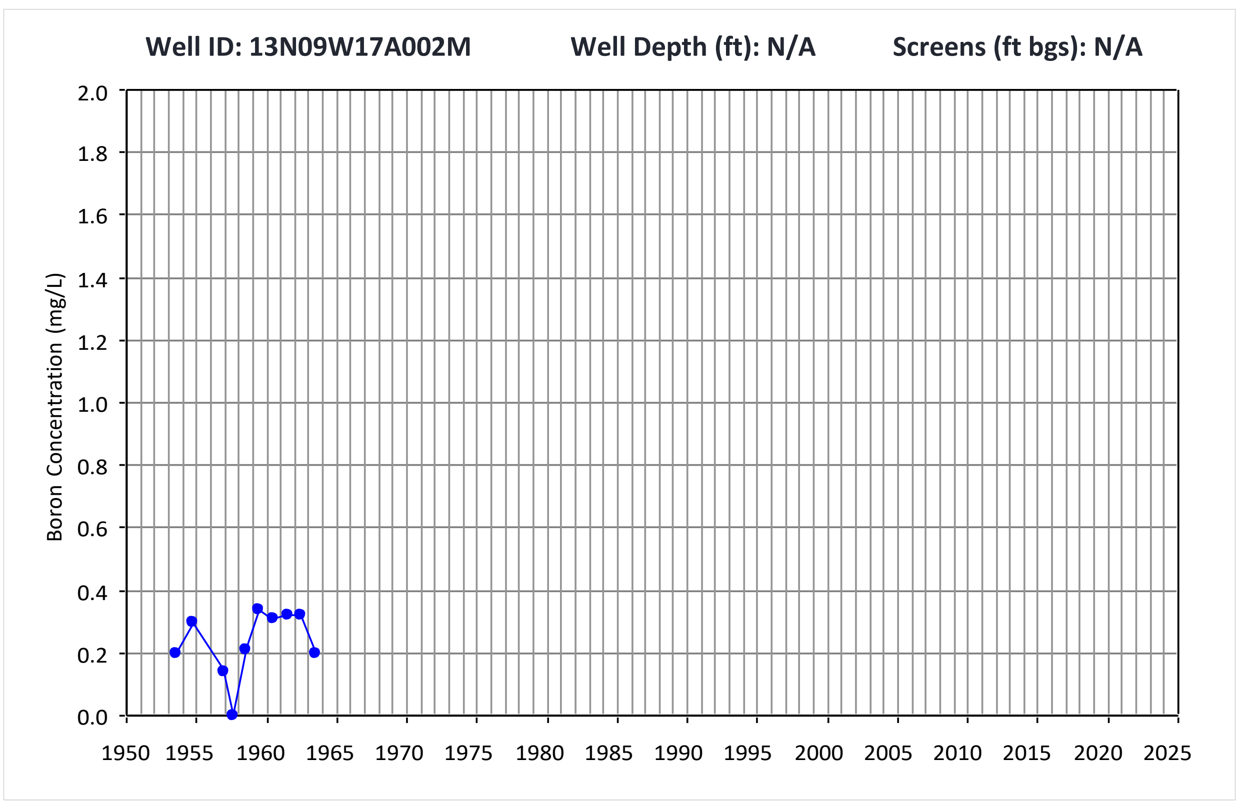
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Screens (ft bgs): N/A
Boron Concentration (mg/L)
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1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1950
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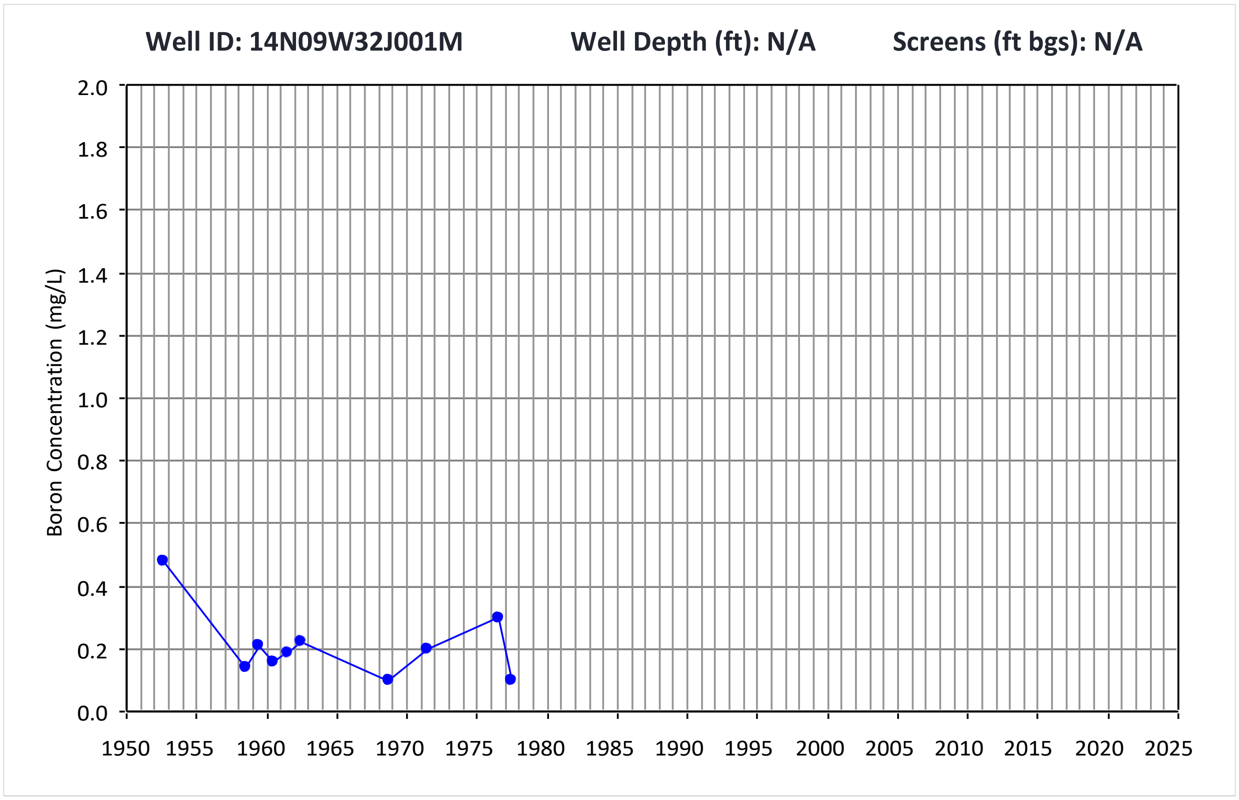
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Well Depth (ft): N/A
Screens (ft bgs): N/A
Boron Concentration (mg/L)
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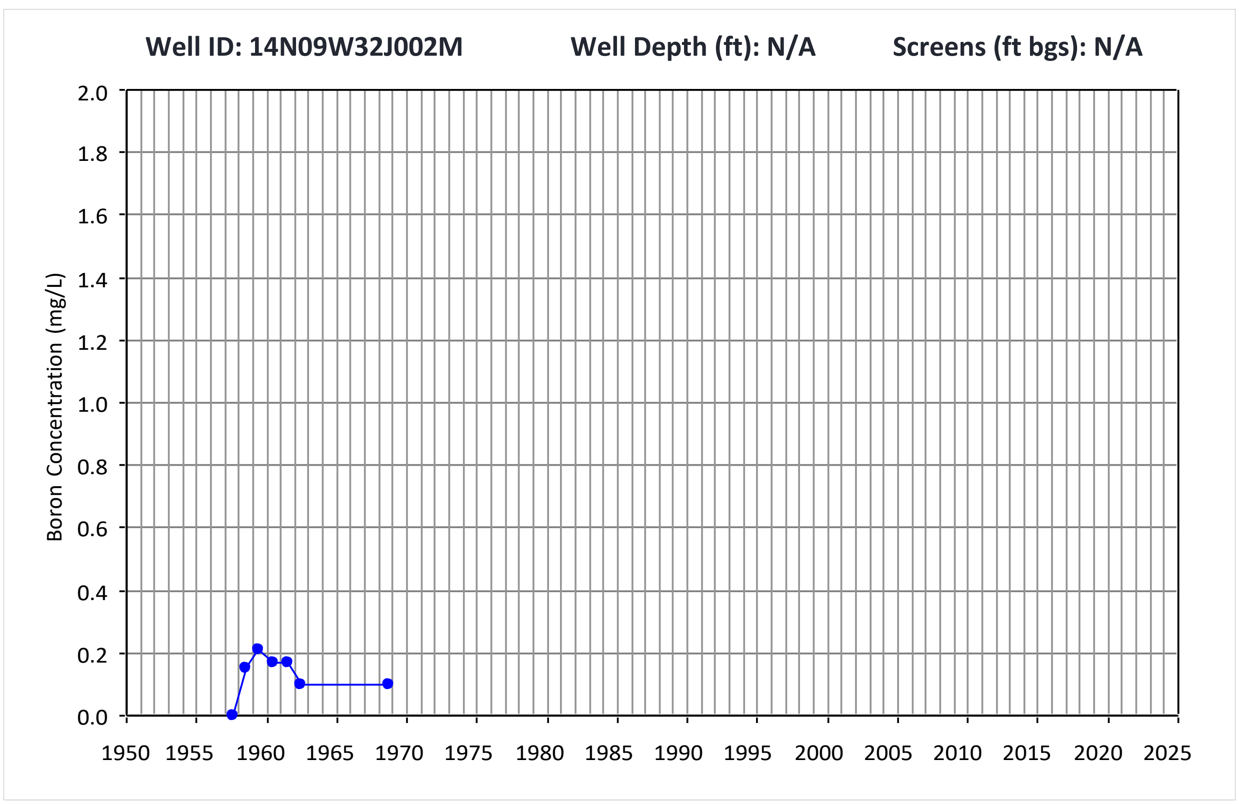
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025


Well ID: 14N09W32J002M
Well Depth (ft): N/A
Screens (ft bgs): N/A
Boron Concentration (mg/L)
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1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025

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Timeseries Graphs of Arsenic Concentrations

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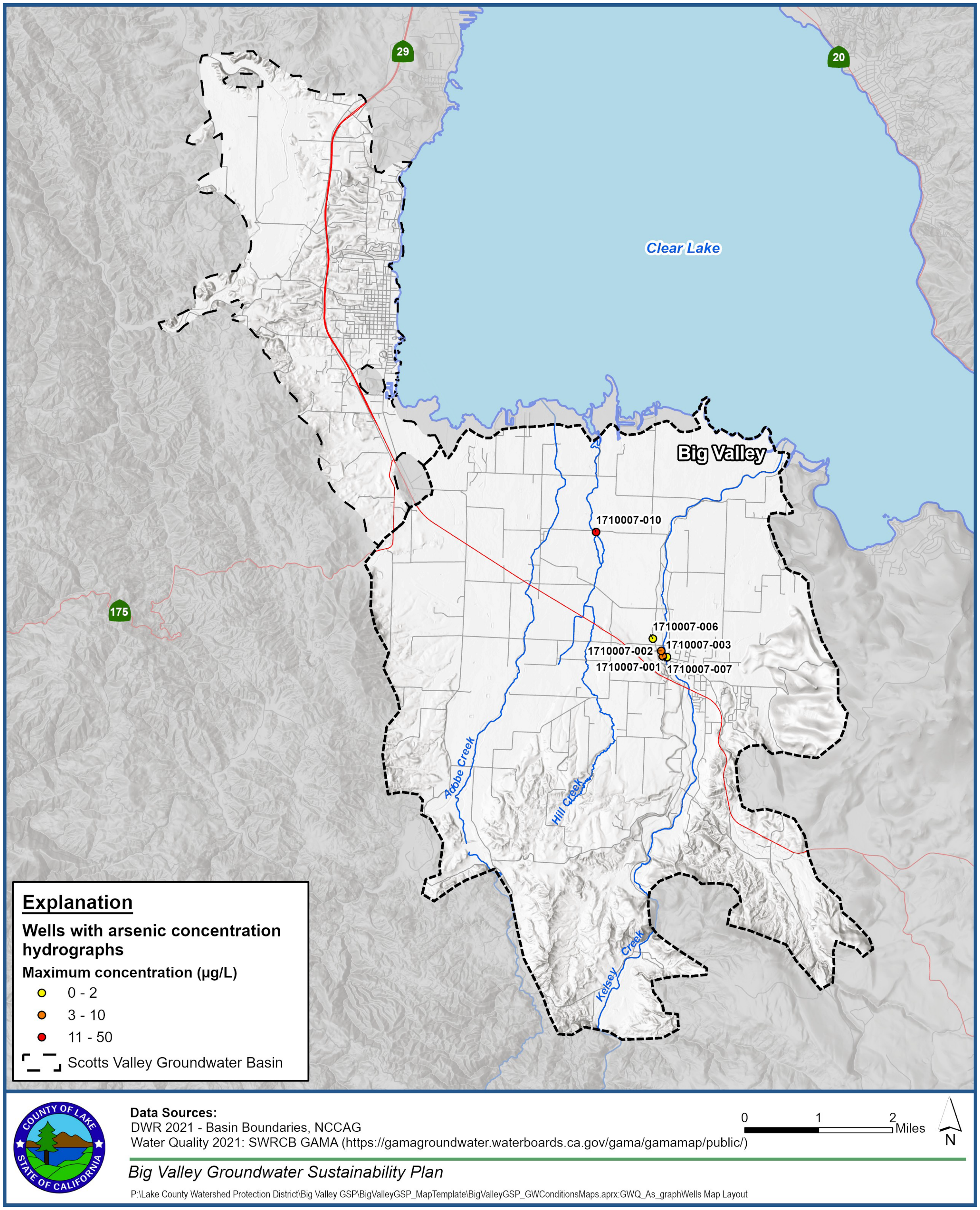
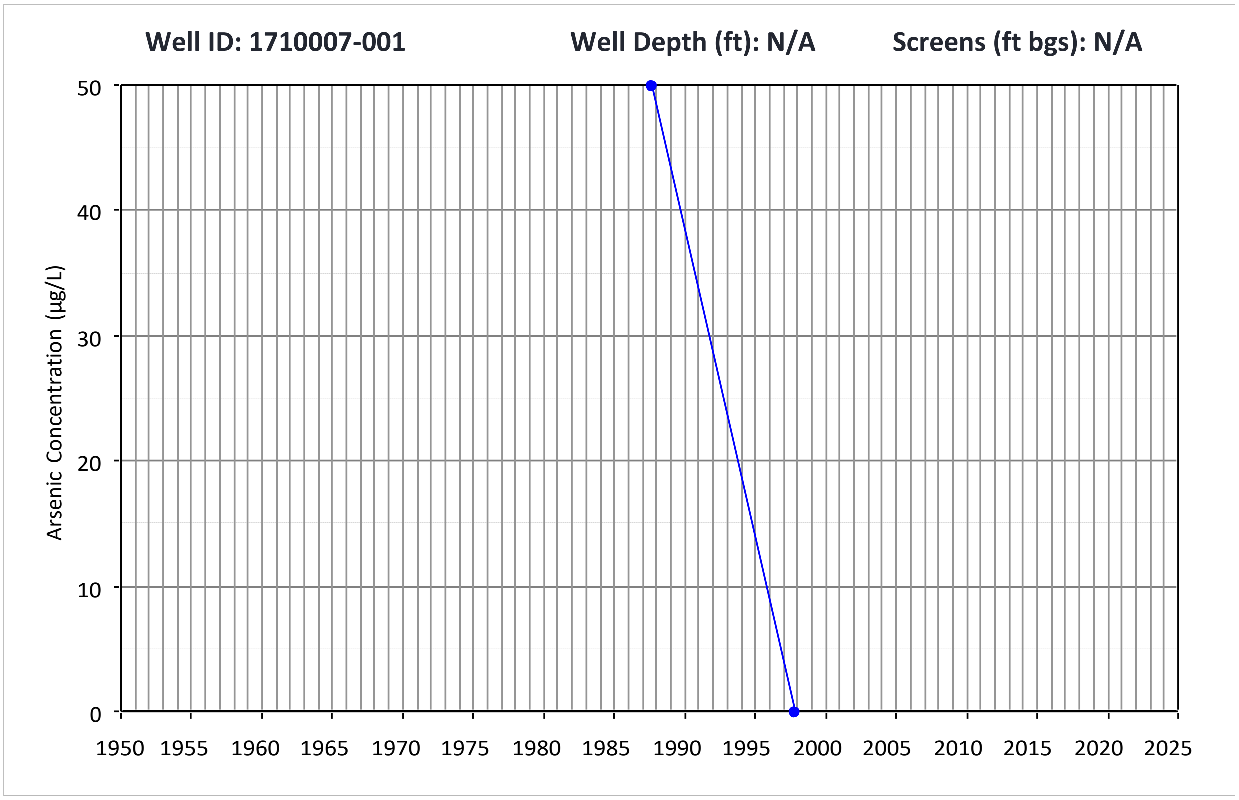

