## MEASURABLE OBJECTIVES

Measurable objectives are quantitative goals that reflect the basin's desired groundwater conditions and allow the GSA to achieve the sustainability goal within 20 years. Measurable objectives are set for each sustainability indicator at the same representative monitoring sites and using the same metrics as minimum thresholds. Measurable objectives should be set such that there is a reasonable margin of operational flexibility (**Figure 14**) between the minimum threshold and measurable objective that will accommodate droughts, climate change, conjunctive use operations, or other groundwater management activities. There are exceptions to this general rule. For example, if the minimum threshold for land subsidence is zero, the measurable objective may also be zero. Projects and management actions included in GSPs should be designed to meet the measurable objectives, with specific descriptions of how those projects and management actions will achieve their desired goals.

In addition to the measurable objective, interim milestones must be defined in five-year increments[16] at each representative monitoring site using the same metrics as the measurable objective, as illustrated in **Figure 14**. These interim milestones are used by GSAs and the Department to track progress toward meeting the basin's sustainability goal. Interim milestones must be coordinated with projects and management actions proposed by the GSA to achieve the sustainability goal. The schedule for implementing projects and management actions will influence how rapidly the interim milestones approach the measurable objectives (i.e., the path to sustainable groundwater management).

The Department will periodically (at least every five years) review GSPs to determine, among other items, whether failure to meet interim milestones is likely to affect the ability of the GSA(s) in a basin to achieve the sustainability goal.[17]

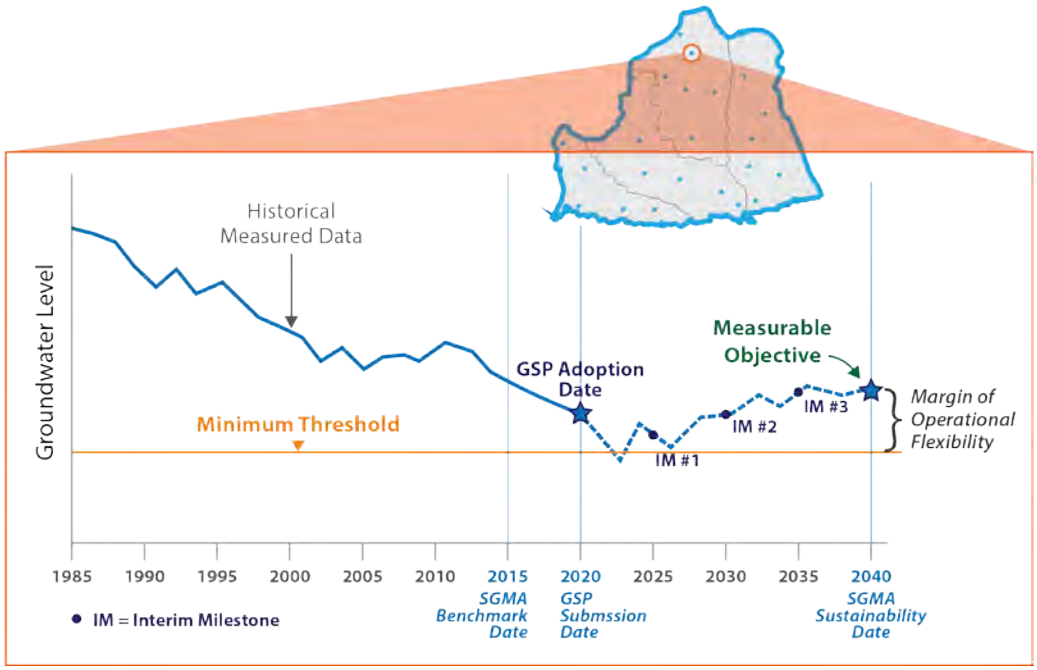


**Figure 14. Relationship between Minimum Thresholds, Measurable Objectives, Interim Milestones (IM), and Margin of Operational Flexibility for a Representative Monitoring Site**

### *The Path to Sustainable Groundwater Management*

There will be many paths to sustainable groundwater management based on groundwater conditions and locally-defined values. **Figure 14** shows the relationship between minimum thresholds, measurable objectives, interim milestones, and margin of operational flexibility for a hypothetical basin. In the example used for **Figure 14**, groundwater levels are predicted to initially decline for the first five years after GSP adoption, and then rise over the subsequent 15 years to meet the measurable objective. At five-year increments, there are interim milestones to check the basin's progress towards the measurable objective. In **Figure 14**, the measured data never drops below the minimum threshold. This is just one example of a path towards reaching sustainability. The Department recognizes that there are different sustainability paths based on basin conditions, future supply and demand forecasts, and implementation of groundwater improvement projects. Three additional potential paths to sustainability are illustrated in **Figure 15**.

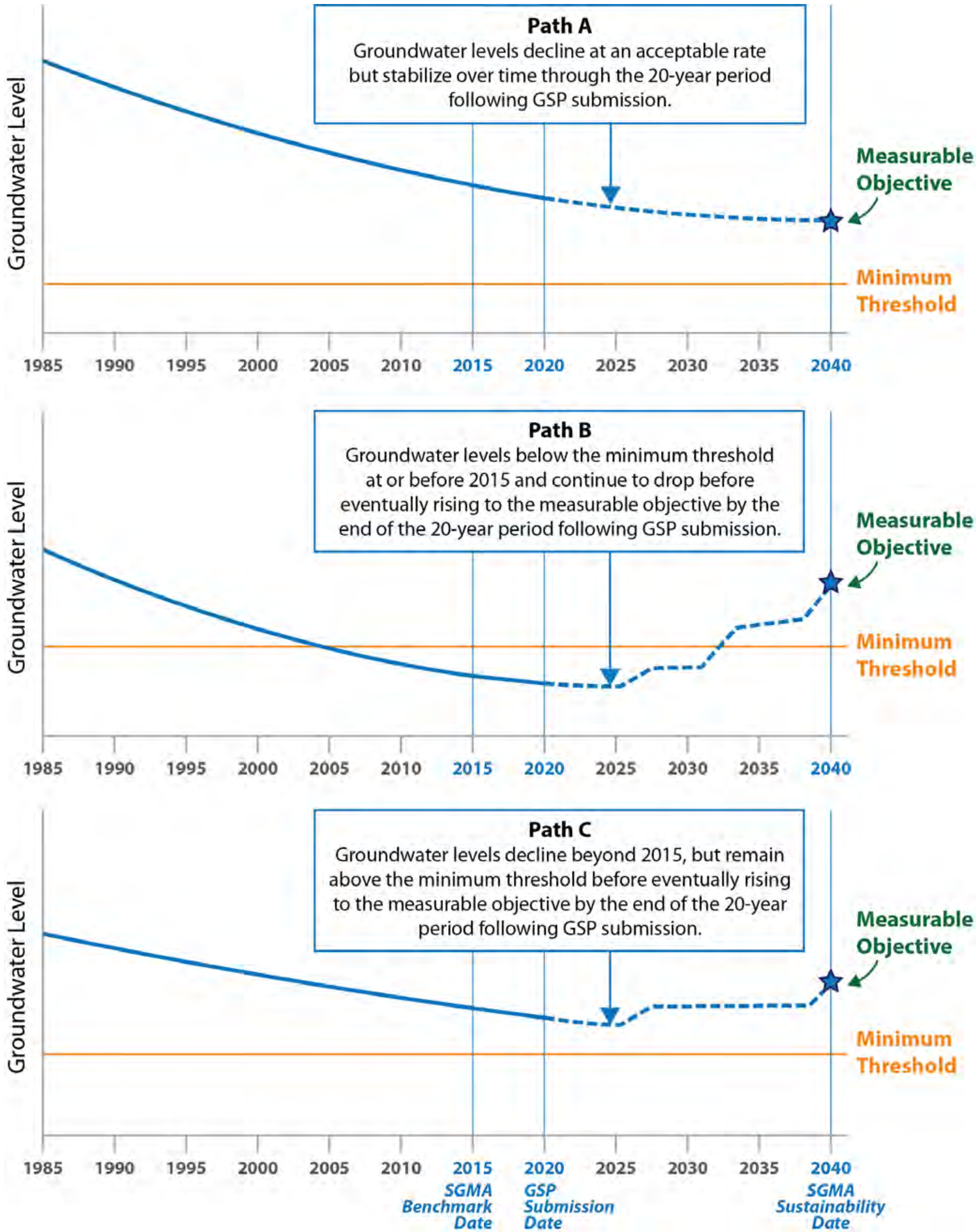


**Figure 15. Potential Paths to Sustainability**

### *Measurable Objectives when an Undesirable Result Occurred before January 1, 2015*

SGMA states that a GSP “may, but is not required to, address undesirable results that occurred before, and have not been corrected by, January 1, 2015.” Once minimum thresholds have been developed and an undesirable result numerically defined, the GSA may evaluate whether that undesirable result was present prior to January 1, 2015. This evaluation is not possible until the GSA has defined what constitutes a significant and unreasonable condition (an undesirable result).

If the evaluation indicates that an undesirable result occurred prior to January 1, 2015, the GSA must set measurable objectives to either maintain or improve upon the conditions that were occurring in 2015. The GSA must plan a pathway, indicated by appropriate interim milestones, to reach and maintain the 2015 conditions within the 20-year implementation timeline.

## SUSTAINABILITY GOAL

GSAs must develop a sustainability goal that is applicable to the entire basin. If multiple GSPs are developed for a single basin, then the sustainability goal must be presented in the basinwide *coordination agreement*.

The sustainability goal should succinctly state the GSA's objectives and desired conditions of the groundwater basin, how the basin will get to that desired condition, and why the measures planned will lead to success.

Unlike the other sustainable management criteria, the sustainability goal is not quantitative. Rather, it is supported by the locally-defined minimum thresholds and undesirable results. Demonstration of the absence of undesirable results supports a determination that basin is operating within its sustainable yield and, thus, that the sustainability goal has been achieved.

GSA's should consider the following when developing their sustainability goal:

- **Goal description**. The goal description should qualitatively state the GSA's objective or mission statement for the basin. The goal description should summarize the overall purpose for sustainably managing groundwater resources and reflect local economic, social, and environmental values within the basin.
- **Discussion of measures**. The sustainability goal should succinctly summarize the measures that will be implemented. This description of measures should be consistent with, but may be less detailed than, the description of projects and management actions proposed in the GSP. Examples of measures a GSA could implement include demand reduction and development of groundwater recharge projects. The goal should affirm that these measures will lead to operation of the basin within its sustainable yield.
- **Explanation of how the goal will be achieved in 20 years**. The sustainability goal should describe how implementation of the measures will result in sustainability. For example, if the measures include demand reduction and implementation of groundwater recharge projects, then the goal would explain how those measures will lead to sustainability (e.g., they will raise groundwater levels above some threshold values and eliminate or reduce future land subsidence).

Note that most of the sustainability goal can only be finalized after minimum thresholds and undesirable results have been defined, projects and management actions have been identified, and the projected impact of those projects and management actions on groundwater conditions have been evaluated. Therefore, completion of the sustainability goal will likely be one of the final components of GSP development.

## Role of Sustainable Yield Estimates in SGMA

In general, the sustainable yield of a basin is the amount of groundwater that can be withdrawn annually without causing undesirable results. Sustainable yield is referenced in SGMA as part of the estimated basinwide water budget and as the outcome of avoiding undesirable results.

Sustainable yield estimates are part of SGMA's required basinwide water budget. Section 354.18(b)(7) of the GSP Regulations requires that an estimate of the basin's sustainable yield be provided in the GSP (or in the coordination agreement for basins with multiple GSPs). A single value of sustainable yield must be calculated basinwide. This sustainable yield estimate can be helpful for estimating the projects and programs needed to achieve sustainability.

SGMA does not incorporate sustainable yield estimates directly into sustainable management criteria. Basinwide pumping within the sustainable yield estimate is neither a measure of, nor proof of, sustainability. Sustainability under SGMA is only demonstrated by avoiding undesirable results for the six sustainability indicators.

# CONCLUSIONS

The key to demonstrating a basin is meeting its sustainability goal is by avoiding undesirable results. Sustainable management criteria are critical elements of the GSP that define sustainability in the basin.

Before setting sustainable management criteria, the GSA should understand the basin setting by establishing a hydrogeological conceptual model, engage stakeholders, and define management areas as applicable. This document addresses best management practices for developing sustainable management criteria, including minimum thresholds, undesirable results, measurable objectives, and the sustainability goal.

Setting sustainable management criteria can be a complex, time consuming, and iterative process depending on the complexity of the basin and its stakeholders. GSAs should allow sufficient time for criteria development during the GSP development process. The public should be engaged early in the process so their perspectives can be considered during sustainable management criteria development. To ensure timely stakeholder participation, it may be useful for GSAs to set a timeline for development of the sustainable management criteria.

# 5. KEY DEFINITIONS

The key definitions related to sustainable management criteria development outlined in applicable SGMA code and regulations are provided below for reference.

**SGMA Definitions (California Water Code 10721)**

(d) "Coordination agreement" means a legal agreement adopted between two or more groundwater sustainability agencies that provides the basis for coordinating multiple agencies or groundwater sustainability plans within a basin pursuant to this part.

(r) "Planning and implementation horizon" means a 50-year period over which a groundwater sustainability agency determines that plans and measures will be implemented in a basin to ensure that the basin is operated within its sustainable yield.

(u) "Sustainability goal" means the existence and implementation of one or more groundwater sustainability plans that achieve sustainable groundwater management by identifying and causing the implementation of measures targeted to ensure that the applicable basin is operated within its sustainable yield.

(v) "Sustainable groundwater management" means the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results.

(w) "Sustainable yield" means the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result.

(x) "Undesirable result" means one or more of the following effects caused by groundwater conditions occurring throughout the basin:

(1) Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods.

(2) Significant and unreasonable reduction of groundwater storage.

(3) Significant and unreasonable seawater intrusion.

(4) Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.

(5) Significant and unreasonable land subsidence that substantially interferes with surface land uses.

(6) Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.

**Groundwater Sustainability Plan Regulations (California Code of Regulations 351)**

(g) “Basin setting” refers to the information about the physical setting, characteristics, and current conditions of the basin as described by the Agency in the hydrogeologic conceptual model, the groundwater conditions, and the water budget, pursuant to Subarticle 2 of Article 5.

(h) “Sustainability indicator” refers to any of the effects caused by groundwater conditions occurring throughout the basin that, when significant and unreasonable, cause undesirable results, as described in Water Code Section 10721(x).

(q) “Interim milestone” refers to a target value representing measurable groundwater conditions, in increments of five years, set by an Agency as part of a Plan.

(r) “Management area” refers to an area within a basin for which the Plan may identify different minimum thresholds, measurable objectives, monitoring, or projects and management actions based on differences in water use sector, water source type, geology, aquifer characteristics, or other factors.

(s) “Measurable objectives” refer to specific, quantifiable goals for the maintenance or improvement of specified groundwater conditions that have been included in an adopted Plan to achieve the sustainability goal for the basin.

(t) “Minimum threshold” refers to a numeric value for each sustainability indicator used to define undesirable results.

(x) “Plan” refers to a groundwater sustainability plan as defined in the Act.