29
20
175
Clear Lake
Big Valley
1710007-010
1710007-006
1710007-003
1710007-002
1710007-001
1710007-007
Adobe Creek
Hill Creek
Kelsey Creek
Explanation
Wells with arsenic concentration hydrographs
Maximum concentration (µg/L)
0 - 2
3 - 10
11 - 50
Scotts Valley Groundwater Basin
Data Sources:
DWR 2021 - Basin Boundaries, NCCAG
Water Quality 2021: SWRCB GAMA (https://gamagroundwater.waterboards.ca.gov/gama/gamamap/public/)
0 1 2 Miles
N
Big Valley Groundwater Sustainability Plan
P:\Lake County Watershed Protection District\Big Valley GSP\BigValleyGSP_MapTemplate\BigValleyGSP_GWConditionsMaps.aprx:GWQ_As_graphWells Map Layout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Well Depth (ft): N/A
Screens (ft bgs): N/A
Arsenic Concentration (µg/L)
0
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1950
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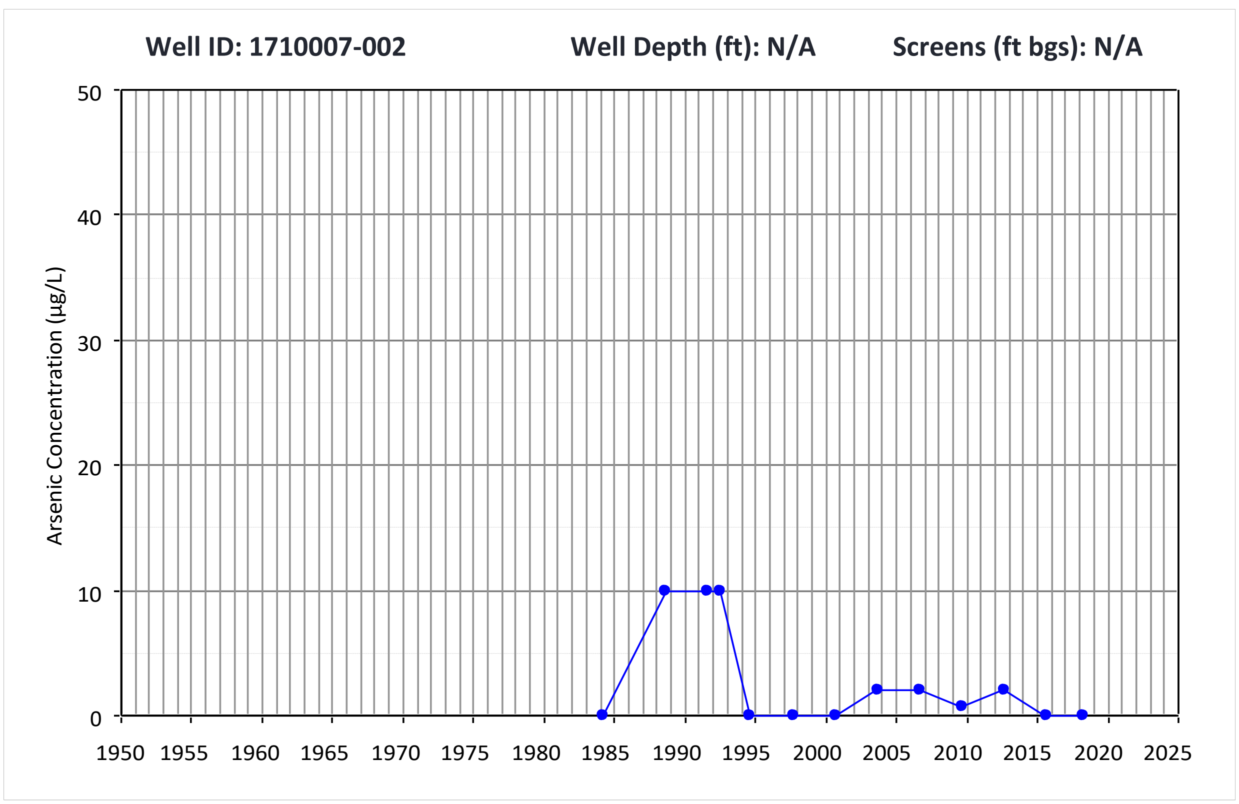
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Screens (ft bgs): N/A
Arsenic Concentration (µg/L)
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10
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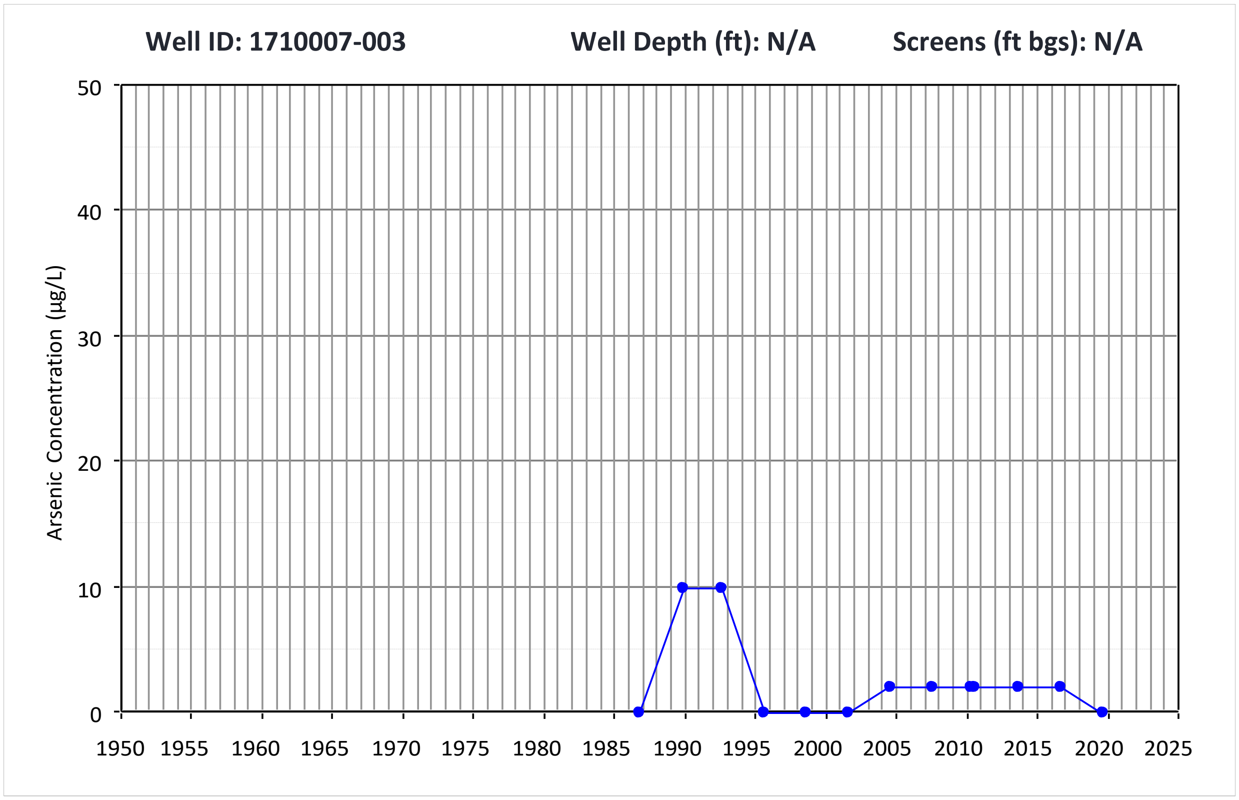
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Well Depth (ft): N/A
Screens (ft bgs): N/A
Arsenic Concentration (µg/L)
0
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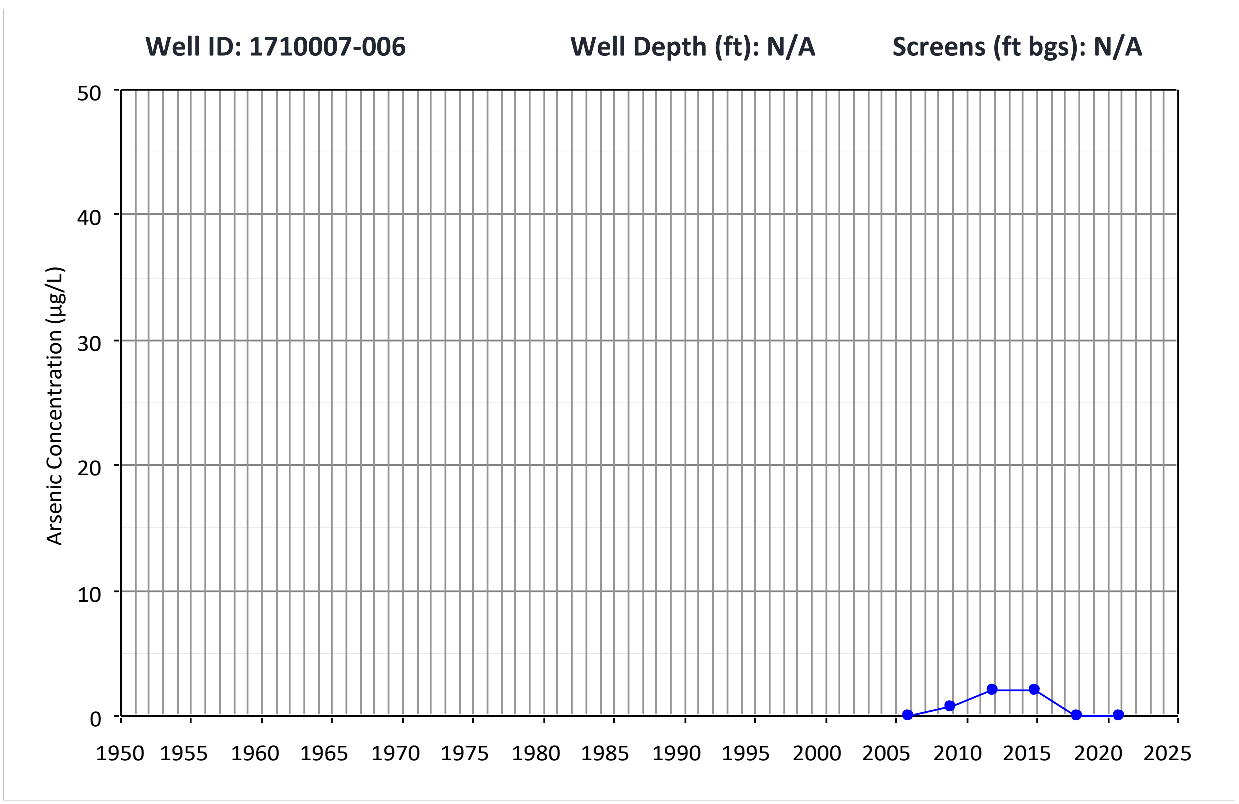
Well ID: 1710007-006
Well Depth (ft): N/A
Screens (ft bgs): N/A
Arsenic Concentration (µg/L)
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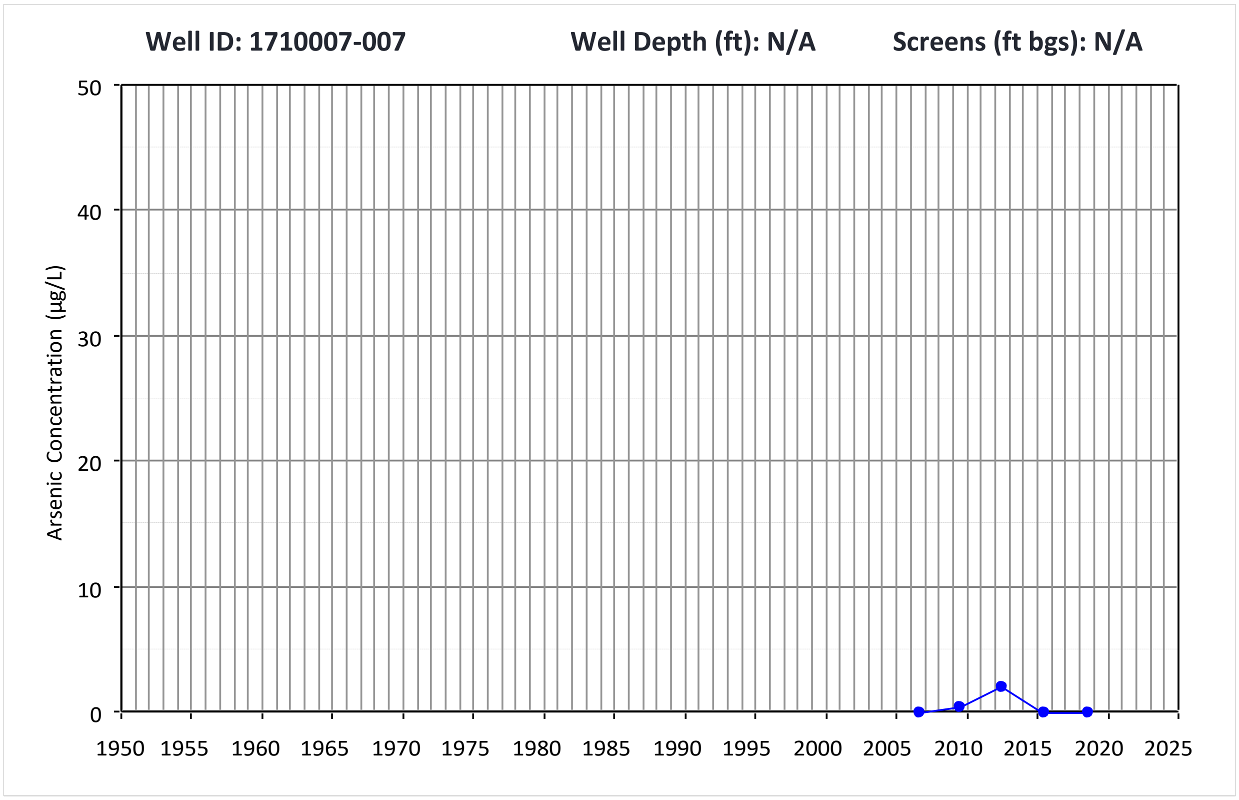
Well ID: 1710007-007
Well Depth (ft): N/A
Screens (ft bgs): N/A
Arsenic Concentration (µg/L)
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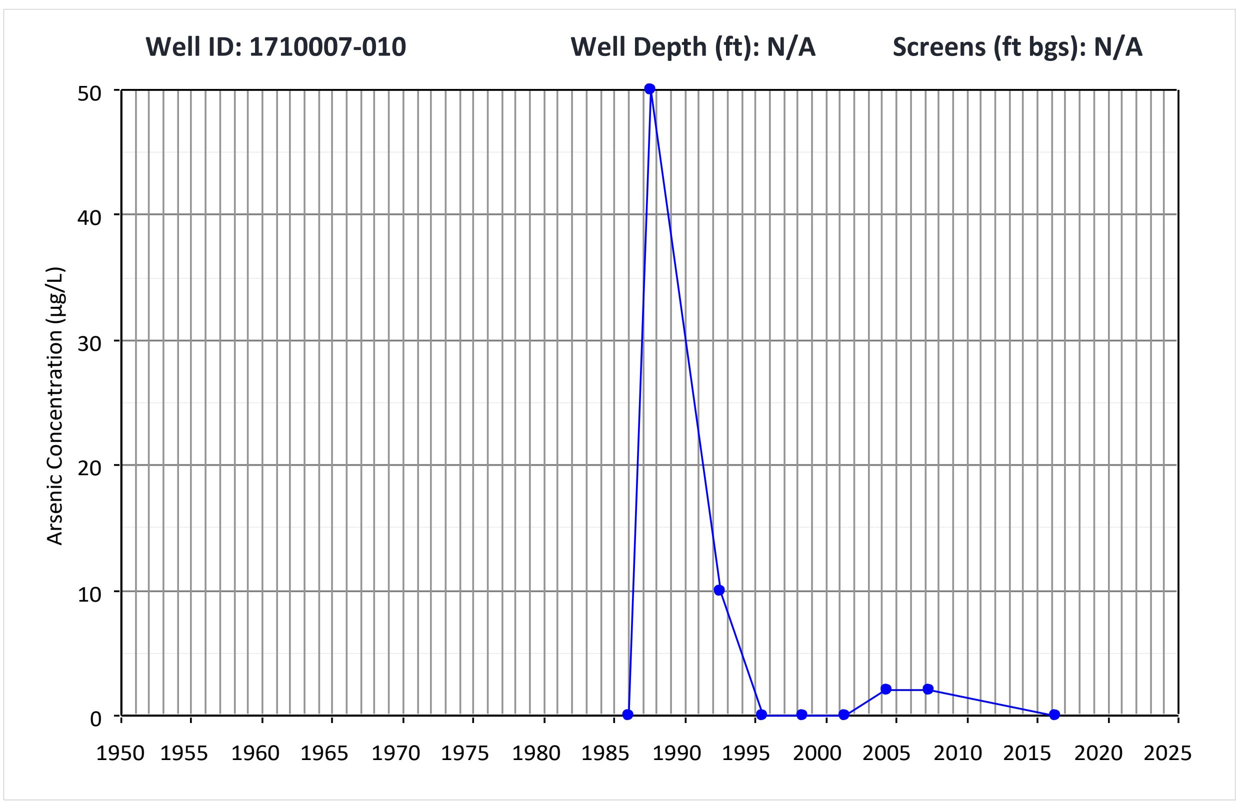
Well ID: 1710007-010
Well Depth (ft): N/A
Screens (ft bgs): N/A
Arsenic Concentration (µg/L)
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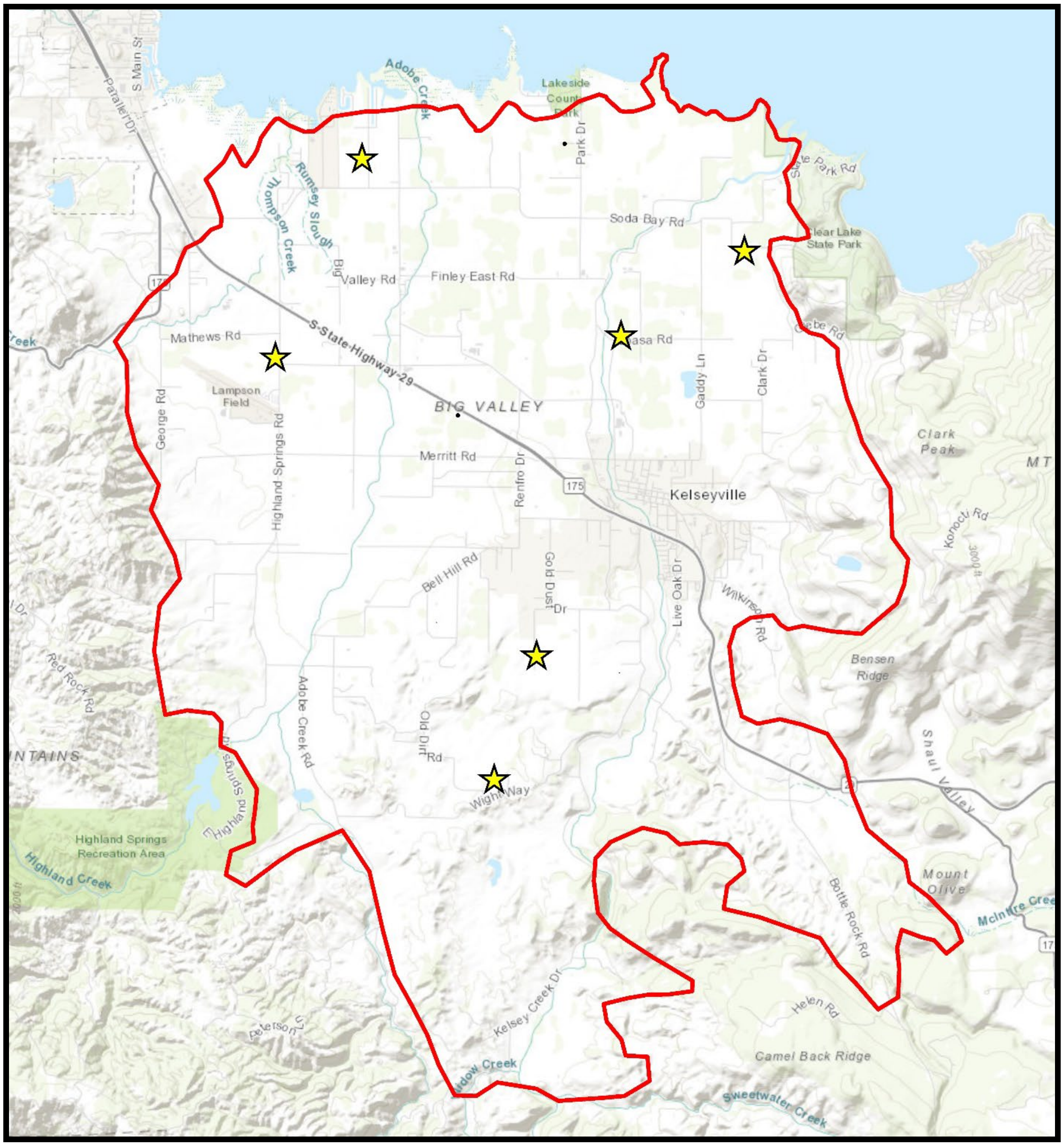
APPENDIX 2B-2