(y) “Plan implementation” refers to an Agency’s exercise of the powers and authorities described in the Act, which commences after an Agency adopts and submits a Plan or Alternative to the Department and begins exercising such powers and authorities.

(ag) “Statutory deadline” refers to the date by which an Agency must be managing a basin pursuant to an adopted Plan, as described in Water Code Sections 10720.7 or 10722.4.

## NOTES

[1] See 23 CCR § 350 *et seq*.

[2] See Water Code § 10720 *et seq*.

[3] See 23 CCR § 355.4(b)(1)

[4] See Water Code § 10721(v)

[5] See 23 CCR § 354.22 *et seq.*

[6] See 23 CCR § 351(ah); *see also* Water Code § 10721(x).

[7] See 23 CCR § 354.28(b)

[8] See 23 CCR § 354.28(c)

[9] See 23 CCR § 354.28(d)

[10] See 23 CCR § 354.30(d)

[11] See 23 CCR § 354.36(b)

[12] See 23 CCR § 354.26(b)

[13] See 23 CCR 354.26(b)(1)

[14] See 23 CCR 354.26(b)(2)

[15] See 23 CCR 354.26(b)(3)

[16] See 23 CCR § 354.30(e)

[17] See 23 CCR § 355.6(c)(1)

# Appendix 4

***4A 2019 First Semiannual Groundwater Monitoring Report, Visalia Water Conservation Plant***

***4B Tulare Irrigation District Groundwater Elevation Monitoring Plan***

***4C Water Quality Monitoring Schedule***

***4D DWR Guidance Documents***

- ***4Da Monitoring Protocols, Standards, and Sites Best Management Practices***
- ***4Db Monitoring Networks and Identification of Data Gaps Best Management Practices***

# Appendix 4A 2019 First Semiannual Groundwater Monitoring Report, Visalia Water Conservation Plant

# 2019 FIRST SEMIANNUAL GROUNDWATER MONITORING REPORT

# VISALIA WATER CONSERVATION PLANT

# VISALIA, CALIFORNIA

Prepared for:

City of Visalia

707 W. Acequia Avenue

Visalia, California

Prepared by:

Moore Twining Associates, Inc.

2527 Fresno Street

Fresno, California

May 16, 2019

Project No. A76404.03

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**VISALIA WATER CONSERVATION PLANT**

**VISALIA, CALIFORNIA**

## 1.0 INTRODUCTION

This report summarizes field activities and analytical results associated with the 2019 First Semiannual groundwater monitoring event at the Visalia Water Conservation Plant (VWCP). The VWCP is operated by the City of Visalia and is located at 7579 Avenue 288, Visalia, California. Groundwater monitoring was conducted per California Regional Water Quality Control Board (CRWQCB) Waste Discharge Requirements (WDR) No. R5-2018-0046.

This report includes a description of the monitoring well network, a summary of groundwater monitoring activities, and the analytical results from the groundwater monitoring event. Monitoring well locations and wastewater discharge areas are depicted in Drawing 1.

## 2.0 GEOLOGY

Based on Boyajian & Ross, Inc. report titled "Groundwater Investigation Report" dated January 30, 1998, the stratigraphy beneath the VWCP can be divided into four predominant zones to depths of 465 feet below surface grade (BSG), the maximum depth explored. These stratigraphic units appear to dip gently to the southwest at approximately 20 feet per mile. The uppermost stratigraphic zone is comprised of interbedded, predominantly coarse-grained sediments to approximately 100 feet BSG. The next zone consists of relatively thin beds of sand interbedded with clay, clayey silt, and silt. This interbedded zone is approximately 160 to 170 feet thick and occurs to about 270 feet BSG. The uppermost coarse-grained zone and the underlying thin bedded sand and silt zone comprise the "upper aquifer".

The third stratigraphic zone is a very stiff, highly plastic clay layer that is approximately 20 feet thick. This clay layer acts as an aquitard (confining layer) between the upper unconfined aquifer and the deeper confined aquifer. A sequence of sand and silty sand interbedded with clay and clayey silt lies stratigraphically below the confining layer. This interbedded zone comprises the "deep aquifer" underneath the site.

## 3.0 GROUNDWATER MONITORING NETWORK

The VWCP groundwater monitoring well network currently consists of 18 groundwater monitoring wells. The monitoring wells are listed below:

MW-G, MW-H1, MW-H2, MW-H3, MW-J1, MW-J2, MW-J3, MW-K1, MW-K2, MW-K3, MW-L, MW-M, MW-N, MW-O, MW-P, MW-Q, MW-R and MW-S.

MW-F was abandoned prior to the Third Quarter 2014 sampling event; it had been dry since 2007. MW-B is no longer sampled per instructions received by City of Visalia from the CRWQCB. Six monitoring wells (MW-N, MW-O, MW-P, MW-Q, MW-R, and MW-S) were installed in April 2014 and added to the monitoring well network.

Monitoring wells with a number 1, 2 or 3 in their designation are clustered wells with each well completed at a different depth. Monitoring wells with numbers “1” and “2” in their designation are screened in the first encountered groundwater (upper aquifer) while the monitoring wells with a number “3” are screened in the deeper groundwater zone (deep aquifer). Monitoring well locations are shown on Drawing 1. Monitoring well construction details are included in Table 1.

Groundwater monitoring wells MW-G, MW-H1, MW-H2, MW-J1, MW-J2, MW-K1, MW-K2, MW-L, MW-M, MW-N, MW-O, MW-P, MW-Q, MW-R and MW-S are screened in the upper aquifer while monitoring wells MW-H3, MW-J3, and MW-K3 are screened in the lower (deep) aquifer.

## 4.0 FIELD ACTIVITIES

Groundwater monitoring activities were conducted on April 2, 3, 4, and 9. Twelve monitoring wells had sufficient water for sampling during this monitoring event. Monitoring wells MW-G, MW-H1, MW-J1, MW-K1, MW-L, and MW-M did not contain sufficient water to sample and were considered dry. Sampling activities included the following:

- Depth-to-groundwater was measured at each well prior to purging. Depth-to-water measurements and calculated groundwater elevations for the past five years are summarized in Table 1.

- Each monitoring well was purged of a minimum of three well volumes prior to sampling using a portable submersible pump. Field parameters including temperature, electrical conductivity (EC) and pH were measured frequently during purging. Purging continued until these parameters were relatively stable. After purging, groundwater samples were collected in laboratory prepared sampling containers, labeled and stored in a cooled ice chest.

- Sampling equipment was cleaned prior to purging and sampling each monitoring well.

- Groundwater samples were transported under chain-of-custody to Moore Twining’s State of California certified analytical laboratory for analysis.

- Groundwater samples were analyzed for; pH, EC, Total Dissolved Solids (TDS), Total Nitrogen (Nitrate as Nitrogen, Nitrite as Nitrogen, and Total Kjeldahl Nitrogen (TKN)), Ammonia as Nitrogen, and General Minerals. Samples for metals were filtered with a 0.45 µm filter prior to preservation.

## 5.0 GROUNDWATER LEVELS

Depth-to-water was measured in the monitoring wells prior to purging. Depth-to-water measurements were used in conjunction with the surveyed top of casing elevations to calculate groundwater elevation in each monitoring well. A groundwater elevation contour map constructed using the data from monitoring wells screened across first encountered groundwater is shown in Drawing 2. A groundwater elevation contour map using the depth-to-water data from the deeper aquifer monitoring wells is included in Drawing 3. Groundwater elevation data collected during the previous five years is summarized in Table 1. Hydrographs for the upper aquifer and lower aquifer monitoring wells are included in Appendix A.

Interpretation of the gradient and flow direction of the first encountered groundwater is complicated by several factors. Monitoring wells that are screened across first encountered groundwater, and not dry, are in a generally linear pattern. Groundwater elevations appear to be significantly affected by the presence and quantity of water in both the on-site and off-site evaporation-percolation ponds. Groundwater elevations in monitoring wells MW-P and MW-Q were above the screened interval during this sampling event. Regarding these factors, during the 2019 First Semiannual monitoring event, in the area southwest of the facility, groundwater was interpreted to flow generally south west at an estimated gradient of 13 feet per mile (0.0024 feet/foot). For reference, included as Drawing 4, is the California Department of Water Resources regional groundwater contour map from the Fall of 2018 (https://gis.water.ca.gov/app/gicima/). This was the most recent map available at the time this report was prepared.

During the 2019 First Semiannual sampling event, groundwater in the deeper aquifer was determined to flow west southwest at a gradient of approximately 15 feet per mile (0.0028 feet/foot).

## 6.0 GROUNDWATER QUALITY

Laboratory analytical results for groundwater monitoring events conducted by Moore Twining for the previous five years are summarized in Table 2. Time concentration graphs for selected constituents in selected upper aquifer monitoring wells are included in Appendix A. Copies of the laboratory reports are included in Appendix B.

Selected constituents from samples collected from groundwater monitoring wells screened in the upper aquifer and sampled in the 2019 First Semiannual sampling event were compared to the average historical values of background groundwater monitoring well MW-N, are summarized below:

- Background monitoring well MW-N has an average EC of 953 micro Siemens per centimeter (µS/cm). During the recent sampling event, EC measurements in samples collected from the upper aquifer monitoring wells ranged from 490 µS/cm in MW-H2 and MW-K2 to 1,300 µS/cm in MW-S. With the exception of MW-S, all monitoring wells sampled this quarter were below average background EC values.

- Background monitoring well MW-N has an average TDS concentration of 672 milligrams per liter (mg/L). During the recent sampling event, TDS concentrations in samples collected from the upper aquifer ranged from 300 mg/L in MW-K2 to 960 mg/L in MW-S. With the exception of MW-S, all monitoring wells sampled this quarter were below average background TDS concentrations.

- Background monitoring well MW-N has an average nitrate as nitrogen (NO3-N) concentration of 41 mg/L. During the recent sampling event, NO3-N concentrations in samples collected from the upper aquifer ranged from 0.30 mg/L (concentration is below the reporting limit; therefore, the result is estimated) in MW-Q to 58 mg/L in MW-S. With the exception of MW-S, all monitoring wells sampled this quarter were below average background NO3-N concentrations.

In the upper aquifer monitoring wells sampled this quarter, NO3-N concentrations exceeded the California Department of Public Health Primary Maximum Contaminant Level (MCL) of 10 mg/L in MW-H2 (12mg/L), MW-N (44 mg/L), MW-O (12 mg/L), and MW-S (58 mg/L). The elevated NO3-N concentrations detected in the wells may also be contributed by sources other than VWCP due to the close proximity of animal confinement facilities and agricultural activities in the area.

## 7.0 CONCLUSIONS AND RECOMMENDATIONS

2019 First Semiannual groundwater laboratory analytical results for monitoring wells MW-H2, MW-O, and MW-S, which are down gradient of the facility, show NO3-N concentrations above the MCL. However, the up-gradient background well MW-N also showed NO3-N concentrations above the MCL. This suggests the elevated NO3-N concentrations detected in down gradient wells may also be contributed by sources other than VWCP.

Moore Twining recommends;

- To continue with Semi-Annual groundwater monitoring activities, the 2019 Second Semi-Annual sampling event will be conducted in October 2019.

**8.0 CLOSING**

Moore Twining appreciates the opportunity to provide environmental services to the City of Visalia. Please contact Moore Twining at (559) 268-7021 if you have any questions regarding the contents of this report.

Sincerely,

MOORE TWINING ASSOCIATES, INC.
Environmental and Geological Services Division

Joe Clark
Environmental Technician


Kirk Jacobsen, PG No. 9094
Project Manager

## TABLES

## TABLE 1
## GROUNDWATER LEVEL DATA
## VISALIA WATER CONSERVATION PLANT

| Monitoring Well | MW-B | | MW-G | | MW-H1 | | MW-H2 | | MW-H3 | | MW-J1 | | MW-J2 | | MW-J3 | | MW-K1 | | MW-K2 | | MW-K3 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Screened Interval (feet BSG) | 13.3-33.3 | | 66.7 - 96.7 | | 78.7 - 108.7 | | 238.8 - 248.8 | | 293.8 - 303.8 | | 100.9 - 120.9 | | 223.9 - 233.9 | | 266.9 - 276.9 | | 104.9 - 114.9 | | 240.9 - 245.9 | | 267.9 - 272.9 | |
| Measuring Point Elevation | 286.15 | | 289.70 | | 267.85 | | 267.92 | | 267.94 | | 278.15 | | 278.15 | | 278.17 | | 278.09 | | 278.11 | | 278.11 | |
| Date | Depth to GW | GW Elev | Depth to GW | GW Elev | Depth to GW | GW Elev | Depth to GW | GW Elev | Depth to GW | GW Elev | Depth to GW | GW Elev | Depth to GW | GW Elev | Depth to GW | GW Elev | Depth to GW | GW Elev | Depth to GW | GW Elev | Depth to GW | GW Elev |
| 1/15/2014 | dry | | dry | | dry | | 119.75 | 148.17 | 159.00 | 108.94 | 78.40 | 199.75 | 91.78 | 186.37 | 141.90 | 136.27 | 97.13 | 180.96 | 100.09 | 178.02 | 147.90 | 130.21 |
| 4/29/2014 | dry | | dry | | dry | | 123.98 | 143.94 | 176.40 | 91.54 | 85.80 | 192.35 | 100.85 | 177.30 | 163.27 | 114.90 | 101.11 | 176.98 | 105.09 | 173.02 | 172.77 | 105.34 |
| 8/13/2014 | dry | | dry | | dry | | 136.65 | 131.27 | 202.80 | 65.14 | 93.57 | 184.58 | 108.16 | 169.99 | 185.70 | 92.47 | 108.10 | 169.99 | 112.62 | 165.49 | 194.36 | 83.75 |
| 10/23/2014 | dry | | dry | | dry | | 124.92 | 143.00 | 172.04 | 95.90 | 97.64 | 180.51 | 108.13 | 170.02 | 160.22 | 117.95 | 109.52 | 168.57 | 112.75 | 165.36 | 166.31 | 111.80 |
| 2/3/2015 | dry | | dry | | dry | | 122.71 | 145.21 | 171.20 | 96.74 | 104.19 | 173.96 | 111.55 | 166.60 | 155.25 | 122.92 | 111.71 | 166.38 | 116.72 | 161.39 | 160.03 | 118.08 |
| 4/27/2015 | dry | | dry | | dry | | 127.34 | 140.58 | 185.61 | 82.33 | 109.75 | 168.40 | 115.27 | 162.88 | 167.47 | 110.70 | 114.21 | 163.88 | 117.57 | 160.54 | 173.02 | 105.09 |
| 7/20/2015 | dry | | dry | | dry | | 135.17 | 132.75 | 220.36 | 47.58 | 110.02 | 168.13 | 122.34 | 155.81 | 201.10 | 77.07 | dry | | 124.60 | 153.51 | 207.91 | 70.20 |
| 10/26/2015 | dry | | dry | | dry | | 125.82 | 142.10 | 173.37 | 94.57 | dry | | 121.54 | 156.61 | 160.64 | 117.53 | dry | | 123.94 | 154.17 | 165.21 | 112.90 |
| 1/26/2016 | NA | | dry | | dry | | 121.88 | 146.04 | 148.00 | 119.94 | dry | | 120.78 | 157.37 | 142.61 | 135.56 | dry | | 123.36 | 154.75 | 146.37 | 131.74 |
| 4/12/2016 | NA | | dry | | dry | | 127.51 | 140.41 | 196.79 | 71.15 | dry | | 124.78 | 153.37 | 172.34 | 105.83 | dry | | 125.77 | 152.34 | 176.41 | 101.70 |
| 7/6/2016 | NA | | dry | | dry | | 134.90 | 133.02 | 219.75 | 48.19 | 106.52 | 171.63 | 125.69 | 152.46 | 198.45 | 79.72 | dry | | 131.22 | 146.89 | 203.53 | 74.58 |
| 10/20/2016 | NA | | dry | | dry | | 129.86 | 138.06 | 189.02 | 78.92 | 96.10 | 182.05 | 115.39 | 162.76 | 176.38 | 101.79 | dry | | 124.28 | 153.83 | 183.83 | 94.28 |
| 1/11/2017 | NA | | dry | | dry | | 125.62 | 142.30 | 152.11 | 115.83 | 110.80 | 167.35 | 118.38 | 159.77 | 146.06 | 132.11 | dry | | 123.78 | 154.33 | 150.78 | 127.33 |
| 4/14/2017 | NA | | dry | | dry | | 128.70 | 139.22 | 173.23 | 94.71 | 102.46 | 175.69 | 114.18 | 163.97 | 155.91 | 122.26 | dry | | 120.16 | 157.95 | 159.66 | 118.45 |
| 7/3/2017 | NA | | dry | | dry | | 127.38 | 140.54 | 202.46 | 65.48 | 107.30 | 170.85 | 115.80 | 162.35 | 178.56 | 99.61 | dry | | 118.96 | 159.15 | 180.78 | 97.33 |
| 10/9/2017 | NA | | dry | | dry | | 120.36 | 147.56 | 180.08 | 87.86 | 110.16 | 167.99 | 116.53 | 161.62 | 166.86 | 111.31 | dry | | 117.36 | 160.75 | 172.08 | 106.03 |
| 1/16/2018 | NA | | dry | | dry | | 119.17 | 148.75 | 149.71 | 118.23 | 112.06 | 166.09 | 117.68 | 160.47 | 142.15 | 136.02 | dry | | 117.76 | 160.35 | 144.60 | 133.51 |
| 4/2/2018 | NA | | dry | | dry | | 117.85 | 150.07 | 165.95 | 101.99 | dry | | 119.37 | 158.78 | 152.64 | 125.53 | dry | | 119.77 | 158.34 | 157.83 | 120.28 |
| 10/2/2018 | dry | | dry | | dry | | 124.89 | 143.03 | 208.93 | 59.01 | dry | | 128.28 | 149.87 | 185.78 | 92.39 | dry | | 124.91 | 153.20 | 188.41 | 89.70 |
| 4/2/2019 | dry | | dry | | dry | | 119.46 | 148.46 | 165.29 | 102.65 | dry | | 124.19 | 153.96 | 149.96 | 128.21 | dry | | 123.38 | 154.73 | 153.92 | 124.19 |