Technical Support Services for Big Valley Basin Groundwater Quality, Lake County, California

STATE OF CALIFORNIA
NATURAL RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
DIVISION OF REGIONAL ASSISTANCE
NORTHERN REGION OFFICE



Technical Support Services for Big Valley Basin Groundwater Quality, Lake County, California.

September 2021

Summary

This report summarizes the results of a Department of Water Resources' (DWR) examination of groundwater quality within the Big Valley groundwater basin in Lake County, California. This study was funded through DWR's Sustainable Groundwater Management Program (SGMP) Technical Support Services. Groundwater samples were collected from six wells in the Big Valley basin and analyzed for minerals, nutrients, and trace elements. Groundwater quality results were evaluated based on contaminant thresholds for drinking water and agricultural water uses. Groundwater quality results showed elevated iron, manganese, specific conductance, and total dissolved solids.

Introduction

The Big Valley Groundwater Sustainability Agency (GSA) requested assistance from DWR's SGMP Technical Support Services (California Department of Water Resources 2021) to collect groundwater quality data in the Big Valley groundwater basin. These data support the development and implementation of the Big Valley Groundwater Sustainability Plan (GSP) to comply with SGMA and achieve sustainable groundwater management by 2042 (Department of Water Resources 2021b).

The goal of this study is to provide technical support services to the GSA by collecting and analyzing groundwater quality samples and presenting the data. Three objectives of this effort are to:

1. Collect and process groundwater quality samples from existing wells in the basin.
2. Apply relevant quality assurance measures and disseminate data using the Water Data Library.
3. Interpret groundwater quality results and identify elevated contaminants based on established thresholds (State Water Resources Control Board 2021).

The Big Valley groundwater basin is underlain by alluvium, terrace and lakebed sediments, volcanic ash deposits, and is known to produce a magnesium bicarbonate groundwater character with naturally occurring salts and minerals; boron has also been shown to be present at concentrations above agricultural limits (Department of Water Resources 2021c). The north side of the basin is open to Clear Lake and the basin shares a northeastern boundary with the Scott Valley Basin and may be hydrologically contiguous. Recharge of the basin is primarily infiltration from creeks, precipitation, applied water, and upland areas like Mt. Konocti (Department of Water Resources 2021c).

Methods

On July 26, 2021, six wells were sampled for groundwater quality. All six wells are part of a groundwater elevation network monitored by the Lake County Watershed Protection District (LCWPD) for the basin's California Statewide Groundwater Elevation Monitoring (CASGEM) Program. Field sampling was coordinated between DWR and LCWPD. A large volume of water must be purged from wells prior to sampling, so sampling efforts were coordinated with well-owner's water needs to minimize water waste.

Water quality samples were collected according to DWR's *Standard Operating Procedure for the Collection of Water Quality Samples for Laboratory Analysis* (California Department of Water Resources 2019). Groundwater samples were collected by direct sampling from an existing well pump at the closest point of distribution from the well. All sampled wells were in use and thus purged.

Standard groundwater quality parameters analyzed by DWR include mineral characters, nutrients, and trace elements (Table 1). Minerals and salts can influence the palatability and irrigation value of water. Nutrients can provide evidence of nutrient leaching from agricultural areas, livestock, or septic systems, and some trace elements and metals can cause health and environmental problems.

The six wells were added to an existing network of groundwater quality monitoring wells in DWR's Water Data Library, an online platform that allows for public access of water quality and other water resources data (California Department of Water Resources 2021d). It also provides a baseline for repeated sampling events, which are necessary to track temporal trends in groundwater quality.

Groundwater quality data were compared to published water quality thresholds for California maximum contaminant levels (MCLs) pursuant to the California Safe Drinking Water Act (U.S. Environmental Protection Agency 1986). This includes California *primary* MCLs that relate to human health concerns, and California *secondary* MCLs that relate to the palatability of water. Other examined thresholds are based on agricultural water quality goals established by the Food and Agriculture Organization of United Nations, which relate to crop irrigation and stock watering.

Results and Conclusion

Several of the six wells sampled in the Big Valley groundwater basin showed elevated iron, manganese, specific conductance, and total dissolved solids (Table 2-4). Analytical results from this study show groundwater quality impairments that are typical for many areas of California: for example, iron and manganese are often naturally high due to the leaching of surrounding rocks and minerals, and specific conductance and total dissolved solids are often associated with salts and minerals that naturally accumulate in a semi-closed groundwater basin, such as the Big Valley basin which receives runoff originating from the upper watersheds of the Coast Ranges.

Regional and basin-specific groundwater studies supported by DWR SGMP Technical Support Services support regional groundwater sustainability planning and management while cultivating partnerships and contributing to statewide groundwater datasets. These new data will help guide groundwater sustainability planning and management in the Big Valley basin under the Sustainable Groundwater Management Act. They also benefit DWR's statewide efforts to evaluate groundwater quality characteristics and trends.

Tables

Table 1 Groundwater Quality Standard Parameter Suite

Water Quality Parameter	Test Method	Units
Minerals		
Alkalinity	2320B	mg/L
Total and dissolved hardness	2340B	mg/L
Total and dissolved calcium	200.7	mg/L
Total and dissolved magnesium	200.7	mg/L
Dissolved sodium	200.7	mg/L
Dissolved potassium	200.7	mg/L
Dissolved sulfate	300.0	mg/L
Dissolved chloride	300.0	mg/L
Dissolved boron	200.7	mg/L
Dissolved carbonate, bicarbonate, and hydroxide	4500	mg/L
Dissolved magnesium	200.7	mg/L
Specific Conductance	2510-B	µS/cm
pH	2320B	pH units
Nutrients		
Total ammonia as nitrogen	350.1	mg/L
Total Kjeldahl nitrogen	351.2	mg/L
Total organic nitrogen		mg/L
Total and dissolved ammonia	350.1	mg/L
Dissolved nitrate	300.0	mg/L
Dissolved nitrate + nitrite	4500-NO3-F	mg/L
Dissolved orthophosphate	365.1	mg/L
Total phosphorus	365.4	mg/L
Total and dissolved organic carbon	415.1 Ox	mg/L
Trace elements and metals		
Total Mercury	245.1	µg/L
Total and dissolved copper	200.8	µg/L
Total and dissolved aluminum	200.8	µg/L
Total and dissolved antimony	200.8	µg/L
Total and dissolved barium	200.8	µg/L
Total and dissolved beryllium	200.8	µg/L
Total and dissolved barium	200.8	µg/L
Total and dissolved cadmium	200.8	µg/L
Total and dissolved chromium	200.8	µg/L
Total and dissolved arsenic	200.8	µg/L
Total and dissolved iron	200.8	µg/L
Total and dissolved lead	200.8	µg/L
Total and dissolved manganese	200.8	µg/L
Total and dissolved nickel	200.8	µg/L
Total and dissolved selenium	200.8	µg/L
Total and dissolved silver	200.8	µg/L
Total and dissolved zinc	200.8	µg/L

Table 2 Analytical Results for Mineral Parameters

Station Name	Total Alkalinity mg/l	Dissolved Hardness mg/l	pH mg/l	Specific Conductance uS/cm	Dissolved Bicarbonate mg/l	Dissolved Carbonate mg/l	Dissolved Calcium mg/l	Dissolved Magnesium mg/l	Dissolved Potassium mg/l	Dissolved Sodium mg/l	Dissolved Chloride mg/l
13N09W07A003M	154.00	107.00	7.30	320.00	153.70	0.29	18.60	14.70	1.61	17.40	5.62
13N09W22M001M	378.00	363.00	7.50	708***	376.86	1.12	20.60	75.60	2.23	13.30	14.10
13N09W28J002M	164.00	136.00	7.60	326.00	163.37	0.61	4.78	30.20	2.64	14.80	5.18
13N09W02H001M	766.00	1275.00	7.40	2090**	764.18	1.81	108.00	244.00	2.71	26.30	107.00
13N09W03R002M	165.00	153.00	7.20	330.00	164.75	0.25	16.60	27.10	1.21	5.75	4.24
14N09W32G002M	460.00	428.00	6.40	837***	459.89	0.11	59.30	67.90	1.83	16.60	10.70

Notes: Results are for six wells sampled within the Big Valley groundwater basin in 2021. Red font designates a parameter concentration above one or more of the examined thresholds published by the State Water Resources Control Board (State Water Resources Control Board 2021). The secondary MCL (**) for specific conductance is 900 µS/cm, and the agricultural limit (***) for this parameter is 700 µS/cm.

Table 3 Analytical Results for Nutrient Parameters

Station Name	Dissolved Nitrate + Nitrite mg/l	Total Phosphorus mg/l	Total Dissolved Solids mg/l	Dissolved Sulfate mg/l	Dissolved ortho-Phosphate mg/l
13N09W07A003M	0.03	0.97	201	2.52	0.76
13N09W22M001M	0.03	0.50	413	4.33	0.48
13N09W28J002M	0.23	0.18	203	2.48	0.24
13N09W02H001M	0.03	0.10	1535**	440.00	0.07
13N09W03R002M	0.90	0.02	187	6.48	0.03
14N09W32G002M	0.03	0.36	480***	4.30	0.27

Notes: Results are for six wells sampled within the Big Valley groundwater basin in 2021. Red font designates a parameter concentration above one or more of the examined thresholds published by the State Water Resources Control Board (State Water Resources Control Board 2021). The secondary MCL (**) for total dissolved solids is 500 mg/l, and the agricultural limit (***) for this parameter is 450 mg/l.

Table 4 Analytical Results for Trace Elements and Metals

Station Name	Total Mercury ug/l	Total Aluminum ug/l	Total Arsenic ug/l	Total Cadmium ug/l	Total Chromium ug/l	Dissolved Boron mg/l	Total Copper ug/l	Total Iron ug/l	Total Lead ug/l	Total Manganese ug/l	Total Nickel ug/l	Total Selenium ug/l	Total Silver ug/l	Total Zinc ug/l
13N09W07A003M	0.01	5.00	2.35	0.50	0.50	0.25	0.50	1480**	0.50	133**	0.50	0.50	0.50	0.25
13N09W22M001M	0.01	5.00	0.50	0.50	0.50	0.05	7.23	1120**	0.50	212**	0.50	0.50	0.50	0.25
13N09W28J002M	0.01	5.00	7.89	0.50	5.13	0.05	2.23	8.52	0.50	0.25	1.14	1.89	0.50	0.25
13N09W02H001M	0.01	114.00	3.85	0.50	1.06	0.14	4.27	728**	0.50	3410**	5.77	1.07	0.50	28.00
13N09W03R002M	0.01	27.60	0.50	0.50	2.78	0.05	2.87	41.20	0.50	0.25	3.46	0.50	0.50	0.25
14N09W32G002M	0.01	5.00	3.40	0.50	0.50	0.27	1.38	4630**	0.50	229**	1.67	0.50	0.50	0.25

Notes: Results are for six wells sampled within the Big Valley groundwater basin in 2021. Red font designates a parameter concentration above one or more of the examined thresholds published by the State Water Resources Control Board (State Water Resources Control Board 2021). The secondary MCL (**) for iron is 300 mg/l and the secondary MCL for manganese is 50 mg/l.

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TECHNICAL MEMORANDUM BIG VALLEY INTEGRATED HYDROLOGIC MODEL

PREPARED FOR

LAKE COUNTY WATERSHED PROTECTION DISTRICT

PREPARED BY

Luhdorff & Scalmanini Consulting Engineers

TABLE OF CONTENTS

LIST OF TABLES

The following tables can be found at the end of each section.

LIST OF FIGURES

The following figures can be found at the end of each section.

APPENDICES

LIST OF ACRONYMS AND ABBREVIATIONS

Acronym	Meaning	Acronym	Meaning
BAS	MODFLOW Basic Package	KCK	Kelsey Creek
Basin	Big Valley Groundwater Basin	Kh	Horizontal Hydraulic Conductivity
BCM	Basin Characterization Model	Kv	Vertical Hydraulic Conductivity
BST	Consolidated Basement zone	LiDAR	Light Detection and Ranging
BVIHM	Big Valley Integrated Hydrologic Model	MAE	mean of absolute residual error
CERFACS	Centre Europeen de Reserches et de Formation Avancee en Calcul Scientifique	MBR	Mountain Block Recharge
CIR	Crop Irrigation Requirement	ME	Mean of Residual Error
CNRM	CNRM-CM5–RCP45 Model	MNW2	Multi-Node Well
CSS	Composite Scaled Sensitivity	NOAA	National Oceanic Atmospheric Administration

CU	Consumptive Water Use	NRMSE	normalized root mean squared error
DEM	Digital Elevation Model	NWT	Newton
DEW	Dry with Extreme Warming	OC	Output Control
DIS	MODFLOW Discretization Package	One-Water	One Water Hydrologic Flow Model Version 2.1
DRN	MODFLOW Drain Package	POD	points of diversion
DRT	MODFLOW Drain Return Package	PWS	Public Water Systems
DWR	California Department of Water Resources	Qa	Quaternary Alluvial zone
EAR	Electronic Annual Reporting	R^2	coefficient of determination
ET	Evapotranspiration	RMSE	root mean of squared residual error
ETo	Reference Evapotranspiration	SCS	Scotts Creeks
eWRIMS	electronic Water Rights Information Management System	SFR	Streamflow Routing
FEI	Fraction of Evaporation from Irrigation	SRD	semi-routed delivery
FMP	MODFLOW Farm Process	SRM	Society for Range Management
FTR	fraction of transpiration	Ss	specific storage
GAMA	Groundwater Ambient Monitoring and Assessment Program	SWRCB	California State Water Resources Control Board
GCM	global circulation models	Sy	specific yield
GHB	General-Head Boundary	UPW	Upstream Weighting
GSA	Groundwater Sustainability Agency	UQa	Upland Quaternary Alluvial zone

GSP	Groundwater Sustainability Plan	WBS	Water Balance Subregion
HadGEM	HadGEM2-ES-RCP85 Model	WEL	MODFLOW Well Package
HFB	Horizontal Flow Barrier	WMW	Wet and Moderate Warming
Kc	Crop Coefficient		

1. INTRODUCTION

This technical memorandum for the Big Valley Groundwater Basin (Basin) summarizes the development and calibration of the Big Valley Integrated Hydrologic Model (BVIHM) developed for the Big Valley Groundwater Sustainability Agency (GSA) to support development of a Groundwater Sustainability Plan (GSP) for the Basin. This technical memorandum includes a summary of model development, calibration and numerical model results including hydrologic analysis of the historic water budget period and current water budget year.

1.1. Background

BVIHM was developed to simulate surface and near-surface farm-related processes and groundwater movement in the Big Valley Groundwater Basin. The development of a calibrated model is intended to support water resources management and GSP development and implementation for the Basin. The model utilizes data and information described in the hydrogeologic conceptualization provided in **Section 2.2.1** of the GSP. BVIHM has been developed to be used as a platform to evaluate historic hydrologic conditions and develop predictive modeling scenarios aimed at evaluating the impact of future management actions, projects, and adaptive management strategies used to reach sustainability objectives in the Basin as part of GSP implementation.

1.2. Objectives and Approach

Integrated hydrologic models are structured tools developed to represent the physical basin setting and simulate groundwater flow and landscape hydrologic processes through integration a multitude of data (e.g., lithology, groundwater levels, surface water features, land use, groundwater pumping, etc.) that compose the conceptualization of the natural geologic and hydrogeologic environment. BVIHM was developed in accordance with the best management practices developed by the California Department of Water Resources (DWR) (DWR, 2016). The objective of the calibrated model documented in this technical memorandum is to simulate historical hydrologic conditions in the Basin including groundwater levels, groundwater storage, streamflow, and stream-aquifer interaction. Results from the model are used to inform the analysis of SGMA sustainability and provide technical support for preparation of the GSP.

The BVIHM was developed using the United States Geological Survey's (USGS) One-Water Hydrologic Flow Model Version 2.1 (One-Water) numerical modeling platform coupled with inputs from the latest version of the Basin Characterization Model (BCM) (Boyce et al., 2020; Flint and Flint, 2021). The One-Water platform was selected due to its robust capability in simulating and integrating landscape hydrology and groundwater flow processes, landscape supply and demand, and groundwater surface-water interaction. The model was calibrated to a diverse set of available historical data using industry standard techniques including trial and error and automated parameter estimation. Model sensitivity was evaluated using a mathematically and statistically robust approach provided in the PEST platform (Doherty, 2018).

1.3. Technical Memorandum Organization

This technical memorandum is organized into the following sections:

- **Section 2**: Model Codes
- **Section 3**: Model Development
- **Section 4**: Model Results
- **Section 5**: Model Projections
- **Section 6**: Model Limitations and Recommendations
- **Section 7**: References

2. MODEL PLATFORM

The model platforms selected and utilized during development of the BVIHM are described below. The selected model codes are in the public domain and suitable for GSP purposes. The decision to select the model code for the Big Valley Basin model was based on providing the Lake County GSA with a modeling tool that can be used for multiple purposes, including GSP development as well as other regulatory programs. With these objectives in mind, the codes described below were determined to be most suitable.