BSG - below surface grade
Measuring Point Elevation - top of well casing (feet above mean sea level)
Depth to GW - depth to groundwater measured from top of well casing (feet)
GW Elev - groundwater elevation (depth to groundwater subtracted from the measuring point elevation) (feet above mean sea level)
dry - insufficient water to collect sample and/or water levels below screened interval of monitoring well

# TABLE 1
# GROUNDWATER LEVEL DATA
# VISALIA WATER CONSERVATION PLANT

| Monitoring Well | MW-L | | MW-M | | MW-N | | MW-O | | MW-P | | MW-Q | | MW-R | | MW-S | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Screened Interval (feet BSG) | 78.6 - 98.6 | | 83.7 - 103.7 | | 108-158 | | 93-143 | | 110-160 | | 110-160 | | 93-143 | | 96-146 | |
| Measuring Point Elevation | 275.63 | | 269.89 | | 294.39 | | 289.40 | | 266.39 | | 266.70 | | 285.46 | | 266.26 | |
| Date | Depth to GW | GW Elev | Depth to GW | GW Elev | Depth to GW | GW Elev | Depth to GW | GW Elev | Depth to GW | GW Elev | Depth to GW | GW Elev | Depth to GW | GW Elev | Depth to GW | GW Elev |
| 1/15/2014 | dry | | dry | | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - - - |
| 4/29/2014 | dry | | dry | | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - - - |
| 8/13/2014 | dry | | dry | | 123.94 | 170.45 | 108.42 | 180.98 | 128.64 | 137.75 | 126.22 | 140.48 | 101.72 | 183.74 | 131.42 | 134.84 |
| 10/23/2014 | dry | | dry | | 125.48 | 168.91 | 111.26 | 178.14 | 124.24 | 142.15 | 127.40 | 139.30 | 103.39 | 182.07 | 127.39 | 138.87 |
| 2/3/2015 | dry | | dry | | 123.49 | 170.90 | 114.42 | 174.98 | 69.42 | 196.97 | 87.19 | 179.51 | 109.32 | 176.14 | 121.51 | 144.75 |
| 4/27/2015 | dry | | dry | | 126.22 | 168.17 | 118.70 | 170.70 | 82.42 | 183.97 | 91.97 | 174.73 | 113.02 | 172.44 | 118.36 | 147.90 |
| 7/20/2015 | dry | | dry | | 129.85 | 164.54 | 122.22 | 167.18 | 104.14 | 162.25 | 107.63 | 159.07 | 115.49 | 169.97 | 122.76 | 143.50 |
| 10/26/2015 | dry | | dry | | 131.81 | 162.58 | 125.75 | 163.65 | 91.58 | 174.81 | 100.01 | 166.69 | 121.29 | 164.17 | 121.42 | 144.84 |
| 1/26/2016 | dry | | dry | | 134.45 | 159.94 | 127.17 | 162.23 | 78.51 | 187.88 | 77.25 | 189.45 | 123.45 | 162.01 | 114.93 | 151.33 |
| 4/12/2016 | dry | | dry | | 131.91 | 162.48 | 127.86 | 161.54 | 89.51 | 176.88 | 76.79 | 189.91 | 125.32 | 160.14 | 114.12 | 152.14 |
| 7/6/2016 | dry | | dry | | 132.97 | 161.42 | 122.79 | 166.61 | 109.00 | 157.39 | 104.70 | 162.00 | 111.53 | 173.93 | 122.20 | 144.06 |
| 10/20/2016 | dry | | dry | | 134.80 | 159.59 | 113.04 | 176.36 | 121.90 | 144.49 | 105.90 | 160.80 | 99.68 | 185.78 | 123.89 | 142.37 |
| 1/11/2017 | dry | | dry | | 135.51 | 158.88 | 121.58 | 167.82 | 98.35 | 168.04 | 77.52 | 189.18 | 115.42 | 170.04 | 118.48 | 147.78 |
| 4/14/2017 | dry | | dry | | 134.74 | 159.65 | 108.10 | 181.30 | 89.76 | 176.63 | 70.49 | 196.21 | 104.43 | 181.03 | 112.32 | 153.94 |
| 7/3/2017 | dry | | dry | | 132.46 | 161.93 | 103.93 | 185.47 | 96.10 | 170.29 | 75.48 | 191.22 | 107.62 | 177.84 | 113.58 | 152.68 |
| 10/9/2017 | dry | | dry | | 132.63 | 161.76 | 109.66 | 179.74 | 102.46 | 163.93 | 82.20 | 184.50 | 110.58 | 174.88 | 114.72 | 151.54 |
| 1/16/2018 | dry | | dry | | 132.33 | 162.06 | 117.66 | 171.74 | 90.96 | 175.43 | 77.56 | 189.14 | 115.55 | 169.91 | 107.36 | 158.90 |
| 4/2/2018 | dry | | dry | | 132.25 | 162.14 | 121.26 | 168.14 | 89.38 | 177.01 | 78.73 | 187.97 | 119.88 | 165.58 | 102.02 | 164.24 |
| 10/2/2018 | dry | | dry | | 135.04 | 159.35 | 125.52 | 163.88 | 107.85 | 158.54 | 93.27 | 173.43 | 124.93 | 160.53 | 112.31 | 153.95 |
| 4/2/2019 | dry | | dry | | 135.84 | 158.55 | 124.59 | 164.81 | 92.98 | 173.41 | 87.78 | 178.92 | 125.68 | 159.78 | 104.52 | 161.74 |

BSG - below surface grade
Measuring Point Elevation - top of well casing (feet above mean sea level)
Depth to GW - depth to groundwater measured from top of well casing (feet)
GW Elev - groundwater elevation (depth to groundwater subtracted from the measuring point elevation) (feet above mean sea level)
dry - insufficient water to collect sample and/or water levels below screened interval of monitoring well

**TABLE 2**
**GROUNDWATER QUALITY RESULTS**
**Visalia Water Conservation Plant**
Results in mg/l unless otherwise noted

| Date | EC (µs/cm) | pH (pH units) | Nitrate as Nitrogen | Total Kjeldahl Nitrogen | Total Nitrogen | Ammonia as N | Total Dissolved Solids | Total Organic Carbon | Total Alkalinity as $CaCO_3$ | Bicarbonate Alkalinity as $HCO_3$ | Carbonate Alkalinity as $CO_3$ | Hydroxide Alkalinity as OH | Cation/Anion Balance (%difference) | Chloride | Phosphate | Hardness | Boron | Calcium | Iron | Magnesium | Manganese | Potassium | Sodium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MW-B (Shallow)** | | | | | | | | | | | | | | | | | | | | | | | |
| 4/17/13 to 4/29/14* | DRY- NOT SAMPLED | | | | | | | | | | | | | | | | | | | | | | |
| **MW-G (Upper Aquifer)** | | | | | | | | | | | | | | | | | | | | | | | |
| 10/23/13 to current | DRY- NOT SAMPLED | | | | | | | | | | | | | | | | | | | | | | |
| **MW-H1 (Upper Aquifer)** | | | | | | | | | | | | | | | | | | | | | | | |
| 7/16/12 to current | DRY- NOT SAMPLED | | | | | | | | | | | | | | | | | | | | | | |
| **MW-H2 (Upper Aquifer)** | | | | | | | | | | | | | | | | | | | | | | | |
| 1/15/14 | 520 | 7.4 | 14 | <0.50 | 15 | <1.0 | 330 | 0.51 | 28 | 34 | <1.0 | <1.0 | 1.7 | 53 | <0.25 | 74 | <0.050 | 29 | <0.10 | 0.15 | <0.0050 | <1.0 | 64 |
| 4/29/14 | 500 | 8.1 | 11 | <0.50 | 11 | <1.0 | 290 | 0.65 | 32 | 39 | <1.0 | <1.0 | 1.1 | 55 | <0.25 | 65 | <0.050 | 26 | <0.10 | 0.13 | <0.0050 | <1.0 | 61 |
| 8/13/14 | 500 | 8.6 | 14 | <0.035 | 14 | 0.061 J | 320 | 1.1 | 36 | 44 | <0.23 | <0.23 | 1.3 | 60 | <0.0056 | 71 | 0.011 J | 28 | <0.017 | 0.16 | 0.00047 J | 0.45 J | 67 |
| 10/23/14 | 520 | 7.9 | 13 | <0.035 | 13 | 0.15 J | 330 | 0.41 | 32 | 39 | <0.23 | <0.23 | 1.8 | 54 | <0.0028 | 72 | 0.0096 J | 28 | <0.017 | 0.15 | 0.00023 J | 0.28 J | 65 |
| 2/10/15 | 510 | 7.9 | 13 | <0.035 | 13 | 0.16 J | 320 | 0.99 | 35 | 42 | <0.23 | <0.23 | 1.3 | 59 | <0.0028 | 66 | 0.012 J | 26 | <0.017 | 0.15 | 0.00048 J | 0.35 J | 63 |
| 4/27/15 | 490 | 8.1 | 12 | <0.035 | 12 | 0.15 J | 290 | 0.58 | 32 | 39 | <0.23 | <0.23 | 3.9 | 55 | <0.0028 | 67 | 0.020 J | 27 | <0.017 | 0.13 | <0.00017 | 0.28 J | 66 |
| 7/21/15 | 500 | 7.9 | 12 | <0.035 | 12 | 0.10 J | 290 | 0.82 | 35 | 42 | <0.23 | <0.23 | 0.98 | 55 | <0.0056 | 63 | 0.010 J | 25 | <0.017 | 0.14 | <0.00017 | 0.20 J | 63 |
| 10/27/15 | 470 | 7.4 | 9.7 | 0.18 J | 9.9 | <0.038 | 310 | 0.64 | 70 | 85 | <0.23 | <0.23 | 2.8 | 50 | <0.0028 | 60 | 0.015 J | 24 | <0.017 | 0.12 | <0.00017 | 0.45 J | 57 |
| 1/26/16 | 520 | 8.2 | 13 | <0.080 | 13 | <0.025 | 340 | 1.2 | 46 | 56 | <0.23 | <0.23 | 4.4 | 63 | <0.0056 | 69 | 0.0094 J | 28 | <0.017 | 0.13 | 0.00019 J | 0.37 J | 65 |
| 4/14/16 | 510 | 8.0 | 12 | 1.6 | 14 | 0.11 J | 310 | 0.36 | 34 | 41 | <0.23 | <0.23 | 1.3 | 61 | <0.0056 | 73 | 0.014 J | 29 | <0.017 | 0.14 | 0.00034 J | 0.49 J | 65 |
| 7/8/16 | 520 | 8.0 | 13 | 0.62 | 13 | <0.038 | 330 | 0.46 | 37 | 45 | <0.23 | <0.23 | 1.5 | 64 | <0.0056 | 74 | 0.019 J | 29 | <0.017 | 0.15 | 0.0002 J | 0.34 J | 66 |
| 10/21/16 | 510 | 7.4 | 13 | 1.1 | 14 | <0.038 | 320 | 0.70 | 34 | 41 | <0.23 | <0.23 | 4.6 | 70 | <0.0056 | 69 | 0.023 J | 27 | <0.017 | 0.13 | <0.00017 | 0.34 J | 65 |
| 1/13/17 | 550 | 8.0 | 13 | 1.3 | 14 | <0.038 | 350 | 0.56 | 37 | 45 | <0.23 | <0.23 | 1.2 | 67 | <0.0056 | 76 | 0.020 J | 30 | <0.017 | 0.19 | <0.00017 | 0.64 J | 67 |
| 4/20/17 | 530 | 7.9 | 13 | 0.91 | 14 | <0.019 | 350 | 0.97 | 35 | 43 | <0.23 | <0.23 | 2.4 | 67 | <0.0056 | 75 | 0.014 J | 30 | <0.017 | 0.20 | 0.00094 J | 0.53 J | 74 |
| 7/7/17 | 530 | 7.7 | 12 | 0.80 | 13 | <0.019 | 310 | 0.48 | 36 | 44 | <0.23 | <0.23 | 5.9 | 64 | <0.0056 | 76 | 0.024 J | 30 | <0.017 | 0.24 | 0.00080 J | 0.67 J | 77 |
| 10/12/17 | 510 | 7.6 | 11 | 1.6 | 13 | 0.16 J | 300 | 1.0 | 36 | 44 | <0.23 | <0.23 | 0.72 | 63 | <0.0028 | 67 | 0.014 J | 27 | <0.017 | 0.17 | 0.00025 J | 0.45 J | 67 |
| 1/16/18 | 480 | 7.5 | 12 | 1.4 | 14 | 0.80 J | 340 | <0.65 | 28 | 34 | <0.23 | <0.23 | 3.2 | 67 | <0.0056 | 74 | 0.015 J | 29 | < 0.017 | 0.21 | <0.00017 | 0.60 J | 71 |
| 4/2/18 | 540 | 7.8 | 12 | 1.1 | 13 | <0.058 | 340 | <1.0 | 37 | 45 | <0.23 | <0.23 | 10 | 75 | <0.0028 | 73 | 0.017 J | 29 | <0.017 | 0.15 | <0.00017 | 0.44 J | 71 |
| 10/4/18 | 480 | 8.4 | 10 | 0.8 | 11 | <0.18 | 320 | -- | 37 | 45 | <0.23 | <0.23 | 0.56 | 69 | -- | 72 | -- | 29 | -- | 0.15 | -- | 0.41 J | 67 |
| 4/4/19 | 490 | 7.5 | 12 | 1.2 | 13 | <0.18 | 320 | -- | 34 | 41 | <0.23 | <0.23 | 2.2 | 71 | -- | 65 | -- | 26 | -- | 0.12 | -- | 0.39 J | 69 |