2.1. Basin Characterization Model

Developed by the USGS, the BCM is a one-dimensional regional watershed model that simulates recharge and runoff, provides estimates of reference evapotranspiration (ET) and precipitation, and allows pairing with global climate models to produce locally downscaled climate projections. The BCM simulates hydrologic responses to climate at monthly timesteps at the spatial resolution of a 270-meter grid (Flint et al., 2013). The BCM has been calibrated to streamflow gages and reconstructed unimpaired flows for 159 basins in California.

2.2. MODFLOW One-Water Hydrologic Model Version 2.0

The One-Water is an integrated hydrologic flow modeling software developed by the USGS to evaluate groundwater-surface water interaction and conjunctive use (Boyce et al., 2020). One-Water integrates various processes and packages to enable the robust and dynamic simulation of landscape supply and demand, groundwater surface water interaction, and groundwater flow. One-Water is based largely on the Farm Process (FMP) developed under the MODFLOW-2005 platform (Schmidt, 2004; Harbaugh, 2005). Similar to previous versions of MODFLOW, One-Water is a three-dimensional, finite difference modeling code which utilizes the concept of modularization to represent various aspects of the hydrologic system (McDonald and Harbaugh, 1988). Modularization is represented by individual model code packages that simulate different hydrologic processes that occur in groundwater basins.

2.2.1. Model Packages

The components of the model (model packages) utilized in the model of the Basin are described below.

Basic Package: The MODFLOW Basic (BAS) package specifies the location of active and inactive model cells and initial heads used at the start of the simulation.

Discretization Package: The MODFLOW Discretization (DIS) package specifies the spatial and temporal model geometry. The spatial discretization includes the row and column spacing and model cell top and bottom elevations. The temporal discretization includes the number and length of model stress periods and timesteps. A MODFLOW stress period is a length of time where specified model stresses are constant. A stress period may be broken up into one or more timesteps for which flow equations for groundwater, landscape and surface water are collectively solved.

Output Control Package: The Output Control (OC) package specifies the printing of simulated groundwater heads and volumetric budget.

Newton Solver: The Newton (NWT) solver is a method for solving the system of equations used to approximate the groundwater flow equation through finite differences. The NWT solver provides a robust method for solving nonlinear problems which include unconfined groundwater flow and cell drying and rewetting.

Upstream Weighting Package: The Upstream Weighting (UPW) package specifies the hydraulic aquifer-layer properties within all active model cells. These include the horizontal hydraulic conductivity, vertical hydraulic conductivity, specific yield, and specific storage.

Well Package: The Well (WEL) package is used to simulate specified flows assigned to model cells used in BVIHM to represent groundwater pumping as a groundwater outflow and mountain block recharge as a groundwater inflow.

Multi-Node Well Package: The Multi-Node Well (MNW2) package is a head dependent flux boundary condition used to simulate pumping from wells which penetrate multiple model cells vertically. The MNW2 package also includes options to correct for the hydraulic head inside of a well.

General-Head Boundary Package: The General-Head Boundary (GHB) package is a head dependent flow boundary condition used in BVIHM to simulate lateral subsurface flow into and out of the model domain from Clear Lake.

Streamflow Routing Package: The Streamflow Routing (SFR) package is used to simulate streams and groundwater-surface water interaction in the model. This includes inflows from tributary watersheds, runoff from the landscape and direct diversions from the stream network.

Horizontal Flow Barrier Package: The Horizontal Flow Barrier (HFB) package is used to simulate faults within the model domain by reducing the conductance between cells as horizontal barriers that reduce lateral groundwater flow.

2.2.2. Farm Process

The MODFLOW Farm Process (FMP) was developed for MODFLOW to dynamically simulate water supply and demand components in the landscapes (Schmidt, 2004; Boyce et al., 2020). These include plant water demand, evapotranspiration, precipitation, surface water delivery, diversions, groundwater pumping, direct groundwater uptake by plants and deep percolation to the water table from applied irrigation and precipitation (**Figure 2-1**). One of the primary advantages of FMP is that irrigation demand and water supply are dynamically coupled to the groundwater and surface water system such that root water uptake and groundwater pumping vary depending on the water table elevation providing a robust link between these systems.

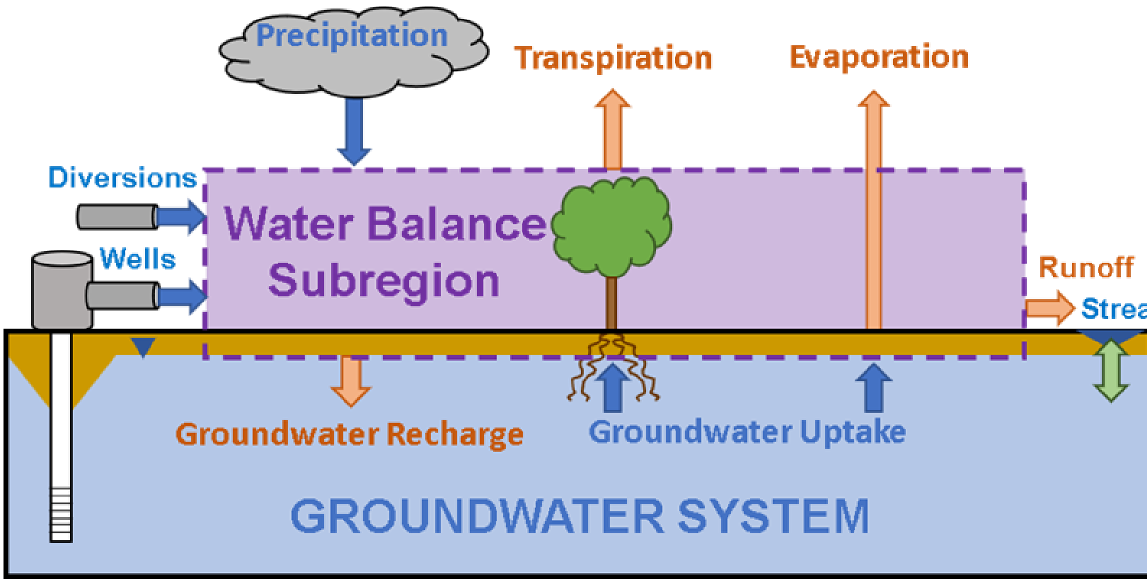

Figure 2-1. Conceptualization of FMP Water Supply and Demand Components

In a strict sense, FMP is a "demand-driven and supply constrained model structure", where the model estimates the surface water deliveries and groundwater pumping required to meet irrigation demand for a given water balance subregion (WBS) within the model domain (Hanson et al., 2014; Boyce et al., 2020). The irrigation demand, or total WBS (farm) delivery requirement (TFDR), is a function of the crop irrigation requirement (CIR) and on-farm irrigation efficiency (OFE):

$$TFDR = \sum_{WBS} (CIR/OFE)$$

with

$$CIR = T_i + E_i$$

Where:

CIR is the crop irrigation requirement
T_i is the transpiration supplied by irrigation ($T_i = T_{c\text{-}act} - T_{gw\text{-}act} - T_{p\text{-}act}$)
$T_{c\text{-}act}$ is the crop transpiration requirement
$T_{gw\text{-}act}$ is the portion of transpiration supplied by groundwater at steady-state
$T_{p\text{-}act}$ is the portion of transpiration supplied by precipitation at steady-state

E_i is the evaporation loss from irrigation
OFE is the on-farm efficiency, defined as the fraction of beneficially applied irrigation water to the field (specified)

In simplified terms, the water demand for a given WBS (composed of evaporation and transpiration) is first met by uptake from groundwater (in instances where the crop roots intersect the water table), precipitation, and surface water supplies including imports and diversions. If the crop water demand exceeds this supply, water demand will be met by groundwater pumped from wells. The FMP prioritizes irrigation supply to utilize available surface water deliveries for a given farm first and any additional demand (if necessary) is through groundwater pumping.

2.3. PEST

Parameter estimation was conducted using PEST (Doherty, 2018). PEST is a parameter estimation code that calculates model parameters which minimize the model error (or difference between observed data and simulated values). This is achieved using modified Gauss-Newton iteration (Marquardt-Levenberg method) which minimizes the least-squares objective function value (Φ) for a potentially wide variety of observations. Observations can include groundwater levels as well as surface-water flows and other related higher-order observations.

As part of the parameter estimation process, the sensitivity of the simulated values is calculated (Doherty, 2018). The sensitivity of all (or groups of) simulated parameters are summarized by the "composite scaled sensitivity" (*CSS*) statistic (modified from Hill and Tiedman, 2007):

$$CSS_j = \left[\frac{\sum_{1=1}^{ND} \left(\frac{\partial y_i}{\partial b_j} \, b_j {w_i}^{1/2} \right)^2}{ND} \right]^{1/2}$$

Where: y_i is the ith simulated observation value
b_j is the jth estimated parameter value
w_i is the weight of the ith observation (1/σ of measurement error)
ND is the number of simulated observations

The CSS is used to determine which parameters affect simulated model equivalents (such as water levels or surface water observations) the most. This approach provides a statistically robust approach to model sensitivity analysis.

3. MODEL DEVELOPMENT

This section describes the spatial and temporal structure of the model and the input data that were utilized for model development. The model development process utilized data and information that were available at the time of model development. The development of the model relied heavily on data and conceptualization of the hydrogeologic system described in the **Section 2.2.1** of the GSP.

3.1. Discretization

Model discretization is a term used to describe spatial and temporal resolution of the model. This includes spatial components such as the model extent, model layering and cell size, as well as the division of time for which flow equations are solved. The discretization of the model was selected to provide sufficient detail and resolution needed to appropriately capture hydrologic conditions Basin while considering the computational time required for each model simulation. Interpretation of results from the model must consider the scale of model discretization and associated simulated processes and conditions and should not be used at resolutions to the scale of a parcel or specific well. For those purposes, a more local, site-specific subregional model would be recommended.

3.1.1. Spatial Discretization and Model Layering

The groundwater model domain (extent) includes an approximately 125 square mile rectangular portion of Lake County encompassing both the Big Valley and Scotts Valley Basins (**Figure 3-1**). The model domain is a finite difference grid consisting of 168 rows and 83 columns oriented 25 degrees west of due north. The model has a uniform horizontal discretization of 500 ft by 500 ft cells, resulting in a cell area of 250,000 square feet (5.74 acres). The active model area totals 72 square miles (~46,000 acres) and includes an approximately half mile buffer of the upland watershed surrounding the Big Valley and Scotts Valley Basins.

The model was discretized vertically into seven layers of spatially varying thickness. The top of layer 1 represents the land surface elevation determined using Light Detection and Ranging (LiDAR) data developed by the National Oceanic Atmospheric Administration (NOAA) for Lake County (NOAA, 2016; **Figure 3-2**). The bottom of layer 1 was assigned such that the thickness of layer 1 below stream nodes was thin enough to adequately simulate groundwater-surface water interaction. Along the valley margins where topography is more variable and streambed gradients are steeper, layer 1 thickness was increased to limit the occurrence of drying and rewetting of model layers, which can cause issues in achieving model convergence. Layer 2 was assigned a fixed thickness of 25 feet. The elevation of layer bottoms below layer 2 were assigned such that layers have relatively equal thickness. Layer thicknesses increase with depth geometrically such that a given layer is between approximately 1.6 and 2.5 times thicker than the layer above it with the total model thickness of the active model is a minimum of 700 feet (**Figure 3-3**). Layer elevations were progressively smoothed with depth using a moving average across rows and columns.

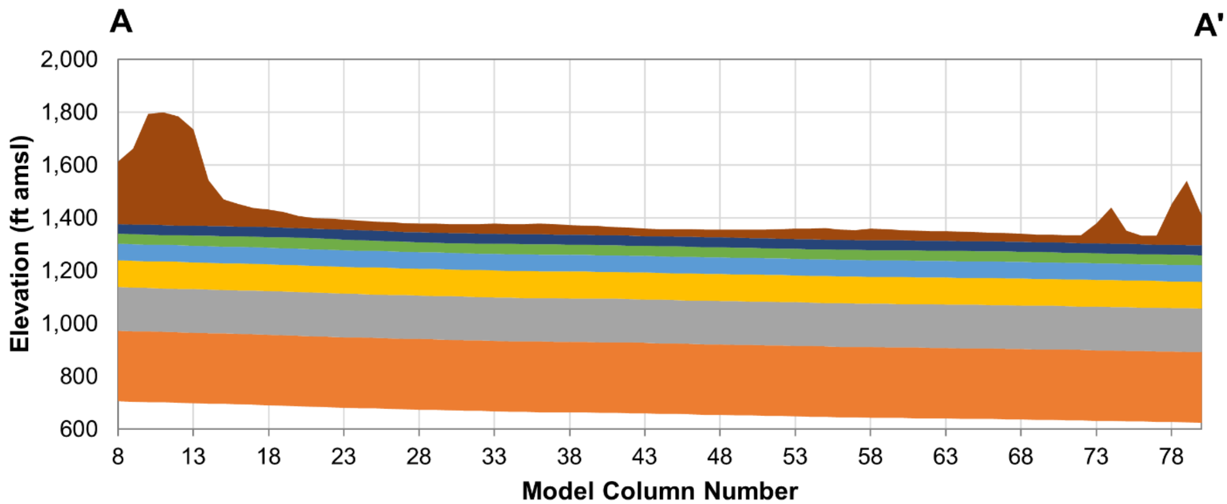

Figure 3-3. BVIHM Model Layering through A – A'

3.1.2. Temporal Discretization

The total time period simulated using the numerical model starts in April 1984 through September 2019. The period from October 1987 through September 2019 (WY 1988-2019) was selected to evaluate water budgets. This period was selected because it represents long-term annual average hydrologic conditions when evaluating the frequency of hydrologic water year types and cumulative departure of mean precipitation in the Big Valley Basin. The period from April 1984 through September 1987 was used as a spin-up period used to allow the model to equilibrate prior to evaluating simulated water budgets. The simulation period is divided into 426 monthly stress periods subdivided equally into two (roughly biweekly) model timesteps for which hydraulic head and model flows are calculated. The simulation period is transient in which water budget components and boundary conditions vary on a monthly basis. During each stress period model stresses (such as precipitation, reference evapotranspiration (ETo), general head boundaries, crop coefficients) are held constant.