**TABLE 2**
**GROUNDWATER QUALITY RESULTS**
**Visalia Water Conservation Plant**
Results in mg/l unless otherwise noted

| Date | EC (µs/cm) | pH (pH units) | Nitrate as Nitrogen | Total Kjeldahl Nitrogen | Total Nitrogen | Ammonia as N | Total Dissolved Solids | Total Organic Carbon | Total Alkalinity as $CaCO_3$ | Bicarbonate Alkalinity as $HCO_3$ | Carbonate Alkalinity as $CO_3$ | Hydroxide Alkalinity as OH | Cation/Anion Balance (%difference) | Chloride | Phosphate | Hardness | Boron | Calcium | Iron | Magnesium | Manganese | Potassium | Sodium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MW-H3 (Deep Aquifer)** | | | | | | | | | | | | | | | | | | | | | | | |
| 1/15/14 | 130 | 9.2 | <0.45 | <0.50 | <0.50 | <1.0 | 76 | 0.52 | 50 | 40 | 10 | <1.0 | 2.2 | 3.1 | <0.25 | 5.8 | <0.050 | 2.3 | <0.10 | <0.10 | <0.0050 | <1.0 | 26 |
| 4/29/14 | 130 | 9.6 | <0.45 | <0.50 | <0.50 | <1.0 | 87 | 0.76 | 52 | 26 | 19 | <1.0 | 0.15 | 2.9 | <0.25 | 5.4 | <0.050 | 2.2 | <0.10 | <0.10 | <0.0050 | <1.0 | 25 |
| 8/14/14 | 120 | 7.8 | <0.45 | 3.3 | 3.4 | 0.88 J | 94 | 1.7 | 56 | 68 | <0.23 | <0.23 | 0.68 | 4.1 | <0.0028 | 7.0 | 0.025 J | 2.8 | <0.017 | 0.016 J | 0.0017 J | 0.27 J | 27 |
| 10/23/14 | 130 | 9.2 | <0.45 | 0.45 J | <0.45 | 0.20 J | 97 | 0.43 | 48 | 36 | 11 | <0.23 | 2.9 | 3.5 | 0.11 J | 6.8 | 0.017 J | 2.7 | 0.032 J | 0.021 J | 0.0018 J | 0.11 J | 25 |
| 2/10/15 | 130 | 9.6 | <0.45 | <0.035 | <0.50 | <0.038 | 110 | 1.2 | 55 | 32 | 17 | <0.23 | 0.61 | 3.2 | <0.0028 | 6.1 | 0.020 J | 2.4 | 0.027 J | 0.014 J | 0.0011 J | 0.089 J | 26 |
| 4/27/15 | 130 | 9.5 | <0.45 | 0.34 J | <0.50 | 0.12 J | 94 | 0.39 | 52 | 29 | 17 | <0.23 | 0.20 | 3.3 | <0.0028 | 6.4 | 0.026 J | 2.6 | <0.017 | <0.0091 | 0.00068 J | <0.077 | 25 |
| 7/21/15 | 130 | 9.3 | 0.033 J | 0.31 J | 0.35 J | 0.086 J | 94 | 0.92 | 68 | 55 | 14 | <0.23 | 8.9 | 3.5 | <0.0028 | 6.3 | 0.028 J | 2.5 | 0.027 J | 0.016 J | 0.0014 J | 0.083 J | 27 |
| 10/2/15 | 130 | 9.5 | 0.021 J | 0.13 J | 0.15 | <0.038 | 100 | 0.59 | 80 | 61 | 18 | <0.23 | 12 | 3.8 | <0.0028 | 7.4 | 0.019 J | 2.9 | 0.030 J | 0.040 J | 0.0011 J | 0.20 J | 27 |
| 1/26/16 | 130 | 9.4 | <0.0040 | 0.12 J | 0.12 J | <0.025 | 120 | 0.50 | 53 | 41 | 12 | <0.23 | 0.82 | 3.5 | <0.0028 | 6.4 | 0.017 J | 2.5 | 0.028 J | 0.018 J | 0.0017 J | <0.077 | 26 |
| 4/14/16 | 130 | 9.4 | <0.0040 | 0.32 J | <1.2 | 0.060 J | 120 | 0.36 | 56 | 36 | 16 | <0.23 | 0.46 | 3.5 | 0.28 | 6.5 | 0.020 J | 2.6 | 0.022 J | 0.017 J | 0.0011 J | 0.25 J | 27 |
| 7/8/16 | 130 | 9.3 | <0.0040 | 0.18 J | <1.2 | 0.066 J | 100 | 0.42 | 52 | 31 | 16 | <0.23 | 0.44 | 3.6 | <0.0028 | 6.4 | 0.024 J | 2.5 | 0.030 J | 0.014 J | 0.0017 J | <0.077 | 26 |
| 10/21/16 | 120 | 7.6 | <0.0040 | 0.33 J | <1.2 | <0.038 | 110 | 0.94 | 55 | 68 | <0.23 | <0.23 | 0.21 | 3.5 | <0.0028 | 6.4 | 0.024 J | 2.5 | 0.051 J | 0.025 J | 0.0020 J | 0.088 J | 27 |
| 1/13/17 | 130 | 9.3 | 0.031 J | 0.22 J | <1.2 | <0.038 | 88 | 0.50 | 49 | 29 | 15 | <0.23 | 5.1 | 3.5 | <0.0028 | 6.6 | 0.027 J | 2.6 | 0.023 J | 0.040 J | 0.0013 J | 0.16 J | 27 |
| 4/20/17 | 130 | 9.2 | <0.0040 | 0.25 J | <1.2 | <0.019 | 110 | 0.90 | 55 | 39 | 13 | <0.23 | 3.0 | 3.5 | <0.0028 | 6.5 | 0.019 J | 2.6 | 0.033 J | 0.040 J | 0.0018 J | 0.17 J | 28 |
| 7/7/17 | 130 | 8.9 | 0.046 J | 0.23 J | <1.6 | <0.019 | 100 | 1.4 | 54 | 48 | 8.5 | <0.23 | 6.8 | 3.4 | <0.0028 | 7.3 | 0.022 J | 2.7 | 0.046 J | 0.13 | 0.0020 J | 0.20 J | 30 |
| 10/12/17 | 170 | 9.1 | 2.7 | 1.1 | 4.2 | 0.085 J | 120 | 2.5 | 53 | 40 | 13 | <0.23 | 2.6 | 7.0 | <0.0028 | 16 | 0.021 J | 5.6 | 0.025 J | 0.57 | 0.0044 J | 1.2 | 32 |
| 1/17/18 | 190 | 8.4 | 3.3 | 2.5 | 5.8 | 0.21 J | 150 | 2.2 | 60 | 70 | 1.3 | <0.23 | 0.42 | 9.9 | <0.0028 | 33 | 0.025 J | 8.9 | 0.040 J | 2.5 | 0.0020 J | 1.6 | 27 |
| 4/2/18 | 130 | 9.2 | 0.11 J | <0.078 | <0.50 | <0.058 | 140 | <1.0 | 56 | 36 | 16 | <0.23 | 2.5 | 5.0 | <0.0028 | 6.5 | 0.022 J | 2.6 | 0.037 J | 0.018 J | 0.0016 J | 0.19 J | 27 |
| 10/4/18 | 120 | 9.5 | 0.25 J | 0.42 J | 0.67 | <0.18 | 160 | -- | 50 | 44 | 8.4 | <0.23 | 5.0 | 3.8 | -- | 8.3 | -- | 3.1 | -- | 0.17 | -- | 0.19 J | 27 |
| 4/4/19 | 120 | 8.9 | <0.028 | 0.26 J | <0.50 | <0.18 | 180 | -- | 47 | 36 | 10 | <0.23 | 7.0 | 2.8 | -- | 5.7 | -- | 2.3 | -- | <0.025 | -- | <0.34 | 26 |
| **MW-J1 (Upper Aquifer)** | | | | | | | | | | | | | | | | | | | | | | | |
| 1/16/14 | 810 | 7.9 | 15 | <0.50 | 15 | <1.0 | 490 | 1.8 | 180 | 220 | <1.0 | <1.0 | 2.2 | 71 | <0.50 | 230 | 0.20 | 77 | <0.10 | 9.2 | <0.0050 | <1.0 | 74 |
| 4/30/14 | 810 | 7.8 | 11 | <0.50 | 11 | <1.0 | 520 | 1.5 | 200 | 250 | <1.0 | <1.0 | 2.4 | 84 | <0.50 | 220 | 0.17 | 74 | <0.10 | 8.4 | <0.0050 | <1.0 | 75 |
| 8/21/14 | 490 | 6.9 | 9.0 | 0.91 | 9.9 | 0.19 J | 330 | 2.5 | 38 | 46 | <0.23 | <0.23 | 41 | 73 | 0.13 J | 320 | 0.13 | 69 | 0.019 J | 36 | 0.048 | 5.9 | 78 |
| 10/24/14 | 780 | 7.4 | 3.6 | 0.038 J | 3.6 | <0.038 | 450 | 1.2 | 230 | 270 | <0.23 | <0.23 | 1.4 | 80 | <0.0056 | 220 | 0.17 | 76 | <0.017 | 8.5 | 0.0013 J | 0.85 J | 74 |
| 2/11/15 | 800 | 7.8 | 4.5 | <0.035 | 4.5 | <0.038 | 470 | 1.9 | 230 | 290 | <0.23 | <0.23 | 2.2 | 77 | <0.0056 | 220 | 0.17 | 72 | <0.017 | 9.1 | 0.0032 J | 0.72 J | 71 |
| 4/30/15 | 830 | 7.9 | 8.8 | 3.3 | 12 | 0.58 J | 560 | 2.5 | 250 | 300 | <0.23 | <0.23 | 1.4 | 75 | <0.0056 | 240 | 0.18 | 82 | <0.017 | 9.8 | 0.091 | 0.94 J | 82 |
| 7/22/15 | 810 | 7.8 | 11 | 8.3 | 19 | 0.51 J | 560 | 4.5 | 230 | 280 | <0.23 | <0.23 | 0.81 | 68 | <0.0056 | 240 | 0.19 | 83 | <0.017 | 8.3 | 0.036 | 1.7 | 72 |
| 10/26/15 | DRY- NOT SAMPLED | | | | | | | | | | | | | | | | | | | | | | |
| 1/25/16 | DRY- NOT SAMPLED | | | | | | | | | | | | | | | | | | | | | | |
| 4/13/16 | DRY- NOT SAMPLED | | | | | | | | | | | | | | | | | | | | | | |
| 7/7/16 | 940 | 7.8 | 18 | 2.3 | 21 | <0.038 | 670 | 1.2 | 270 | 330 | <0.23 | <0.23 | 0.88 | 62 | <0.0056 | 290 | 0.21 | 98 | <0.017 | 11 | 0.00017 J | 0.98 J | 79 |
| 10/21/16 | 520 | 8.1 | 0.061 J | 0.33 | <2.0 | <0.038 | 360 | 1.4 | 140 | 170 | <0.23 | <0.23 | 0.92 | 59 | <0.0056 | 120 | 0.22 | 42 | 0.026 J | 4.7 | 0.0020 J | 0.85 J | 56 |
| 1/13/17 | 680 | 7.6 | 0.67 J | 1.6 | <2.5 | 0.17 J | 410 | 1.7 | 220 | 260 | <0.23 | <0.23 | 2.4 | 55 | <0.0056 | 180 | 0.22 | 63 | <0.017 | 6.8 | 0.011 | 1.1 | 65 |
| 4/19/17 | 720 | 7.3 | 17 | 2.0 | 19 | 1.6 J | 490 | 1.5 | 150 | 190 | <0.23 | <0.23 | 1.0 | 55 | <0.0056 | 170 | 0.18 | 59 | 0.059 J | 6.4 | 0.018 | 1.1 | 81 |
| 7/6/17 | 730 | 7.2 | 14 | 3.4 | 17 | <0.047 | 480 | 1.8 | 170 | 210 | <0.23 | <0.23 | 4.3 | 45 | <0.0056 | 180 | 0.21 | 62 | <0.017 | 7.1 | <0.00017 | 1.2 | 87 |
| 10/12/17 | 540 | 7.5 | 5.7 | 4.0 | 9.7 | 0.12 J | 370 | 2.3 | 190 | 230 | <0.23 | <0.23 | 1.7 | 13 | <0.0028 | 140 | 0.16 | 46 | 0.037 J | 5.0 | 0.057 | 0.96 J | 62 |
| 1/18/18 | DRY- NOT SAMPLED | | | | | | | | | | | | | | | | | | | | | | |
| 4/2/18 | DRY- NOT SAMPLED | | | | | | | | | | | | | | | | | | | | | | |
| 10/2/18 | DRY- NOT SAMPLED | | | | | | | | | | | | | | | | | | | | | | |
| 4/2/19 | DRY- NOT SAMPLED | | | | | | | | | | | | | | | | | | | | | | |

**TABLE 2**
**GROUNDWATER QUALITY RESULTS**
**Visalia Water Conservation Plant**
Results in mg/l unless otherwise noted

| Date | EC (µs/cm) | pH (pH units) | Nitrate as Nitrogen | Total Kjeldahl Nitrogen | Total Nitrogen | Ammonia as N | Total Dissolved Solids | Total Organic Carbon | Total Alkalinity as $CaCO_3$ | Bicarbonate Alkalinity as $HCO_3$ | Carbonate Alkalinity as $CO_3$ | Hydroxide Alkalinity as OH | Cation/Anion Balance (%difference) | Chloride | Phosphate | Hardness | Boron | Calcium | Iron | Magnesium | Manganese | Potassium | Sodium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MW-J2 (Upper Aquifer)** | | | | | | | | | | | | | | | | | | | | | | | |
| 1/16/14 | 720 | 8.0 | 8.8 | <0.50 | 8.8 | <1.0 | 420 | 1.3 | 160 | 200 | <1.0 | <1.0 | 0.77 | 70 | <0.50 | 150 | 0.079 | 61 | <0.10 | 0.72 | <0.0050 | <1.0 | 82 |
| 4/29/14 | 710 | 7.9 | 9.1 | <0.50 | 9.1 | <1.0 | 440 | 1.1 | 160 | 200 | <1.0 | <1.0 | 0.24 | 71 | <0.50 | 150 | 0.067 | 58 | <0.10 | 0.68 | <0.0050 | <1.0 | 85 |
| 8/21/14 | 500 | 7.1 | 9.4 | 26 | 37 | 0.22 J | 320 | 4.5 | 40 | 49 | <0.23 | <0.23 | 2.6 | 72 | <0.0056 | 71 | 0.014 J | 27 | <0.017 | 0.53 | 0.0056 | 2.4 | 69 |
| 10/24/14 | 720 | 7.5 | 9.8 | 0.092 J | 9.8 | 0.24 J | 400 | 0.96 | 170 | 200 | <0.23 | <0.23 | 1.7 | 74 | <0.0056 | 160 | 0.087 J | 63 | <0.017 | 0.71 | 0.0031 J | 0.63 J | 88 |
| 2/11/15 | 730 | 8.0 | 9.4 | 0.068 J | 9.4 | <0.038 | 420 | 2.0 | 170 | 210 | <0.23 | <0.23 | 0.82 | 69 | <0.0056 | 150 | 0.073 | 59 | <0.017 | 0.69 | 0.0036 J | 0.59 J | 83 |
| 4/30/15 | 710 | 8.0 | 9.7 | <0.035 | 9.7 | 0.21 J | 450 | 1.0 | 170 | 210 | <0.23 | <0.23 | 0.20 | 70 | <0.0056 | 150 | 0.089 | 60 | <0.017 | 0.72 | 0.0031 J | 0.66 J | 86 |
| 7/22/15 | 700 | 7.9 | 9.7 | <0.035 | 9.7 | 0.10 J | 430 | 1.3 | 160 | 200 | <0.23 | <0.23 | 1.2 | 71 | <0.0056 | 160 | 0.084 | 62 | <0.017 | 0.67 | 0.0029 J | 0.60 J | 85 |
| 10/28/15 | 690 | 7.5 | 9.5 | 0.13 J | 9.6 | <0.038 | 420 | 1.0 | 160 | 190 | <0.23 | <0.23 | 4.8 | 70 | <0.0056 | 140 | 0.082 | 56 | <0.017 | 0.59 | 0.0055 | 0.71 J | 80 |
| 1/25/16 | 710 | 7.9 | 10 | 0.11 J | 10 | <0.025 | 400 | 1.1 | 160 | 200 | <0.23 | <0.23 | 1.6 | 74 | <0.0056 | 150 | 0.10 | 58 | <0.017 | 0.70 | 0.0054 | 0.87 J | 81 |
| 4/13/16 | 710 | 8.1 | 9.5 | 1.1 | 11 | 0.19 J | 440 | 0.95 | 160 | 200 | <0.23 | <0.23 | 0.56 | 70 | <0.0056 | 150 | 0.080 | 58 | <0.017 | 0.70 | 0.0042 J | 0.90 J | 83 |
| 7/7/16 | 690 | 8.0 | 9.2 | 1.2 | 10 | <0.038 | 410 | 1.1 | 160 | 190 | <0.23 | <0.23 | 0.40 | 70 | <0.0056 | 140 | 0.076 | 55 | <0.017 | 0.63 | 0.0037 J | 0.63 J | 83 |
| 10/21/16 | 650 | 8.0 | 8.3 | 1.2 | 9.5 | <0.038 | 440 | 1.2 | 140 | 170 | <0.23 | <0.23 | 4.2 | 74 | <0.0056 | 150 | 0.095 | 59 | 0.024 J | 0.71 | 0.0032 J | 0.72 J | 85 |
| 1/20/17 | 750 | 7.8 | 9.5 | 1.7 | 11 | 0.12 J | 420 | 1.6 | 160 | 190 | <0.23 | <0.23 | 3.4 | 71 | <0.0056 | 160 | 0.11 | 63 | <0.017 | 1.3 | 0.0085 | 1.4 | 84 |
| 4/19/17 | 720 | 7.8 | 7.4 | 2.4 | 9.8 | <0.019 | 440 | 1.3 | 170 | 200 | <0.23 | <0.23 | 2.2 | 73 | <0.0056 | 150 | 0.089 | 59 | <0.017 | 0.82 J | 0.0049 | 0.92 J | 88 |
| 7/7/17 | 710 | 7.9 | 7.5 | 0.76 | 8.2 | <0.019 | 420 | 0.98 | 170 | 200 | <0.23 | <0.23 | 2.5 | 73 | <0.0056 | 150 | 0.090 | 57 | <0.017 | 0.87 | 0.0057 | 0.95 J | 91 |
| 10/10/17 | 700 | 7.7 | 7.2 | 1.3 | 8.4 | 0.20 J | 400 | 1.5 | 160 | 200 | <0.23 | <0.23 | 0.85 | 74 | <0.0056 | 140 | 0.072 | 55 | <0.017 | 0.70 | 0.0043 J | 0.78 J | 84 |
| 1/18/18 | 690 | 7.6 | 9.5 | 1.3 | 11 | 0.24 J | 420 | 1.4 | 150 | 180 | <0.23 | <0.23 | 4.7 | 71 | <0.0056 | 150 | 0.090 | 57 | <0.017 | 1.5 | 0.014 | 2.4 | 89 |
| 4/4/18 | 800 | 7.6 | 15 | 1.6 | 16 | <0.058 | 450 | 1.6 | 180 | 220 | <0.23 | <0.23 | 0.79 | 73 | <0.0056 | 170 | 0.099 | 66 | <0.017 | 2.3 | 0.017 | 2.2 | 92 |
| 10/5/18 | 640 | 7.5 | 6.4 | 1.2 | 7.6 | <0.18 | 420 | -- | 160 | 190 | <0.23 | <0.23 | 2.0 | 71 | -- | 150 | -- | 57 | -- | 0.79 | -- | 0.74 J | 82 |
| 4/9/19 | 670 | 7.7 | 8.0 | 1.0 | 9.0 | 0.45 J | 410 | -- | 160 | 200 | <0.23 | <0.23 | 2.8 | 79 | -- | 140 | -- | 53 | -- | 1.2 | -- | 1.4 | 84 |
| **MW-J3 (Deep Aquifer)** | | | | | | | | | | | | | | | | | | | | | | | |
| 1/16/14 | 120 | 8.8 | <0.45 | <0.50 | <0.50 | <1.0 | 65 | 0.23 | 44 | 45 | 3.9 | <1.0 | 0.84 | 5.4 | <0.25 | 6.8 | <0.050 | 2.7 | <0.10 | <0.10 | <0.0050 | <1.0 | 23 |
| 4/30/14 | 120 | 9.0 | <0.45 | <0.50 | <0.50 | <1.0 | 92 | 0.29 | 48 | 47 | 5.9 | <1.0 | 0.54 | 4.7 | <0.25 | 6.1 | <0.050 | 2.5 | <0.10 | <0.10 | <0.0050 | <1.0 | 24 |
| 8/14/14 | 110 | 7.2 | <0.45 | <0.035 | <0.50 | 0.17 J | 88 | 1.5 | 33 | 40 | <0.23 | <0.23 | 17 | 4.4 | <0.0028 | 6.9 | 0.020 | 2.7 | <0.017 | 0.024 J | 0.00094 J | 0.77 J | 24 |
| 10/24/14 | 120 | 9.4 | <0.45 | 0.14 J | <0.45 | <0.038 | 71 | 0.19 J | 49 | 51 | 4.0 | <0.23 | 1.2 | 4.3 | 0.082 J | 7.2 | 0.016 J | 2.9 | <0.017 | <0.0091 | 0.00019 J | 0.27 J | 24 |
| 2/11/15 | 120 | 9.2 | <0.45 | <0.035 | <0.50 | <0.038 | 84 | 0.81 | 48 | 43 | 7.8 | <0.23 | 0.050 | 3.8 | <0.0028 | 6.4 | 0.016 J | 2.6 | <0.017 | 0.013 J | 0.00039 J | 0.20 J | 23 |
| 4/30/15 | 120 | 9.1 | <0.45 | 0.18 J | <0.50 | 0.23 J | 100 | 0.28 | 52 | 48 | 7.3 | <0.23 | 2.7 | 3.8 | <0.0028 | 6.6 | 0.038 J | 2.6 | <0.017 | <0.0091 | <0.00017 | 0.16 J | 23 |
| 7/22/15 | 120 | 8.8 | 0.026 J | <0.035 | <0.035 | 0.083 | 96 | 0.49 | 53 | 55 | 4.9 | <0.23 | 4.3 | 4.0 | <0.0028 | 6.7 | 0.024 J | 2.7 | <0.017 | 0.013 J | <0.00017 | 0.28 J | 23 |
| 10/28/15 | 120 | 9.1 | 0.029 J | <0.080 | 0.030 J | <0.038 | 100 | 0.31 | 75 | 55 | 18 | <0.23 | 17 | 4.0 | <0.0028 | 7.3 | 0.021 J | 2.9 | <0.017 | 0.011 J | <0.00017 | 0.26 J | 23 |
| 1/25/16 | 120 | 9.2 | <0.0040 | <0.080 | <0.50 | <0.025 | 110 | 0.24 | 56 | 58 | 5.0 | <0.23 | 5.3 | 4.5 | <0.0028 | 7.0 | 0.026 J | 2.8 | <0.017 | 0.016 J | 0.00020 J | 0.24 J | 24 |
| 4/13/16 | 120 | 9.0 | <0.0040 | 0.046 J | <1.2 | 0.051 J | 98 | 0.57 | 49 | 48 | 6.1 | <0.23 | 1.4 | 5.2 | 0.27 | 7.2 | 0.019 J | 2.8 | <0.017 | 0.027 J | 0.00024 J | 0.32 J | 24 |
| 7/7/16 | 120 | 9.0 | <0.0040 | 0.32 J | <1.2 | <0.038 | 100 | 0.46 | 46 | 40 | 8.1 | <0.23 | 2.3 | 5.7 | <0.0028 | 7.2 | 0.018 J | 2.8 | <0.017 | 0.031 J | 0.00038 J | 0.17 J | 25 |
| 10/21/16 | 120 | 7.6 | <0.0040 | 0.35 J | <1.2 | <0.038 | 110 | 0.50 | 49 | 60 | <0.23 | <0.23 | 1.4 | 6.1 | <0.0028 | 7.5 | 0.021 J | 3.0 | 0.026 J | 0.019 J | 0.00030 J | 0.24 J | 26 |
| 1/13/17 | 130 | 9.0 | 0.0093 J | 0.055 J | <1.2 | <0.038 | 100 | 0.39 | 46 | 43 | 6.3 | <0.23 | 5.0 | 5.5 | <0.0028 | 7.3 | 0.022 J | 2.9 | <0.017 | 0.032 J | <0.00017 | 0.29 J | 26 |
| 4/19/17 | 120 | 9.0 | 0.023 J | 0.30 J | <1.2 | <0.019 | 120 | 0.43 | 50 | 49 | 6.2 | <0.23 | 0.47 | 5.6 | <0.0028 | 7.1 | 0.017 J | 2.8 | <0.017 | 0.012 J | 0.0002 J | 0.21 J | 26 |
| 7/7/17 | 130 | 8.6 | <0.0040 | <0.10 | <1.2 | <0.019 | 100 | 0.56 | 47 | 50 | 3.2 | <0.23 | 5.9 | 6.9 | <0.0028 | 7.6 | 0.018 J | 3.0 | <0.017 | 0.046 J | 0.00025 J | 0.30 J | 28 |
| 10/10/17 | 120 | 8.8 | 0.012 J | 0.17 J | 0.75 | 0.23 J | 90 | 0.46 | 44 | 43 | 5.3 | <0.23 | 0.95 | 6.7 | <0.0028 | 7.4 | 0.017 J | 2.9 | <0.017 | 0.010 J | 0.00018 J | 0.25 J | 25 |
| 1/18/18 | 120 | 8.4 | 0.016 J | <0.10 | <0.50 | 0.078 J | 81 | <0.65 | 42 | 49 | 0.77 J | <0.23 | 7.6 | 6.0 | <0.0028 | 7.3 | 0.017 J | 2.9 | <0.017 | 0.017 J | 0.00036 J | 0.27 J | 25 |
| 4/4/18 | 130 | 8.9 | 0.14 J | <0.078 | <0.50 | <0.058 | 140 | <1.0 | 53 | 56 | 4.1 | <0.23 | 2.4 | 6.7 | <0.0028 | 7.6 | 0.022 J | 3.0 | <0.017 | 0.012 J | <0.00017 | 0.27 J | 26 |
| 10/5/18 | 130 | 9.2 | 0.19 J | 4.2 | 4.4 | <0.18 | 120 | -- | 41 | 50 | 0.39 J | <0.23 | 2.0 | 9.4 | -- | 8.3 | -- | 3.3 | -- | <0.025 | -- | 0.22 J | 25 |
| 4/9/19 | 120 | 8.6 | <0.028 | <0.18 | <0.50 | <0.18 | 96 | -- | 44 | 46 | 3.3 | <0.23 | 0.28 | 8.7 | -- | 7.1 | -- | 2.8 | -- | <0.025 | -- | <0.34 | 25 |