3.2. Boundary Conditions

3.2.1. No Flow Boundary Conditions

No-flow boundaries were used to define the bottom and landward lateral boundaries of the active model area except for Clear Lake which was defined using a General Head Boundary described in the following section (**Figure 3-1**). No flow boundaries were placed approximately one half of a mile outside the Bulletin 118 Basin boundaries beyond which there is little to no groundwater development. This provides a buffer which enables the model to better capture hydrologic conditions and interaction occurring near the Basin boundary.

3.2.2. General Head Boundary Conditions

Lateral subsurface flow into and out of the model domain from Clear Lake was simulated using the General Head Boundary (GHB) package (Harbaugh et. al, 2000, **Figure 3-4**). In the general head boundary, a groundwater elevation is specified at an external reference or "ghost" cell outside of the model domain where the water level (or boundary head) is known or extrapolated from known data. The groundwater flow into or out of the domain from the GHB is calculated from the difference in groundwater elevations between the ghost cell and model cell with a conductance value assigned between them. Flow (Q) between a GHB cell and a model cell is a product of the hydraulic head difference between the boundary head and the model cell and conductance $\left(\frac{kA}{L}\right)$ between them given by:

$$Q = (h_{cell} - h_{ghb})\frac{kA}{L}$$ **Equation 3-1**

where: k is the hydraulic conductivity
A is the cell area
L is the distance from the model cell to the GHB
h_{cell} is the hydraulic head in the model cell
h_{ghb} is the hydraulic head in the GHB

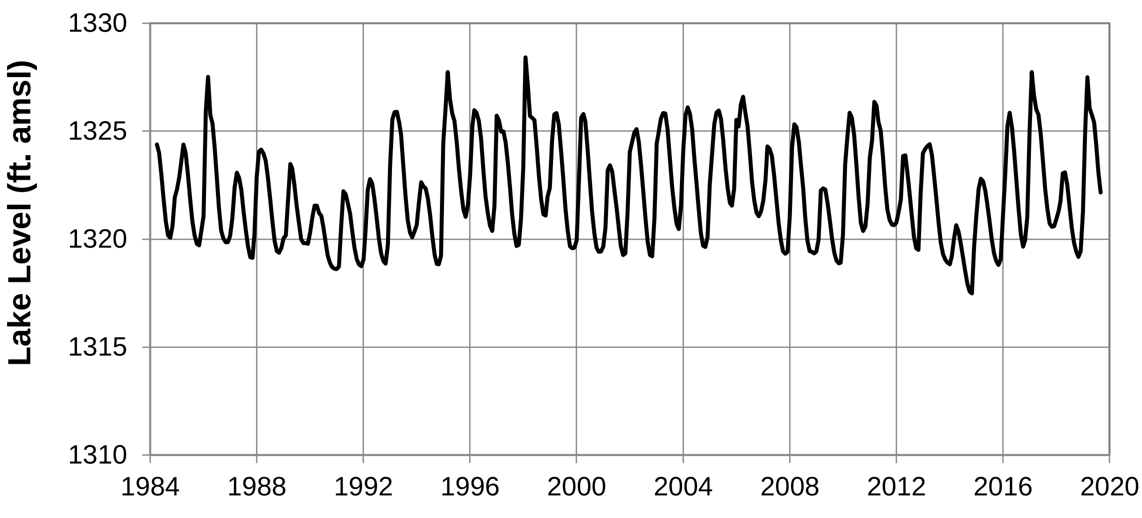

Figure 3-5. Monthly Lake Level at the USGS Gage in Clear Lake at Lakeport

Monthly water levels assigned to the GHB were derived from daily lake levels at the USGS gage in Clear Lake at Lakeport (11450000) (**Figure 3-5**). Conductance in GHB cells was assigned based on the hydraulic conductivity in each model cell along the GHB boundary. Hydraulic conductivity and cell thickness are updated internally in MODFLOW-OWHM based on the cell thickness and hydraulic conductivity specified in model cells where a GHB is assigned.

3.2.3. Groundwater-Surface Water Interaction

Surface water features were simulated using the Streamflow Routing (SFR) package (Prudic et al., 2004). The SFR package simulates the routing of surface water throughout the active model domain using an interconnected network of stream segments, which in-turn are subdivided into stream reaches. The relationship between stream flow and stream depth (i.e., stage) is calculated based on Manning's equation relating channel characteristics (e.g., roughness, gradient, geometry) and flow conditions using a fixed stream width and rectangular channel geometry. Flow (Q) between the stream and a model cell is calculated based on the difference between the hydraulic head in the stream compared to the head in the model cell and the conductance $\left(\frac{kA}{L}\right)$ between them using a modified version of Equation 3-1 given by:

$$Q = (h_{cell} - h_{stream})\frac{kA}{L}$$ **Equation 3-2**

where: k is the hydraulic conductivity of the streambed
A is the streambed area overlying a model cell
L is the streambed thickness
h_{cell} is the hydraulic head in the model cell
h_{stream} is the hydraulic head in the stream

The network of streams, tributaries and sloughs included in BVIHM was delineated based on stream flowlines mapped in the High-Resolution National Hydrography Dataset (Moore et al., 2019). These include Kelsey Creek, Adobe Creek, Cole Creek, Scotts Creek and significant tributaries and sloughs (USFWS, 2019). The resulting surface water features were then modified to more closely align with a flow accumulation surface raster calculated using high-precision LIDAR data (NOAA, 2016). In addition, small "virtual" stream segments were added to represent in-stream diversions from major creeks. The final stream network contains 115 segments (1,635 reaches) including 31 headwater tributary reaches and ten points of diversion (**Figure 3-6**).

3.2.3.1. Stream Geometry and Properties

Streambed elevation was assigned in each stream reach within the active model domain. The primary source used to define streambed elevation is airborne LIDAR dataset (NOAA, 2016). Streambed conductance is a function of the streambed thickness, width, and vertical hydraulic conductivity of the streambed. A streambed thickness of two feet was assumed for all SFR reaches. Streambed width is not measured and was estimated using a combination of the high-resolution LIDAR dataset and areal imagery and specified for each SFR segment (group of SFR model cells called reaches). Hydraulic conductivity is also unknown and was treated as a calibration parameter. Parameterization of streambed K was developed based on the stream type (river, tributary, slough, diversion) and location. Manning's roughness coefficient was estimated from reported literature values based on channel type (Chow, 1959).

3.2.3.2. Tributary Inflows

Inflows to each unimpaired tributary stream were specified for each simulation month of the simulation period based on discharge calculations from simulated output from the BCM Version 8 for California (Flint et al., 2021). Simulated monthly recharge and runoff were summed from each 270-meter cell within the contributing watershed to each tributary stream (**Figure 3-6**). Stream discharge in each tributary was computed using locally calibrated parameters using post-processing equations described in Flint et al. (2021). A comparison of monthly inflows in Adobe Creek near the model boundary and synthetic flows independently estimated by FlowWest in 2020 produce a coefficient of determination (R^2) of 0.93 and are shown in **Figure 3-7** (FlowWest, 2020)**.**

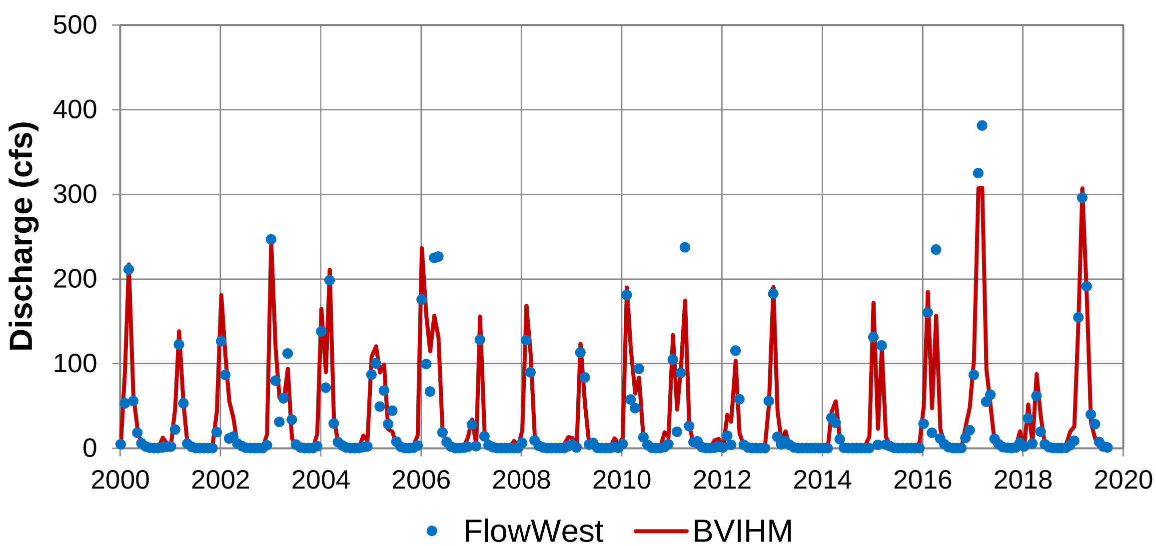

Figure 3-7. BVIHM and FlowWest (Synthetic) Monthly Stream Discharge in Adobe Creek Below Highland Creek Confluence

3.2.4. Mountain Block Recharge

Lateral subsurface inflow, referred to as mountain block recharge (MBR), occurs along the boundary of the Big Valley and Scotts Valley Basins from the upper watersheds (**Figure 3-4**). MBR is a time-varying flow calculated from the BCM for each sub-watershed entering the BVIHM domain. Monthly recharge for each upper watershed catchment area were applied as horizontal inflow into the active model. MBR was simulated as a specified flow boundary using the Well

(WEL) package, represented as a fraction of BCM recharge at assigned grid cells adjacent to the inflow points of the active model domain for layers 1, 2 and 3.

3.3. Landscape Processes (FMP)

The MODFLOW Farm Process (FMP) was utilized in the model to simulate landscape water supply and demand and dynamically calculate agricultural water budgets including groundwater pumping, surface-water deliveries, consumptive use of native vegetation and agriculture across the landscape, groundwater recharge and runoff as described in **Section 2.2.2** (Boyce et al., 2020). A description of the components of the FMP are described below.

3.3.1. Water Balance Subregions

The active portion of the model domain was divided into 25 areas designated as WBS for which landscape supply and demand are calculated **(Figure 3-8**). WBS were delineated based on areas of common hydrogeologic characteristics, land use and water supply sources. A key distinction in WBS delineation is areas served by municipal supply versus agricultural and rural residential areas which are predominantly self-supplied. To accurately calculating water budgets, delineation of WBS also conforms to the Big Valley and Scotts Valley Bulletin 118 Basin boundaries.

3.3.2. Climate Data

Monthly precipitation was specified at each model cell. Precipitation fluxes used in the model were derived from monthly datasets included in the BCM, which utilize spatially distributed models of precipitation developed by the PRISM Climate Group at a 270-meter scale (Flint et al., 2021; http://prism.oregonstate.edu/). Precipitation data were downscaled through interpolation to assign precipitation in each model cell (**Figure 3-9**). A timeseries of specified precipitation at Kesleyville is shown in **Figure 3-10**.

Monthly potential evapotranspiration (PET) fluxes were specified at each model cell based on datasets provided in the BCM. Monthly PET estimates in the BCM are calculated using the Priestly-Taylor equation based on values provided by the PRISM Climate on a 270-meter scale (Flint et al., 2021; http://prism.oregonstate.edu/). PET data were downscaled through interpolation to assign fluxes at each model cell (**Figure 3-11**). A timeseries of specified PET at Kesleyville is shown in **Figure 3-10**.

3.3.3. Land Use

Land use type was specified in each model cell for each year of the model simulation period. Land use characteristics factor into the estimates of consumptive use for irrigated and non-irrigated landscapes generated in FMP. The irrigated and non-irrigated landscape types include irrigated agricultural areas, fallowed lands, semiagricultural areas, native vegetation, as well as urban areas and water bodies. Land use data were derived from a combination of DWR Land Use

Surveys, statewide land use surveys and mapping of vegetation available from the U.S. Dept. of Agriculture (USDA, 2020).

3.3.3.1. Land Use Data

DWR performs detailed land use surveys on an irregular basis, every 5 to 10 years approximately, at both the county and state level. Lake County surveys were conducted by DWR in 1995, 2001 and 2013 (DWR, 1995; DWR, 2001; DWR, 2013). County surveys provide the type and distribution of land use generally down to the parcel scale. Surveys typically provide a detailed differentiation of crop and urban land use classes with more broad interpretation of native land classes (e.g., native, native riparian, barren).

Beginning in 2016, DWR began coordinating with LandIQ to develop statewide coverages of agricultural lands which were prepared for 2016 and 2018. These data generally include detailed assessment and refinement of agricultural lands down to the parcel or field scale but lack information regarding native and urban land use classes, which cover a substantial portion of the model domain.

The USDA maintains a database which provides a mid-level resolution of various spatial datasets of native vegetation types. Based on review of these datasets, the Society for Range Management (SRM) Rangeland Cover Types offers a refined dataset of native vegetation types within the active model domain which is well suited to the GSP modeling goals.