**TABLE 2**
**GROUNDWATER QUALITY RESULTS**
**Visalia Water Conservation Plant**
Results in mg/l unless otherwise noted

| Date | EC (µs/cm) | pH (pH units) | Nitrate as Nitrogen | Total Kjeldahl Nitrogen | Total Nitrogen | Ammonia as N | Total Dissolved Solids | Total Organic Carbon | Total Alkalinity as $CaCO_3$ | Bicarbonate Alkalinity as $HCO_3$ | Carbonate Alkalinity as $CO_3$ | Hydroxide Alkalinity as OH | Cation/Anion Balance (%difference) | Chloride | Phosphate | Hardness | Boron | Calcium | Iron | Magnesium | Manganese | Potassium | Sodium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MW-K1 (Upper Aquifer)** | | | | | | | | | | | | | | | | | | | | | | | |
| 1/16/14 | 780 | 8.0 | 8.1 | <0.50 | 8.1 | <1.0 | 440 | 0.87 | 230 | 290 | <1.0 | <1.0 | 1.4 | 52 | <0.50 | 270 | 0.067 | 92 | <0.10 | 9.0 | <0.0050 | <1.0 | 55 |
| 4/29/14 | 800 | 7.9 | 8.6 | <0.50 | 8.6 | <1.0 | 490 | 0.92 | 250 | 310 | <1.0 | <1.0 | 2.0 | 59 | <0.50 | 260 | 0.056 | 91 | <0.10 | 8.8 | <0.0050 | 1.1 | 58 |
| 8/21/14 | 760 | 7.9 | 7.6 | 0.13 J | 7.8 | 0.17 J | 490 | 0.90 J | 260 | 310 | <0.23 | <0.23 | 4.3 | 51 | <0.0056 | 280 | 0.075 | 95 | <0.017 | 9.7 | <0.00017 | 1.2 | 66 |
| 10/24/14 | 770 | 7.3 | 7.4 | <0.035 | 7.4 | <0.038 | 450 | 0.65 | 250 | 300 | <0.23 | <0.23 | 0.31 | 53 | <0.0056 | 270 | 0.068 | 92 | <0.017 | 8.7 | <0.00017 | 1.0 | 58 |
| 2/11/15 | 750 | 8.0 | 6.6 | <0.035 | 6.6 | <0.038 | 440 | 1.4 | 240 | 290 | <0.23 | <0.23 | 1.0 | 50 | <0.0056 | 240 | 0.051 | 84 | 0.042 J | 8.2 | 0.0014 J | 0.82 J | 53 |
| 4/30/15 | 740 | 7.9 | 6.7 | 0.21 J | 6.9 | 0.20 J | 460 | 0.78 | 240 | 290 | <0.23 | <0.23 | 0.97 | 49 | <0.0056 | 260 | 0.070 | 91 | <0.017 | 7.7 | <0.00017 | 0.88 J | 53 |
| 7/20/15 to current | DRY- NOT SAMPLED | | | | | | | | | | | | | | | | | | | | | | |
| **MW-K2 (Upper Aquifer)** | | | | | | | | | | | | | | | | | | | | | | | |
| 1/16/14 | 530 | 7.9 | 5.6 | <0.50 | 6.5 | <1.0 | 270 | 0.74 | 70 | 85 | <1.0 | <1.0 | 0.15 | 69 | <0.50 | 73 | <0.050 | 29 | <0.10 | 0.26 | <0.0050 | <1.0 | 68 |
| 4/29/14 | 530 | 7.9 | 5.7 | <0.50 | 5.7 | <1.0 | 310 | 0.69 | 66 | 81 | <1.0 | <1.0 | 1.0 | 70 | <0.50 | 76 | <0.050 | 30 | <0.10 | 0.40 | <0.0050 | <1.0 | 67 |
| 8/21/14 | 500 | 7.6 | 6.2 | 0.21 J | 6.4 | 0.16 J | 310 | 0.65 | 73 | 89 | <0.23 | <0.23 | 1.2 | 68 | <0.0056 | 76 | 0.018 J | 30 | <0.017 | 0.45 | 0.0023 J | 0.69 J | 70 |
| 10/24/14 | 530 | 8.1 | 6.4 | <0.035 | 6.4 | <0.038 | 280 | 0.55 | 62 | 76 | <0.23 | <0.23 | 0.29 | 73 | <0.0028 | 72 | 0.013 J | 28 | <0.017 | 0.29 | 0.0022 J | 0.63 J | 69 |
| 2/11/15 | 520 | 8.0 | 6.1 | <0.035 | 6.1 | <0.038 | 280 | 1.4 | 62 | 76 | <0.23 | <0.23 | 18 | 70 | <0.0028 | 65 | 0.013 J | 26 | 0.067 | 0.30 | 0.0028 J | 0.45 J | 65 |
| 4/30/15 | 520 | 8.1 | 7.0 | 0.080 J | 7.0 | 0.18 J | 320 | 0.67 | 66 | 81 | <0.23 | <0.23 | 0.29 | 72 | <0.0056 | 73 | 0.030 J | 29 | <0.017 | 0.30 | 0.0031 J | 0.52 J | 70 |
| 7/22/15 | 580 | 7.9 | 7.9 | 0.045 J | 8.0 | 0.10 J | 350 | 1.0 | 88 | 110 | <0.23 | <0.23 | 2.0 | 75 | <0.0056 | 87 | 0.021 J | 35 | <0.017 | 0.25 | 0.0021 J | 0.62 J | 74 |
| 10/28/15 | 590 | 7.5 | 7.6 | 0.13 J | 7.7 | <0.038 | 330 | 0.82 | 97 | 120 | <0.23 | <0.23 | 5.4 | 72 | <0.0056 | 90 | 0.025 J | 35 | <0.017 | 0.28 | 0.0039 J | 0.69 J | 75 |
| 1/25/16 | 580 | 8.0 | 8.4 | <0.080 | 8.4 | <0.025 | 340 | 0.76 | 87 | 110 | <0.23 | <0.23 | 2.0 | 75 | <0.0056 | 89 | 0.026 J | 35 | <0.017 | 0.42 | 0.0062 | 0.80 J | 74 |
| 4/13/16 | 570 | 8.0 | 8.1 | 1.4 | 9.5 | 0.047 J | 340 | 0.66 | 84 | 100 | <0.23 | <0.23 | 0.55 | 74 | <0.0056 | 83 | 0.030 J | 33 | <0.017 | 0.30 | 0.0044 J | 0.86 J | 76 |
| 7/7/16 | 570 | 8.1 | 7.5 | 1.0 | 8.5 | <0.038 | 360 | 0.77 | 91 | 110 | <0.23 | <0.23 | 0.31 | 71 | <0.0056 | 84 | 0.028 J | 33 | <0.017 | 0.30 | 0.0030 J | 0.71 J | 77 |
| 10/24/16 | 490 | 7.8 | 6.0 | 1.3 | 7.3 | <0.038 | 310 | 0.27 | 63 | 77 | <0.23 | <0.23 | 1.4 | 69 | <0.0028 | 72 | 0.026 J | 29 | <0.017 | 0.26 | 0.0018 J | 0.71 J | 68 |
| 1/13/17 | 520 | 7.9 | 5.5 | 1.1 | 6.6 | <0.038 | 280 | 0.67 | 57 | 70 | <0.23 | <0.23 | 2.7 | 68 | <0.0028 | 70 | 0.028 J | 28 | <0.017 | 0.26 | 0.0023 J | 0.73 J | 67 |
| 4/19/17 | 480 | 7.7 | 5.2 | 0.92 | 6.1 | <0.019 | 310 | 0.70 | 53 | 65 | <0.23 | <0.23 | 3.2 | 69 | <0.0028 | 67 | 0.020 J | 26 | <0.017 | 0.24 | 0.0022 J | 0.68 J | 69 |
| 7/6/17 | 480 | 7.7 | 5.0 | 0.60 | 5.6 | <0.019 | 280 | 0.79 | 58 | 71 | <0.23 | <0.23 | 5.1 | 67 | <0.0056 | 68 | 0.029 J | 27 | <0.017 | 0.24 | <0.00017 | 0.79 J | 72 |
| 10/10/17 | 550 | 7.8 | 7.5 | 0.99 | 8.5 | 0.21 J | 310 | 0.92 | 72 | 88 | <0.23 | <0.23 | 1.3 | 75 | <0.0028 | 78 | 0.024 J | 31 | <0.017 | 0.26 | 0.0027 J | 0.71 J | 72 |
| 1/18/18 | 530 | 7.7 | 7.7 | 1.4 | 9.1 | 0.27 J | 300 | <0.65 | 59 | 73 | <0.23 | <0.23 | 2.8 | 74 | <0.0056 | 79 | 0.021 J | 31 | <0.017 | 0.29 | 0.0033 J | 0.69 J | 74 |
| 4/3/18 | 550 | 7.4 | 9.1 (a) | 1.6 | 11 | 0.17 J | 350 | <1.0 | 75 | 92 | <0.23 | <0.23 | 0.41 | 72 | <0.0056 HT5 | 84 | 0.025 J | 33 | <0.017 | 0.35 | 0.0032 J | 0.75 J | 72 |
| 10/4/18 | 490 | 7.9 | 6.9 | 1.1 | 8.0 | <0.18 | 370 | -- | 60 | 73 | <0.23 | <0.23 | 2.3 | 73 | -- | 83 | -- | 33 | -- | 0.34 | -- | 0.61 J | 69 |
| 4/9/19 | 490 | 7.6 | 7.0 | 1.7 | 8.7 | <0.18 | 300 | -- | 55 | 68 | <0.23 | <0.23 | 4.3 | 82 | -- | 75 | -- | 29 | -- | 0.38 | -- | 0.82 J | 66 |

**TABLE 2**
**GROUNDWATER QUALITY RESULTS**
**Visalia Water Conservation Plant**

Results in mg/l unless otherwise noted

| Date | EC (µs/cm) | pH (pH units) | Nitrate as Nitrogen | Total Kjeldahl Nitrogen | Total Nitrogen | Ammonia as N | Total Dissolved Solids | Total Organic Carbon | Total Alkalinity as $CaCO_3$ | Bicarbonate Alkalinity as $HCO_3$ | Carbonate Alkalinity as $CO_3$ | Hydroxide Alkalinity as OH | Cation/Anion Balance (%difference) | Chloride | Phosphate | Hardness | Boron | Calcium | Iron | Magnesium | Manganese | Potassium | Sodium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MW-K3 (Deep Aquifer)** | | | | | | | | | | | | | | | | | | | | | | | |
| 1/16/14 | 120 | 9.0 | <0.45 | <0.50 | <0.50 | <1.0 | 81 | 0.30 | 45 | 42 | 6.3 | <1.0 | 1.8 | 3.7 | <0.25 | 6.1 | <0.050 | 2.5 | <0.10 | <0.10 | <0.0050 | <1.0 | 23 |
| 4/29/14 | 120 | 9.2 | <0.45 | <0.50 | <0.50 | <1.0 | 88 | 0.31 | 50 | 39 | 11 | <1.0 | 1.2 | 3.8 | <0.25 | 6.0 | <0.050 | 2.4 | <0.10 | <0.10 | <0.0050 | <1.0 | 24 |
| 8/14/14 | 110 | 7.3 | <0.45 | <0.035 | <0.50 | 0.10 J | 82 | 0.83 | 33 | 41 | <0.23 | <0.23 | 16 | 4.7 | <0.0028 | 7.4 | 0.020 J | 2.9 | <0.017 | 0.050 J | 0.0011 J | 0.41 J | 25 |
| 10/24/14 | 120 | 9.5 | <0.45 | 0.16 J | <0.50 | <0.038 | 76 | 0.21 | 45 | 44 | 5.5 | <0.23 | 4.0 | 4.0 | <0.0028 | 6.7 | 0.014 J | 2.7 | <0.017 | <0.0091 | 0.00045 J | 0.29 J | 24 |
| 2/11/15 | 120 | 9.3 | <0.45 | <0.035 | <0.50 | <0.038 | 72 | 0.99 | 49 | 40 | 9.6 | <0.23 | 2.7 | 4.0 | <0.0028 | 6.4 | 0.014 J | 2.6 | <0.017 | 0.010 J | 0.00037 J | 0.26 J | 25 |
| 4/30/15 | 120 | 9.2 | <0.45 | 0.13 J | <0.50 | 0.19 J | 92 | 0.30 | 51 | 39 | 11 | <0.23 | 0.69 | 4.1 | <0.0028 | 6.3 | 0.029 J | 2.5 | <0.017 | <0.0091 | 0.00020 J | 0.13 J | 24 |
| 7/22/15 | 120 | 9.0 | 0.055 J | 0.30 J | 0.35 J | 0.093 J | 100 | 0.70 | 50 | 46 | 7.7 | <0.23 | 0.51 | 4.1 | <0.0028 | 6.9 | 0.023 J | 2.7 | <0.017 | 0.014 J | <0.00017 | 0.23 J | 24 |
| 10/28/15 | 120 | 9.3 | 0.061 J | <0.080 | 0.060 J | <0.038 | 81 | 0.26 | 73 | 34 | 27 | <0.23 | 14 | 3.8 | <0.0028 | 7.0 | 0.015 J | 2.8 | <0.017 | 0.022 J | 0.00062 J | 0.29 J | 24 |
| 1/25/16 | 120 | 9.3 | <0.0040 | <0.080 | <0.50 | <0.025 | 79 | 0.34 | 52 | 41 | 11 | <0.23 | 0.53 | 4.3 | <0.0028 | 6.4 | 0.017 J | 2.6 | <0.017 | <0.0091 | <0.00017 | 0.18 J | 25 |
| 4/13/16 | 120 | 9.1 | <0.0040 | 0.24 J | <1.2 | 0.047 J | 100 | 0.32 | 52 | 43 | 9.8 | <0.23 | 0.37 | 4.4 | <0.0028 | 6.6 | 0.018 J | 2.6 | 0.017 J | 0.0097 J | <0.00017 | 0.29 J | 25 |
| 7/7/16 | 120 | 9.2 | <0.0040 | 0.29 J | <1.2 | <0.038 | 110 | 0.24 | 51 | 39 | 12 | <0.23 | 0.30 | 4.2 | <0.0028 | 6.7 | 0.012 J | 2.7 | <0.017 | 0.012 J | 0.00036 J | 0.16 J | 25 |
| 10/24/16 | 120 | 9.0 | 0.037 J | 0.35 J | <1.2 | <0.038 | 100 | 0.33 | 49 | 46 | 6.8 | <0.23 | 2.9 | 4.9 | <0.0028 | 7.0 | 0.024 J | 2.8 | <0.017 | 0.018 J | 0.00018 J | 0.16 J | 26 |
| 1/13/17 | 130 | 9.1 | 0.040 J | 0.34 J | <1.2 | <0.038 | 89 | 0.33 | 51 | 43 | 9.4 | <0.23 | 1.3 | 4.8 | <0.0028 | 6.8 | 0.021 J | 2.7 | <0.017 | 0.035 J | <0.00017 | 0.27 J | 26 |
| 4/19/17 | 120 | 9.0 | <0.0040 | 0.28 J | <1.2 | <0.019 | 93 | 0.38 | 49 | 41 | 9.6 | <0.23 | 3.3 | 5.2 | <0.0028 | 6.7 | 0.018 J | 2.7 | <0.017 | 0.0091 J | <0.00017 | 0.20 J | 27 |
| 7/6/17 | 130 | 8.8 | <0.0040 | 0.15 J | <1.2 | <0.019 | 96 | 1.0 | 49 | 48 | 5.4 | <0.23 | 8.1 | 5.4 | <0.0028 | 7.5 | 0.021 J | 2.9 | <0.017 | 0.053 J | 0.00058 J | 0.44 J | 30 |
| 10/10/17 | 120 | 8.9 | 0.044 J | 0.17 J | 0.73 | 0.14 J | 100 | 0.42 | 52 | 48 | 7.4 | <0.23 | 1.3 | 3.8 | <0.0028 | 6.4 | 0.015 J | 2.5 | <0.017 | 0.027 J | 0.00024 J | 0.20 J | 25 |
| 1/18/18 | 110 | 8.8 | 0.032 J | 0.12 J | <0.50 | <0.019 | 81 | <0.65 | 43 | 41 | 5.5 | <0.23 | 6.0 | 5.3 | <0.0028 | 6.4 | 0.014 J | 2.5 | <0.017 | 0.011 J | 0.00023 J | 0.23 J | 25 |
| 4/3/18 | 120 | 8.9 | 0.29 (a) | <0.078 | <0.50 | 0.18 J | 86 | <1.0 | 50 | 54 | 3.6 | <0.23 | 4.7 | 5.3 | <0.0028 HT5 | 6.3 | 0.024 J | 2.5 | <0.017 | <0.0091 | <0.00017 | 0.29 J | 25 |
| 10/4/18 | 110 | 9.4 | 0.13 J | 0.27 J | 0.71 | <0.18 | 97 | -- | 49 | 49 | 4.9 | <0.23 | 0.23 | 3.8 | -- | 6.4 | -- | 2.6 | -- | <0.025 | -- | 0.13 J | 24 |
| 4/9/19 | 110 | 8.8 | 0.036 J | <0.18 | <0.50 | <0.18 | 92 | -- | 48 | 45 | 6.7 | <0.23 | 1.9 | 4.0 | -- | 5.8 | -- | 2.3 | -- | <0.025 | -- | <0.34 | 25 |
| **MW-L (Upper Aquifer)** | | | | | | | | | | | | | | | | | | | | | | | |
| 7/29/13 to current | DRY- NOT SAMPLED | | | | | | | | | | | | | | | | | | | | | | |
| **MW-M (Upper Aquifer)** | | | | | | | | | | | | | | | | | | | | | | | |
| 7/16/12 to current | DRY- NOT SAMPLED | | | | | | | | | | | | | | | | | | | | | | |

**TABLE 2**
**GROUNDWATER QUALITY RESULTS**
**Visalia Water Conservation Plant**
Results in mg/l unless otherwise noted

| Date | EC (µs/cm) | pH (pH units) | Nitrate as Nitrogen | Total Kjeldahl Nitrogen | Total Nitrogen | Ammonia as N | Total Dissolved Solids | Total Organic Carbon | Total Alkalinity as $CaCO_3$ | Bicarbonate Alkalinity as $HCO_3$ | Carbonate Alkalinity as $CO_3$ | Hydroxide Alkalinity as OH | Cation/Anion Balance (%difference) | Chloride | Phosphate | Hardness | Boron | Calcium | Iron | Magnesium | Manganese | Potassium | Sodium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MW-N (Upper Aquifer)** | | | | | | | | | | | | | | | | | | | | | | | |
| 8/26/14 | 920 | 7.7 | 41 | <0.035 | 41 | 0.14 J | 740 | 1.1 | 190 | 230 | <0.23 | <0.23 | 2.5 | 58 | <0.0056 | 360 | 0.054 | 120 | <0.017 | 15 | 0.00064 J | 1.6 | 32 |
| 10/23/14 | 980 | 7.9 | 43 | <0.035 | 43 | <0.038 | 650 | 0.92 | 190 | 230 | <0.23 | <0.23 | 3.1 | 57 | <0.0056 | 400 | 0.019 J | 140 | <0.017 | 16 | 0.00045 J | 1.7 | 34 |
| 2/11/15 | 980 | 8.0 | 41 | <0.035 | 41 | <0.038 | 650 | 2.1 | 190 | 230 | <0.23 | <0.23 | 0.38 | 59 | <0.0056 | 380 | 0.019 J | 130 | 0.053 J | 15 | 0.0015 | 1.6 | 32 |
| 4/28/15 | 1,000 | 7.9 | 46 | <0.035 | 46 | 0.75 J | 660 | 1.1 | 220 | 270 | <0.23 | <0.23 | 0.99 | 59 | <0.0056 | 410 | 0.026 J | 140 | 0.022 J | 17 | <0.00017 | 1.7 | 34 |
| 7/20/15 | 960 | 7.8 | 44 | <0.035 | 44 | <0.038 | 630 | 1.9 | 190 | 230 | <0.23 | <0.23 | 2.0 | 63 | <0.0056 | 390 | 0.023 J | 130 | <0.017 | 15 | 0.0014 J | 1.5 | 33 |
| 10/27/15 | 950 | 7.4 | 36 | <0.080 | 36 | <0.038 | 700 | 7.4 | 200 | 250 | <0.23 | <0.23 | 6.5 | 53 | <0.0056 | 390 | 0.021 J | 130 | 2.9 | 16 | 0.066 | 2.3 | 31 |
| 1/26/16 | 960 | 7.9 | 40 | <0.080 | 40 | <0.025 | 700 | 0.92 | 190 | 230 | <0.23 | <0.23 | 13 | 60 | <0.0056 | 380 | 0.019 J | 130 | <0.017 | 14 | 0.0017 J | 1.8 | 32 |
| 4/12/16 | 930 | 7.0 | 40 | 0.15 J | 40 | 0.043 J | 670 | 0.73 | 190 | 230 | <0.23 | <0.23 | 0.43 | 59 | <0.0056 | 390 | 0.030 J | 130 | <0.017 | 15 | 0.00022 J | 1.9 | 31 |
| 7/6/16 | 920 | 7.8 | 39 | <0.035 | 39 | <0.038 | 670 | 0.98 | 190 | 230 | <0.23 | <0.23 | 1.1 | 55 | <0.0056 | 370 | 0.040 J | 130 | <0.017 | 15 | 0.0023 J | 1.6 | 30 |
| 10/24/16 | 910 | 7.7 | 40 | 0.69 | 40 | <0.038 | 710 | 0.80 | 190 | 230 | <0.23 | <0.23 | 0.62 | 57 | <0.0056 | 390 | 0.030 J | 130 | <0.017 | 15 | 0.00060 J | 1.8 | 32 |
| 1/12/17 | 990 | 7.7 | 39 | 0.58 | 40 | <0.038 | 680 | 0.93 | 190 | 240 | <0.23 | <0.23 | 0.88 | 55 | <0.0056 | 400 | 0.035 J | 130 | <0.017 | 16 | 0.0017 J | 1.9 | 32 |
| 4/19/17 | 1,000 | 7.6 | 40 | 0.11 J | 40 | <0.031 | 740 | 1.3 | 190 | 230 | <0.23 | <0.23 | 3.2 | 65 | <0.0056 | 430 | 0.024 J | 140 | <0.017 | 16 | 0.0017 J | 1.9 | 36 |
| 7/7/17 | 1,000 | 7.8 | 43 | 1.7 | 44 | <0.019 | 660 | 1.0 | 200 | 240 | <0.23 | <0.23 | 2.7 | 61 | <0.0056 | 410 | 0.023 J | 140 | <0.017 | 17 | 0.00040 J | 1.9 | 36 |
| 10/12/17 | 970 | 7.6 | 44 | <0.10 | 44 | 0.10 J | 670 | 1.5 | 190 | 230 | <0.23 | <0.23 | 0.18 | 57 | <0.0056 | 390 | 0.025 J | 130 | <0.017 | 16 | 0.00069 J | 1.8 | 32 |
| 1/18/18 | 920 | 7.7 | 39 | 0.40 J | 39 | 0.049 J | 600 | <0.65 | 170 | 210 | <0.23 | <0.23 | 4.3 | 53 | <0.0056 | 380 | 0.020 J | 130 | <0.017 | 15 | <0.00017 | 1.8 | 33 |
| 4/3/18 | 930 | 7.4 | 43 (a) | <0.078 | 43 | 0.14 J | 600 | <1.0 | 210 | 260 | <0.23 | <0.23 | 0.35 | 50 | <0.0056 HT5 | 380 | 0.028 J | 130 | <0.017 | 15 | <0.00017 | 1.7 | 32 |
| 10/4/18 | 890 | 7.3 | 42 | 0.36 J | 42 | <0.18 | 660 | -- | 190 | 230 | <0.23 | <0.23 | 0.64 | 53 | -- | 400 | -- | 130 | -- | 16 | -- | 1.6 | 32 |
| 4/2/19 | 940 | 7.9 | 44 | <0.18 | 44 | <0.18 | 700 | -- | 190 | 230 | <0.23 | <0.23 | 1.0 | 64 | -- | 400 | -- | 130 | -- | 16 | -- | 1.8 J | 35 |
| **MW-O (Upper Aquifer)** | | | | | | | | | | | | | | | | | | | | | | | |
| 8/26/14 | 860 | 7.6 | 11 | <0.035 | 11 | 0.13 J | 540 | 1.5 | 260 | 310 | <0.23 | <0.23 | 2.2 | 71 | 0.47 | 260 | 0.18 | 85 | <0.017 | 11 | 0.0015 J | 1.4 | 71 |
| 10/23/14 | 870 | 7.7 | 11 | <0.035 | 11 | <0.038 | 500 | 1.1 | 250 | 300 | <0.23 | <0.23 | 1.0 | 71 | 0.60 | 280 | 0.15 | 93 | <0.017 | 11 | 0.0025 J | 1.5 | 71 |
| 2/3/15 | 810 | 7.8 | 8.2 | 0.80 J | 9.0 | 0.41 J | 490 | 1.4 | 220 | 270 | <0.23 | <0.23 | 1.6 | 69 | <0.0056 | 230 | 0.14 | 77 | 0.034 J | 9.1 | 0.0036 J | 1.8 | 63 |
| 4/27/15 | 860 | 7.9 | 9.7 | 0.12 J | 9.8 | 0.096 J | 530 | 1.3 | 240 | 300 | <0.23 | <0.23 | 0.99 | 71 | <0.0056 | 260 | 0.17 | 87 | 0.49 | 10 | 0.019 | 1.4 | 77 |
| 7/20/15 | 870 | 7.9 | 9.8 | <0.035 | 9.8 | <0.038 | 530 | 1.5 | 250 | 300 | <0.23 | <0.23 | 1.1 | 71 | <0.0056 | 250 | 0.16 | 83 | <0.017 | 9.5 | 0.0077 J | 1.1 | 84 |
| 10/26/15 | 880 | 7.3 | 11 | 0.61 | 12 | <0.038 | 560 | 1.9 | 260 | 310 | <0.23 | <0.23 | 9.2 | 68 | <0.0056 | 260 | 0.19 | 89 | <0.017 | 8.8 | 0.011 | 1.4 | 79 |
| 1/25/16 | 880 | 7.8 | 12 | 0.31 | 12 | <0.025 | 570 | 1.2 | 250 | 310 | <0.23 | <0.23 | 1.4 | 74 | <0.0056 | 240 | 0.16 | 83 | <0.017 | 8.3 | 0.012 | 1.4 | 83 |
| 4/12/16 | 860 | 7.2 | 12 | 1.4 | 13 | 0.046 J | 550 | 1.0 | 260 | 310 | <0.23 | <0.23 | 0.62 | 70 | <0.0056 | 250 | 0.19 | 86 | 0.023 J | 8.7 | 0.0030 J | 1.6 | 83 |
| 7/6/16 | 880 | 7.8 | 12 | 1.3 | 14 | <0.038 | 530 | 1.2 | 260 | 310 | <0.23 | <0.23 | 1.6 | 68 | <0.0056 | 230 | 0.19 | 79 | <0.017 | 8.2 | 0.0048 J | 1.2 | 87 |
| 10/20/16 | 860 | 8.3 | 12 | 1.9 | 14 | <0.038 | 550 | 1.5 | 250 | 300 | 1.2 | <0.23 | 6.5 | 68 | <0.0056 | 300 | 0.22 | 100 | 0.020 J | 13 | <0.00017 | 2.3 | 80 |
| 1/20/17 | 930 | 7.7 | 13 | 1.9 | 15 | 0.15 J | 540 | 1.7 | 240 | 290 | <0.23 | <0.23 | 2.4 | 69 | <0.0056 | 260 | 0.18 | 88 | <0.017 | 10 | 0.0026 J | 1.5 | 83 |
| 4/20/17 | 890 | 7.7 | 13 | 1.4 | 14 | <0.019 | 550 | 1.4 | 240 | 300 | <0.23 | <0.23 | 1.5 | 73 | <0.0056 | 250 | 0.17 | 85 | <0.017 | 9.6 | 0.00059 J | 1.3 | 91 |
| 7/7/17 | 890 | 7.8 | 12 | 2.0 | 14 | <0.019 | 520 | 0.97 | 260 | 320 | <0.23 | <0.23 | 2.0 | 68 | <0.0056 | 250 | 0.17 | 85 | <0.017 | 9.1 | 0.0051 | 1.4 | 96 |
| 10/12/17 | 880 | 7.6 | 10 | 1.7 | 12 | <0.019 | 520 | 1.4 | 260 | 320 | <0.23 | <0.23 | 0.84 | 68 | <0.0056 | 260 | 0.16 | 88 | <0.017 | 9.9 | <0.00017 | 1.6 | 83 |
| 1/18/18 | 870 | 7.6 | 11 | 1.4 | 12 | 0.035 J | 520 | 0.69 J | 220 | 270 | <0.23 | <0.23 | 4.7 | 69 | <0.0028 | 260 | 0.16 | 89 | <0.017 | 9.9 | <0.00017 | 1.5 | 79 |
| 4/4/18 | 880 | 7.3 | 11 | 1.8 | 13 | 0.16 J | 540 | <1.0 | 270 | 330 | <0.23 | <0.23 | 1.0 | 67 | <0.0056 | 270 | 0.19 | 91 | <0.017 | 10 | 0.00096 J | 1.5 | 76 |
| 10/5/18 | 810 | 7.2 | 11 | 1.5 | 13 | 0.29 J | 510 | -- | 250 | 310 | <0.23 | <0.23 | 0.91 | 68 | -- | 250 | -- | 87 | -- | 9.1 | -- | 1.3 | 83 |
| 4/2/19 | 810 | 8.0 | 12 | 1.5 | 13 | <0.18 | 580 | -- | 240 | 290 | <0.23 | <0.23 | 1.4 | 67 | -- | 220 | -- | 74 | -- | 8.1 | -- | 1.4 J | 96 |