3.3.3.2. Land Use Processing

The various land use datasets described above were used to develop composite land use coverages for 2001, 2013 and 2018 encompassing the active model domain. Review of the DWR county survey for Lake County from 1995 was shown to be of generally poor quality and was excluded from further data analysis. The 2018 dataset was processed by LandIQ to provide a continuous coverage of agricultural, native and urban lands. Land use data from 2001, 2013 and 2018 were then merged with the SRM spatial data to provide greater mapping precision within native land use classes. The raw land use classes from the various sources were grouped based on type to provide a more simplified set of land use classes for numerical model development. Land use types which represent a small fraction of the total land use in the Basin were grouped based on the similarity of crops characteristics. These in turn were upscaled to the model cell scale based on the dominant land use class within each cell. A summary of land use classes and acreages for each land use class used in the model are shown in **Table 3-1**. The distribution of land use classes specified in BVIHM are shown for 2001 and 2018 in **Figure 3-12** and **Figure 3-13**.

Table 3-1. Total Area of BVIHM Land Use Classes

Land Use	Type	Crop ID	Area (acres)		
			2001	2013	2018
Grassland	Native	1	1,439	1,541	1,660
Native Riparian	Native	2	128	116	114
Chamise	Native	3	633	637	648
Forest	Native	4	2,070	2,091	2,128
Scrub Oak	Native	5	1,146	1,146	1,154
Water	Native	6	41	66	63
Grapes	Crop	7	662	701	768
Walnuts	Crop	8	500	484	398
Pears	Crop	9	546	394	344
Grain	Crop	10	32	276	76
Fallow	Crop	11	339	14	158
Farmstead	Urban	12	160	169	135
Paved	Urban	13	2	44	44
Urban	Urban	14	122	77	60
Residential	Urban	15	188	212	214
Landscape	Urban	16	9	24	25
Vacant	Urban	17	9	34	37

3.3.3.3. Crop Parameters

Crop coefficients (Kc) are used in the FMP to calculate the consumptive water use (CU) for each crop for each model stress period as a function of Potential Evapotranspiration (PET) described in **Section 3.3.3** (**Table 3-2**):

$$CU = K_c \times PET \quad \textbf{Equation 3-3}$$

Consumptive use represents actual transpiratory and evaporative ET and is a fundamental driver of water use and movement within the FMP which is used to calculate water budget components such as irrigation demand, groundwater pumping, deep percolation, and direct uptake of water. Monthly Kc estimates for each crop type included in BVIHM were derived from values provided in other regional models developed for California and the north coast including the BCM used for native land use classes.

Other key consumptive use model input parameters include the fraction of transpiration (FTR) and fraction of evaporation from irrigation (FEI). The FTR specifies the fractional area for each crop type which is covered by crop canopy is more formally described in Schmidt et al. (2004) and Boyce et al. (2020). The FEI specifies the fractional area of evaporation from irrigation which represents the fraction of the cropped area where irrigation is applied to bare soil. FEI is generally very small for drip irrigated crops and may be higher for other land use classes such as urban landscaping.

Table 3-2. Monthly Crop Coefficients												
Land Use	Monthly Crop Coefficient											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Grassland	0.35	0.28	0.74	0.99	0.99	0.76	0.67	0.65	0.40	0.07	0.25	0.20
Native Riparian	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Chamise	0.16	0.19	0.37	0.38	0.44	0.40	0.35	0.28	0.18	0.07	0.09	0.13
Forest	0.19	0.21	0.53	0.65	0.73	0.58	0.47	0.34	0.19	0.08	0.12	0.17
Scrub Oak	0.15	0.18	0.30	0.32	0.39	0.38	0.33	0.26	0.17	0.09	0.07	0.12
Water	0.97	1.16	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.77
Grapes	0.02	0.19	0.54	0.43	0.39	0.59	0.64	0.45	0.43	0.32	0.02	0.02
Walnuts	0.06	0.40	0.52	0.80	0.97	0.97	0.92	0.90	0.85	0.80	0.75	0.06
Pears	0.06	0.40	0.55	0.69	0.81	0.93	1.01	1.04	1.02	0.80	0.50	0.05
Grain	0.55	1.03	1.17	1.17	0.87	0.17	0.17	0.17	0.17	0.17	0.17	0.25
Fallow	0.48	0.95	0.70	0.65	0.67	0.61	0.48	0.58	0.40	0.48	0.91	1.13
Farmstead	0.52	0.91	0.63	0.38	0.42	0.53	0.47	0.56	0.47	0.61	0.89	1.10
Paved	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Urban	0.49	0.88	0.47	0.21	0.27	0.46	0.40	0.50	0.45	0.59	0.82	1.07
Residential	0.52	0.91	0.63	0.38	0.42	0.53	0.47	0.56	0.47	0.61	0.89	1.10
Landscape	0.80	1.09	0.78	0.64	0.73	0.85	0.72	0.84	0.71	0.81	1.15	1.25
Vacant	0.47	0.87	0.43	0.21	0.28	0.45	0.39	0.43	0.39	0.53	0.78	1.05

Other crop parameters include rooting depths, runoff fractions and irrigation efficiency. Rooting depths determine the depth of plant roots for each crop type which determines the crop transpiration from groundwater. Rooting depths for native crop types were estimated from the rooting depth database provided as a SGMA resource based on compiled literature values (Canadell et al., 1996; groundwaterresourcehub.org). Runoff fractions represent the fraction of precipitation and irrigation which manifest as runoff from the land surface. These were specified as non-time or climate variant values for each crop type and treated as parameter values based on initial estimates. Irrigation efficiency was specified for irrigated land use classes based on irrigation method.

3.3.4. Soils

Spatial information on soil types and characteristics were acquired through the National Cooperative Soil Survey Geographic Database (SSURGO; NRCS, 2019). Each soil map unit area was related to a major soil component, which was then related to primary soil horizons. Each primary soil horizon was designated into one of five general soil types (sandy loam, silt, silty clay, or sand) (**Figure 3-14**). Clay was not found within the BVIHM model domain. The thickness of the capillary fringe estimated for each soil type ranges from 3 to 16 feet. These soil characteristics are specified by cell, independent of land use, crop, or WBS, and remain unchanged for the entire simulation period. With capillary fringe defined for each soil type, FMP can determine an analytical solution to calculate the amount of evapotranspiration as a function of depth to water.

3.3.5. Water Supply

Water supply is used to meet calculated evapotranspiration demand in the FMP as well as external demand such as indoor domestic pumping and frost protection. In addition to precipitation and direct groundwater uptake, water supply sources include surface water from Clear Lake, in-stream diversions, and groundwater extraction.

3.3.5.1. Surface Water Supply

Surface water is supplied by public water supply purveyors sourced from Clear Lake and from in-stream diversions from streams within the model domain that supply water to agricultural water users.

Public Water Systems

Treated surface water from Clear Lake is furnished to water users located in Public Water Systems (PWS) serving the City of Lakeport (CA1710004), North Lakeport (CA1710021) and Soda Bay (CA1710022) (**Figure 3-15**). Monthly surface water deliveries from each of these PWS was acquired from the Electronic Annual Reports (EAR) submitted annually to the California State Water Resources Control Board (SWRCB) (**Figure 3-16**). Prior to the start of available records in 2013, monthly surface water supplies were estimated from the mean of monthly reported supply from wet and dry years. Surface water supplies were specified monthly as a non-routed delivery (piped water) in the FMP to WBS overlying public water supply systems and scaled based on the overlapping WBS area. Smaller PWS which have not reported to the SWRCB through the EAR were assumed to be reliant solely on groundwater with water usage estimated using the methodology described in **Section 3.3.5.2**.

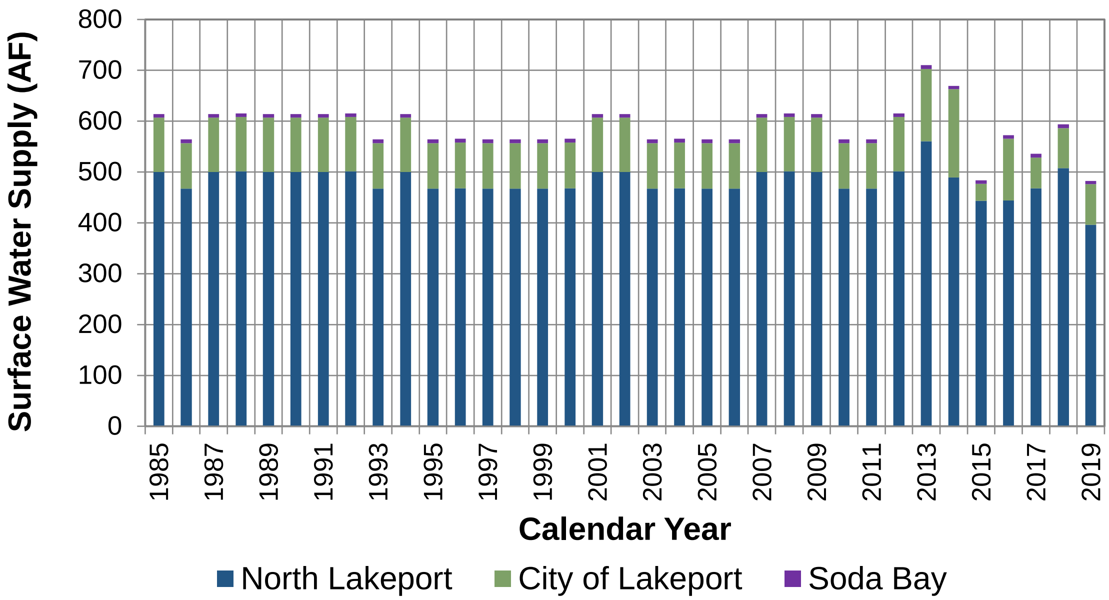

Figure 3-16. Surface Water from Clear Lake Supplied by Public Water Systems (1985-2019)

In-Stream Diversions

In-stream diversions within the model domain were estimated using water rights data from the electronic Water Rights Information Management System (eWRIMS) operated by the California SWRCB (SWRCB, 2021). This database includes the timing, volume and use of surface water diversions. The SWRCB implemented eWRIMS in 2007, therefore, diversion and storage data reported before 2007 is sparse. Additionally, physical reports of water rights are frequently filled out inconsistently or incorrectly by the water right holder, making the reconstruction of historical diversions problematic. There are 50 active points of diversion (POD) associated with 43 water right applications within the active model area. Within the Big Valley Basin, 41 PODs exist for 35 water right applications. Within the Scotts Valley Basin, 6 PODs exist for five water right applications.

The locations of surface water diversions were aggregated for modelling purposes and simulated on ten stream segments, with a majority of water right applications on Kelsey and Adobe Creeks (**Figure 3-6**). Monthly diversions from each point of diversion in years prior to the period of reliable data available from eWRIMS were estimated using mean monthly diversion volumes from the period of record and are summarized by water year for major creeks in **Figure 3-17.** In-stream diversions were simulated as a semi-routed delivery (SRD) in the FMP and were coupled to the SFR package. SRDs are added as a water supply source to overlying WBS within each model timestep which are utilized to the extent that there is streamflow available in the stream. Specified diversion amounts that exceed the required water demand for a given WBS are re-routed to the stream system below the diversion node.

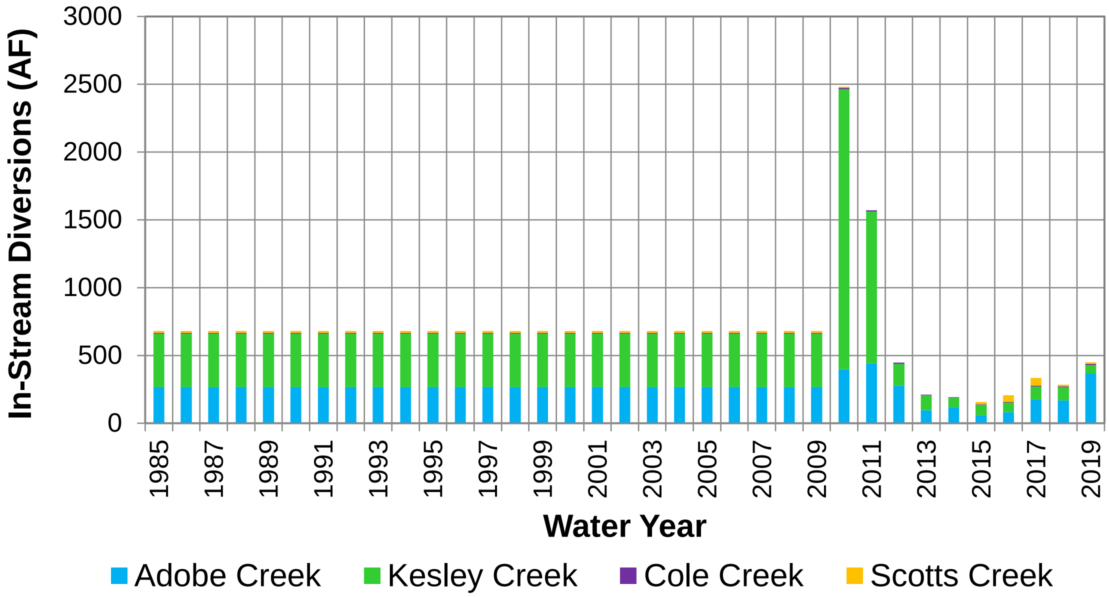

Figure 3-17. In-Stream Agricultural Diversions Summarized by Stream (1985-2019)

3.3.5.2. Groundwater Supply

Groundwater extraction makes up the majority of water supply in the Basin and model domain. Groundwater supply can be broadly divided into three primary use groups – municipal and public water supply water users, self-supplied domestic water users and agricultural water users.

Public Water Systems

Groundwater extraction from PWS were specified monthly. Pumping amounts were assigned from monthly reports contained in the EAR database from 2013 through 2019 (SWRCB, 2020). This includes groundwater extracted by the City of Lakeport (CA1710004), Kelseyville (CA1710007) and Corinthian Bay Mutual Water Company (CA1700549) as well as 12 other small public water supply systems (extract less than 10 AFY) which submit annual report to the SWRCB through the EAR (**Figure 3-18** and **Figure 3-19)**. Groundwater usage from other small PWS which did not report to the SWRCB was estimated using the methodology for domestic groundwater pumping described in the next section. Groundwater pumping amounts prior to 2013 were estimated using mean monthly average pumping from wet and dry year types.

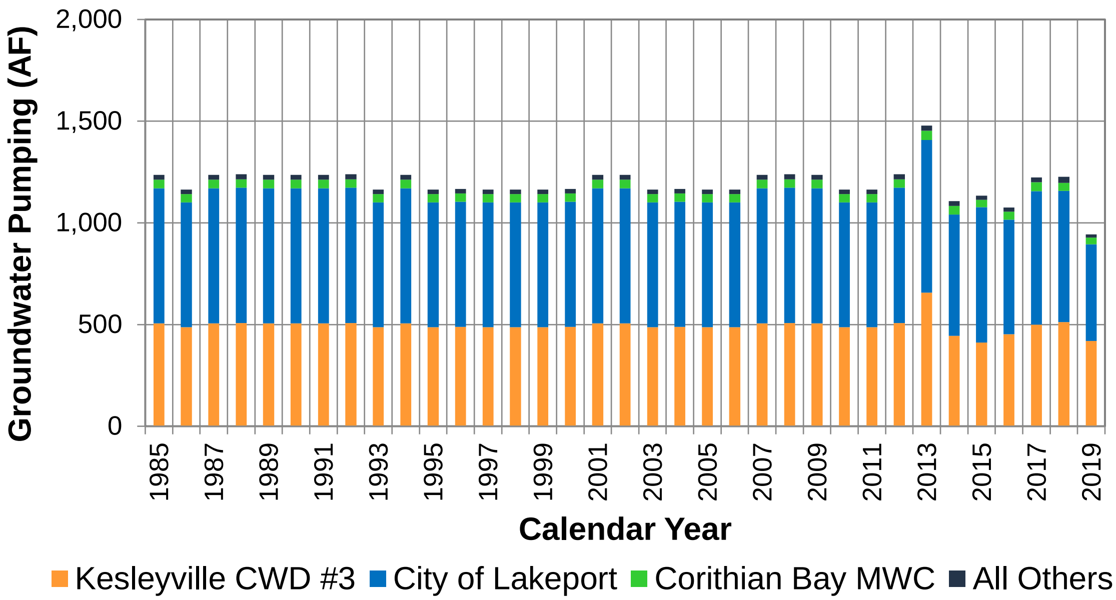

Figure 3-19. Groundwater Pumping by Public Water System (1985-2019)

Monthly groundwater pumping from municipal and other public water supply wells was assigned using the MNW package (Konikow et al., 2009). Well locations were obtained using a spatial dataset provided by GAMA (SWRCB, 2020) (**Figure 3-18**). Well construction was determined from well completion information available from the California Dept. of Drinking Water and from Lake County. Well construction in the remaining PWS wells was inferred based on the available well construction data.

Domestic Groundwater Pumping and Recharge from Septic

Groundwater pumping for rural self-supplied domestic users was both specified and calculated internally. Unlike pumping for agricultural water demand, domestic pumping also includes demand for indoor water usage which is not a function of crop demand. As a result, indoor pumping was calculated externally and assigned using the WEL package, while pumping required for outdoor watering was calculated internally in the FMP based on urban, urban residential and urban landscape land use classes from assigned multi-node wells (Harbaugh et al., 2000; Konikow et al., 2009).

Groundwater pumping for indoor domestic use was calculated based on population estimates and per-capita daily indoor water usage. Per-capita indoor water usage was assumed to be 80 gallons per day based on a 2015 study by the USGS (Dieter et al., 2018). Population estimates were based on by results provided the 1990 and 2010 U.S. Census by census block (U.S. Census Bureau, 1990; U.S. Census, 2010). Census block data from the 2000 census has been shown to provide erroneous population estimates and was not used. Population was aggregated by WBS and use to assign monthly pumping distributed between domestic wells within each WBS. Domestic well location and construction were assigned based on information in the DWR OSCWR database (**Figure 3-20** and **Figure 3-21**).

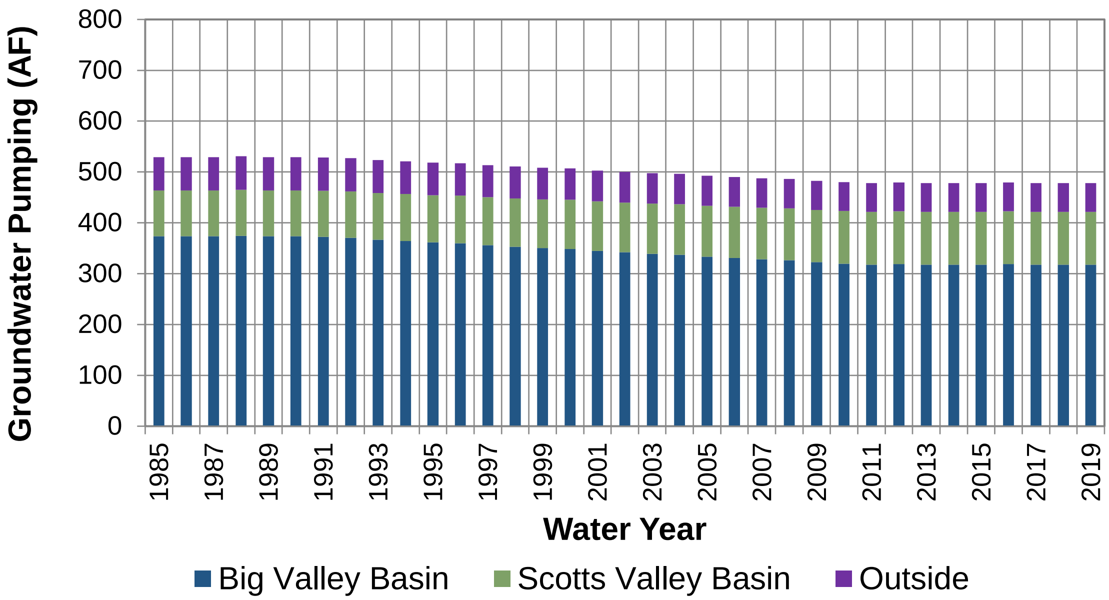

Figure 3-21. Indoor Self-Supplied Domestic Groundwater Pumping (1985-2019)

Recharge from septic systems was assigned as spatially variable monthly rates through direct recharge within the FMP. Recharge from septic was estimated from indoor water demand assigned to each model cell given the assumption that 80% percent of indoor water usage would recharge the groundwater system through septic return.

Agricultural Groundwater Pumping

Groundwater pumping required to meet irrigation demand for agriculture was calculated internally in the FMP. A total of 180 agricultural wells were identified based on an inventory of available well completion reports provided by the DWR OSCWR database. Well construction information is not available for many agricultural wells in the DWR well completion report dataset. In such instances, well construction was inferred from available agricultural well construction in each PLSS section. The location of simulated agricultural wells is shown in **Figure 3-22**.

3.3.6. Frost Protection

Irrigation for frost protection which occurs on pear orchards and vineyards in the model domain generally from March through May. Irrigation for frost protection was estimated using minimum temperature data obtained from local weather stations maintained by the Western Weather Group and the PRISM Climate Group. The volume of irrigation for frost protection was estimated based on crop acreage assuming an irrigation rate of 0.11 acre-inches per hour for four hours in each day where minimum temperatures drop below 32 degrees Fahrenheit. This is represented by specifying and external "Added Demand" in the FMP which is met largely through additional inflow via groundwater pumping.

3.4. Geologic Framework and Aquifer Properties

The geologic framework and aquifer properties were informed by the hydrogeologic conceptualization described in **Section 2.2.1** of the GSP and textural information provided in driller reports.

3.4.1. Lithologic Data

Lithologic data were used as a primary source in developing geologic framework and estimates of hydraulic parameters in the numerical model. The primary source of lithologic data are descriptions reported in well completion reports submitted by drillers at the time of well completion. Model development relied on digitized lithologic data from 233 wells within the active model domain which were digitized during model development (**Figure 3-23**). Data from well completion reports were used to develop a database including the well location (latitude and longitude), elevation, well construction, drilling contractor, diameter, well depth, drilling depth, well test results and textural descriptions and intervals.

3.4.2. Hydrogeologic Zones

The model domain was subdivided into two primary hydrogeologic zones based on surficial geologic maps, lithologic descriptions, and geologic cross sections from a 1967 groundwater recharge report (Soil Mechanics and Foundation Engineers, 1967). Alluvial deposits were identified from textural information provided in well completion reports, cross sections, and surficial geologic maps (**Figure 3-24**). This information was used to develop a 3-dimensional surface of the contact elevation between alluvial deposits and other geologic units present in the model domain used to delineate a Quaternary Alluvial zone (**Qa**), Upland Quaternary Alluvial zone (**UQa**) and Consolidated Basement zone (**BST**) in BVIHM (**Figure 3-25**).

The first zone represents unconsolidated ash and alluvium deposited by streams within the Big Valley and Scotts Valley Basins (**Figure 3-25**). Notably, the Qa zone does not extend to the Basin boundaries due to thinning of alluvial terrace deposits and increase in model layer thickness in these areas. This zone was further characterized based on textural information contained in drillers reports and described in **Section 3.4.3**.

The Qa hydraulic zone was also refined into two sub-zones during model calibration. The primary is the Qa zone which encompasses the majority of the Big Valley Basin. The upland portion of the Qa zone in the Big Valley Basin was represented by a separate upland zone (**UQa**) with modified hydraulic characteristics (**Figure 3-25**).

The third zone delineated corresponds to consolidated basement rocks (**BST**) present in the model domain (**Figure 3-25**). Statewide surficial geologic maps indicate that basement units are comprised predominantly of Jurassic to Cretaceous sandstones and greenstones of the Franciscan formation west of the Big Valley and Scotts Valley Basins and quaternary andesite east of the Big Valley Basin. For initial modeling purposes, basement rocks were treated as a single homogenous unit encompassing all units not included in the Qa zone.

3.4.3. Geostatistical Analysis

A geostatistical model was developed to better simulate the spatial distribution and variability of hydraulic properties within the Quaternary alluvial zone in the Basin. The geostatistical model relies on percentage coarse-grained material as the principal variable in determining the distribution of hydraulic properties (Laudon and Belitz, 1991; Burow et al., 2004). This relied on a binary textural classification of digitized lithologic information provided in well completion reports. Each textural depth interval was assigned as coarse-grained (sands, gravels, clayey sands) or fine-grained (clay, silt, sandy clays) based on the description provided in the well completion report. Coarse-grained members were assigned a value of 1 and fine-grained members were assigned a value of 0. The data were then upscaled to determine the thickness-weighted average of the coarse-grained percentage within a model layer at each location with available textural information.

From the texture data developed by model layer at points across the Basin, as described above, the spatial distribution of percentage coarse in each model cell within a given model layer was interpolated using an ordinary kriging model. Kriging relies on an assessment of the spatial autocorrelation of datasets using an empirical semi-variogram γ(h) (Krige, 1951; Matheron, 1963; Goovaerts, 1997). This was evaluated using a semi-variogram statistical package developed by Schwanghart (2009). Kriging parameters were developed by fitting a spherical variable model to the empirical semi-variogram informed by data from the textural analysis given by:

$$\gamma(h) = \begin{cases} 0 & , h = 0 \\ n + (s - n)\left(\frac{3h}{2r} - \frac{h^3}{2r}\right) & , 0 < h \leq r \\ s & , h > r \end{cases} \qquad \textbf{(Equation 3-4)}$$

Where: h is the lag

r is the range

s is the sill

n is the nugget

The value at each location in the sampling grid was estimated as a linear combination of weighted values in surrounding points and executed using the Spatial Analyst in ArcGIS (ESRI, 2020). Due to variability in the spacing of available data, a fixed number of points used to estimate the value at each location in place of a fixed search distance. Experimentation indicated that utilization of 15 points in conjunction with adjustments to the range (r) produced the most geologically plausible results. Results from the kriging model were averaged from a 100-foot rectilinear kriging grid to the 500-foot model grid (**Figures 3-26** and **3-27**).

3.4.4. Lithologic End Members

Aquifer parameters (vertical and horizontal hydraulic conductivity, specific storage, specific yield) in each model cell were estimated using the modeled spatial distribution of course and fine-grained materials within the alluvial aquifer (Phillips et al., 2007; Faunt et al., 2009). Hydraulic parameters (P) in each alluvial model cell were derived using parameter values for coarse (P_c) and fine-grained (P_f) end members using a weighted power mean:

$$P = \left((P_c \times F_c)^p + \left(P_f \times F_f\right)^p \right)^{1/p}$$ (**Equation 3-5**)

Where: F_{coarse} is the coarse-grained volume fraction
F_{fine} is the fine-grained volume fraction
p is the power mean weight

The horizontal hydraulic conductivity (K_h), specific yield (S_y) and specific storage (S_s) were calculated using a special case of the power mean (p =0) which yields an arithmetic mean. Due to the arrangement of sediments in layered alluvial systems which produces anisotropy (preferential horizontal conductivity), vertical hydraulic conductivity (K_v) is best estimated using a value of p between a geometric mean ($\frac{lim}{p \to 0}$) and a harmonic mean (p =-1).

3.4.5. Hydrogeologic Structures

Faults can behave as barriers to groundwater flow as deformation, offsets and chemical reactions can change the permeability of aquifer materials. Faults were simulated using the Horizontal Flow Barrier (HFB) package (Hanson et al, 2014; Harbaugh et al., 2000; Hsieh and Freckleton, 1993). Although numerous mapped and unmapped faults exist within the model domain, only the Adobe Creek Fault was included in the model (**Figure 3-28**) (CGS, 2010).

3.5. Initial Conditions

Initial conditions were specified for groundwater levels at the start of the model simulation. Initial conditions were derived from groundwater level measurements in spring of 1984 (**Figure 3-29**). As these data are relatively sparse, groundwater levels were also inferred from the elevation of streams and springs.