**TABLE 2**
**GROUNDWATER QUALITY RESULTS**
**Visalia Water Conservation Plant**
Results in mg/l unless otherwise noted

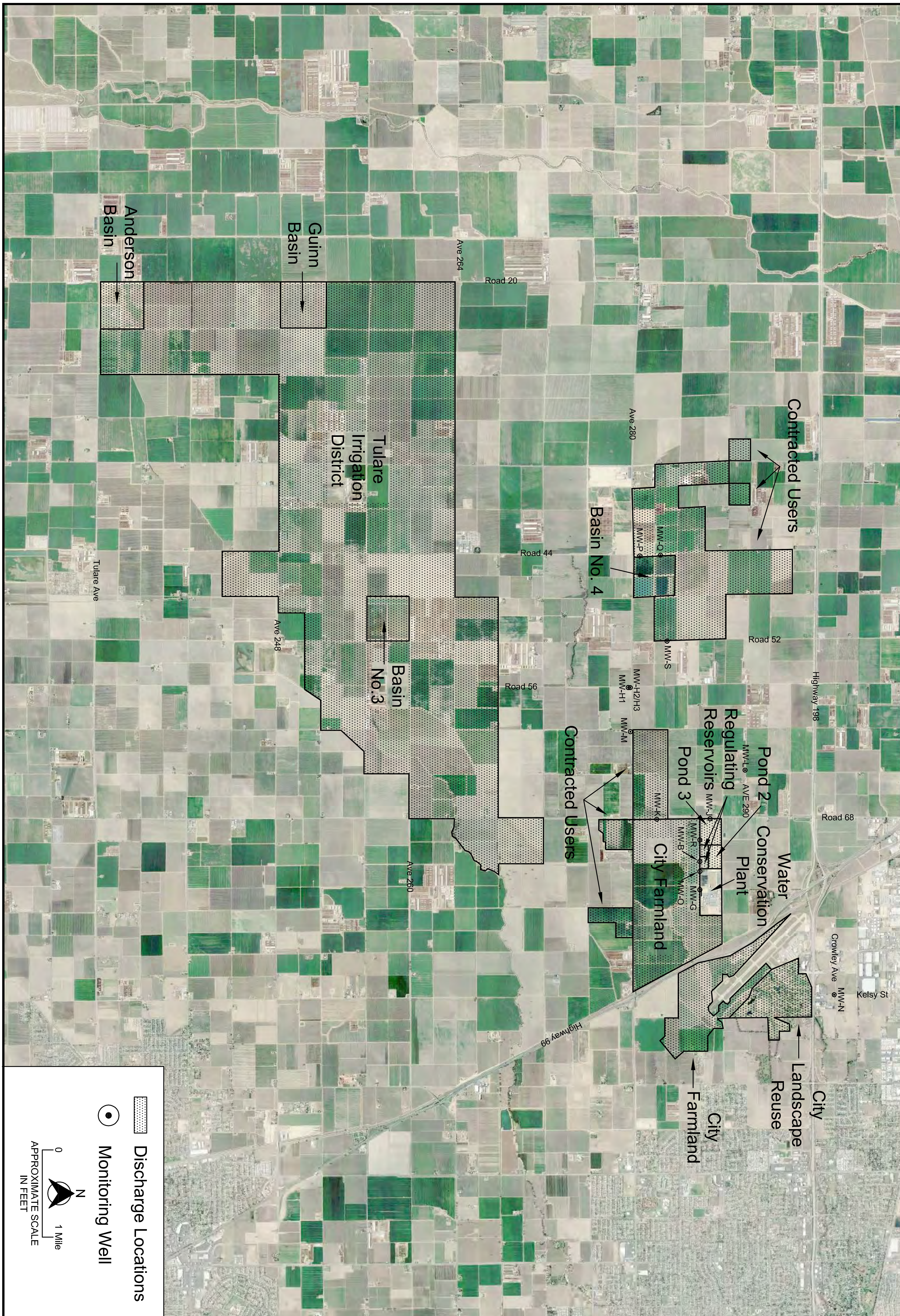
| Date | EC (µs/cm) | pH (pH units) | Nitrate as Nitrogen | Total Kjeldahl Nitrogen | Total Nitrogen | Ammonia as N | Total Dissolved Solids | Total Organic Carbon | Total Alkalinity as $CaCO_3$ | Bicarbonate Alkalinity as $HCO_3$ | Carbonate Alkalinity as $CO_3$ | Hydroxide Alkalinity as OH | Cation/Anion Balance (%difference) | Chloride | Phosphate | Hardness | Boron | Calcium | Iron | Magnesium | Manganese | Potassium | Sodium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MW-P (Upper Aquifer)** | | | | | | | | | | | | | | | | | | | | | | | |
| 8/13/14 | 760 | 7.4 | 9.7 | <0.035 | 9.7 | 0.10 J | 520 | NA | 220 | 270 | <0.23 | <0.23 | 0.33 | 66 | <0.0056 | 260 | 0.12 | 93 | <0.017 | 7.7 | 0.0049 J | 1.0 | 56 |
| 10/23/14 | 770 | 7.9 | 11 | <0.035 | 11 | <0.038 | 420 | 0.89 | 190 | 230 | <0.23 | <0.23 | 3.2 | 64 | <0.0056 | 260 | 0.11 | 93 | <0.017 | 6.3 | 0.0013 J | 0.54 J | 55 |
| 2/10/15 | 650 | 7.9 | <0.90 | <0.50 | <0.90 | <0.038 | 390 | 2.0 | 200 | 240 | <0.23 | <0.23 | 0.11 | 51 | <0.0056 | 200 | 0.12 | 67 | <0.017 | 7.8 | <0.00017 | 0.35 | 48 |
| 4/28/15 | 640 | 8.0 | <0.90 | 0.49 J | <0.90 | 0.16 J | 370 | 2.4 | 200 | 240 | <0.23 | <0.23 | 0.040 | 57 | <0.0056 | 200 | 0.12 | 67 | <0.017 | 7.6 | <0.00017 | 0.31 J | 49 |
| 7/21/15 | 650 | 8.0 | 0.53 J | 0.39 J | 0.92 | 0.043 J | 370 | 2.1 | 200 | 240 | <0.23 | <0.23 | 4.3 | 85 | <0.0056 | 190 | 0.17 | 66 | <0.017 | 7.4 | 0.0012 J | 0.19 J | 54 |
| 10/27/15 | 660 | 7.4 | 0.15 J | 0.24 | 0.39 J | <0.038 | 420 | 2.2 | 230 | 280 | <0.23 | <0.23 | 2.9 | 57 | <0.0056 | 190 | 0.23 | 67 | <0.017 | 6.4 | 0.0015 J | 0.48 J | 62 |
| 1/26/16 | 610 | 7.9 | <0.0080 | 0.19 J | 0.19 J | <0.025 | 380 | 2.1 | 180 | 220 | <0.23 | <0.23 | 1.1 | 59 | <0.0056 | 160 | 0.16 | 56 | <0.017 | 5.6 | 0.0035 J | 0.38 J | 58 |
| 4/14/16 | 590 | 8.1 | <0.0080 | 0.35 J | <2.0 | 0.11 J | 370 | 1.7 | 180 | 220 | <0.23 | <0.23 | 0.17 | 53 | <0.0056 | 160 | 0.12 | 56 | 0.098 J | 5.9 | 0.0087 | 0.52 J | 55 |
| 7/6/16 | 610 | 7.9 | 0.015 J | 0.24 J | <2.0 | <0.038 | 360 | 1.7 | 190 | 240 | <0.23 | <0.23 | 0.82 | 51 | <0.0056 | 180 | 0.093 | 61 | <0.017 | 6.4 | 0.012 | 0.28 J | 55 |
| 10/20/16 | 510 | 8.0 | 0.040 J | 0.37 J | <2.0 | <0.038 | 390 | 2.0 | 140 | 170 | <0.23 | <0.23 | 15 | 53 | <0.0056 | 190 | 0.17 | 65 | 0.023 J | 7.0 | 0.021 | 0.96 J | 58 |
| 1/12/17 | 670 | 7.8 | 0.89 J | 0.33 J | <2.0 | <0.038 | 380 | 1.4 | 210 | 250 | <0.23 | <0.23 | 2.6 | 52 | <0.0056 | 190 | 0.14 | 67 | <0.017 | 6.2 | 0.0058 | 0.56 J | 59 |
| 4/20/17 | 730 | 7.7 | 7.9 | 1.1 | 9.0 | <0.019 | 440 | 1.8 | 230 | 280 | <0.23 | <0.23 | 0.86 | 60 | <0.0056 | 230 | 0.092 | 76 | <0.017 | 8.7 | <0.00017 | 0.40 J | 65 |
| 7/6/17 | 740 | 7.7 | 2.3 | 1.1 | 3.4 | <0.019 | 440 | 5.5 | 260 | 310 | <0.23 | <0.23 | 2.7 | 62 | <0.0056 | 230 | 0.11 | 77 | <0.017 | 9.9 | 0.018 | 1.5 | 72 |
| 10/9/17 | 710 | 7.6 | 0.66 J | 0.21 J | <0.90 | <0.019 | 420 | 2.5 | 240 | 290 | <0.23 | <0.23 | 0.14 | 64 | <0.0056 | 220 | 0.12 | 74 | <0.017 | 7.5 | 0.0037 J | 0.44 J | 64 |
| 1/16/18 | 630 | 7.7 | 0.77 J | 0.30 J | 1.1 | 0.11 J | 400 | 1.5 | 220 | 270 | <0.23 | <0.23 | 4.6 | 55 | <0.0056 | 220 | 0.12 | 75 | <0.017 | 7.4 | 0.0056 | 0.57 J | 66 |
| 4/3/18 | 710 | 7.6 | 0.95 (a) | 0.25 J | 1.2 | 0.20 J | 410 | 1.3 | 250 | 300 | <0.23 | <0.23 | 0.45 | 50 | <0.0056 HT5 | 210 | 0.12 | 69 | <0.017 | 7.9 | 0.0058 | 0.45 J | 64 |
| 10/2/18 | 650 | 7.4 | 0.21 J | 0.39 J | <0.90 | <0.18 | 420 | -- | 230 | 280 | <0.23 | <0.23 | 3.4 | 63 | -- | 200 | -- | 69 | -- | 7.2 | -- | 0.53 J | 71 |
| 4/3/19 | 740 | 7.7 | 0.34 J | <0.18 | <0.90 | <0.18 | 550 | -- | 190 | 230 | <0.23 | <0.23 | 1.4 | 68 | -- | 220 | -- | 74 | -- | 8.3 | -- | 0.49 J | 73 |
| **MW-Q (Upper Aquifer)** | | | | | | | | | | | | | | | | | | | | | | | |
| 8/13/14 | 790 | 7.3 | 8.7 | <0.035 | 8.7 | 0.099 J | 520 | NA | 230 | 280 | <0.23 | <0.23 | 6.2 | 68 | 0.32 J | 290 | 0.25 | 99 | <0.017 | 11 | 1.1 | 0.91 J | 77 |
| 10/23/14 | 830 | 7.8 | 8.1 | 0.038 J | 8.1 | <0.038 | 490 | 1.8 | 240 | 290 | <0.23 | <0.23 | 3.1 | 58 | <0.0056 | 270 | 0.14 | 90 | <0.017 | 10 | 0.99 | 0.71 J | 70 |
| 2/10/15 | 780 | 7.9 | 3.9 | <0.035 | 3.9 | <0.038 | 480 | 3.5 | 240 | 290 | <0.23 | <0.23 | 1.7 | 51 | <0.0056 | 220 | 0.13 | 73 | <0.017 | 9.8 | 0.013 | 0.47 J | 69 |
| 4/28/15 | 710 | 7.9 | 2.6 | 0.44 J | 3.0 | 0.086 J | 430 | 1.5 | 220 | 270 | <0.23 | <0.23 | 0.95 | 54 | <0.0056 | 210 | 0.13 | 71 | 0.020 J | 8.6 | 0.0049 J | 0.42 J | 63 |
| 7/21/15 | 700 | 7.9 | 4.8 | <0.035 | 4.8 | 0.092 J | 410 | 2.1 | 210 | 250 | <0.23 | <0.23 | 1.5 | 56 | <0.0056 | 200 | 0.14 | 65 | <0.017 | 8.1 | 0.035 | 0.32 J | 65 |
| 10/27/15 | 740 | 7.3 | 4.1 | 0.37 | 4.5 | 0.052 J | 460 | 1.4 | 250 | 300 | <0.23 | <0.23 | 6.0 | 52 | <0.0056 | 230 | 0.13 | 79 | <0.017 | 8.3 | 0.32 | 0.51 J | 66 |
| 1/26/16 | 910 | 7.8 | 8.4 | 0.38 | 8.8 | <0.025 | 570 | 2.3 | 280 | 340 | <0.23 | <0.23 | 1.6 | 71 | <0.0056 | 290 | 0.14 | 100 | <0.017 | 11 | 0.24 | 0.53 J | 72 |
| 4/14/16 | 850 | 7.8 | 7.6 | 2.9 | 11 | <0.038 | 540 | 1.9 | 280 | 340 | <0.23 | <0.23 | 0.34 | 62 | <0.0056 | 280 | 0.15 | 97 | <0.017 | 10 | 0.079 | 0.69 J | 68 |
| 7/6/16 | 720 | 7.8 | 1.7 | 0.52 | 2.2 | <0.038 | 440 | 2.3 | 250 | 300 | <0.23 | <0.23 | 0.1 | 54 | <0.0056 | 230 | 0.12 | 80 | <0.017 | 8.4 | 0.067 | 0.44 J | 56 |
| 10/20/16 | 670 | 8.0 | 9.7 | 1.2 | 11 | <0.038 | 500 | 1.8 | 190 | 240 | <0.23 | <0.23 | 16 | 53 | <0.0056 | 300 | 0.17 | 100 | 0.031 J | 11 | 0.015 | 0.87 J | 70 |
| 1/12/17 | 810 | 7.6 | 5.5 | 1.1 | 6.6 | <0.038 | 500 | 2.1 | 260 | 320 | <0.23 | <0.23 | 1.2 | 52 | <0.0056 | 250 | 0.17 | 84 | <0.017 | 9.2 | 0.022 | 0.55 J | 67 |
| 4/20/17 | 670 | 7.7 | 2.0 | 0.86 | 2.8 | <0.019 | 410 | 2.2 | 210 | 260 | <0.23 | <0.23 | 3.2 | 51 | <0.0056 | 210 | 0.15 | 72 | <0.017 | 8.1 | 0.020 | 0.45 J | 62 |
| 7/6/17 | 580 | 7.8 | 0.39 J | 0.27 J | <2.0 | <0.019 | 350 | 2.3 | 160 | 200 | <0.23 | <0.23 | 2.5 | 52 | <0.0056 | 170 | 0.13 | 59 | <0.017 | 6.4 | <0.00017 | 0.47 J | 56 |
| 10/9/17 | 590 | 7.6 | 0.33 J | 0.35 J | <0.90 | <0.019 | 390 | 3.2 | 170 | 200 | <0.23 | <0.23 | 1.2 | 56 | <0.0056 | 170 | 0.19 | 57 | <0.017 | 6.5 | 0.034 | 0.48 J | 54 |
| 1/16/18 | 510 | 7.5 | 0.22 J | 0.30 J | <0.90 | 0.13 J | 340 | 2.1 | 140 | 170 | <0.23 | <0.23 | 1.4 | 67 | <0.0056 | 150 | 0.22 | 52 | <0.017 | 5.6 | 0.0098 | 0.57 J | 61 |
| 4/3/18 | 580 | 7.5 | 0.15 J | 0.17 J | <0.50 | 0.23 J | 440 | 2.0 | 170 | 200 | <0.23 | <0.23 | 0.4 | 54 | <0.0028 | 140 | 0.20 | 47 | 0.020 J | 5.3 | 0.14 | 0.55 J | 64 |
| 10/2/18 | 560 | 7.3 | 1.5 (a) | 0.45 J | 1.9 | <0.18 | 360 | -- | 190 | 230 | <0.23 | <0.23 | 1.2 | 57 | -- | 170 | -- | 57 | -- | 6.0 | -- | 0.48 J | 61 |
| 4/4/19 | 570 | 7.6 | 0.30 J | 0.37 J | 0.67 | <0.18 | 370 | -- | 180 | 220 | <0.23 | <0.23 | 0.17 | 56 | -- | 150 | -- | 49 | -- | 5.7 | -- | 0.42 J | 62 |

**TABLE 2**
**GROUNDWATER QUALITY RESULTS**
**Visalia Water Conservation Plant**
Results in mg/l unless otherwise noted

| Date | EC (µs/cm) | pH (pH units) | Nitrate as Nitrogen | Total Kjeldahl Nitrogen | Total Nitrogen | Ammonia as N | Total Dissolved Solids | Total Organic Carbon | Total Alkalinity as $CaCO_3$ | Bicarbonate Alkalinity as $HCO_3$ | Carbonate Alkalinity as $CO_3$ | Hydroxide Alkalinity as OH | Cation/Anion Balance (%difference) | Chloride | Phosphate | Hardness | Boron | Calcium | Iron | Magnesium | Manganese | Potassium | Sodium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MW-R (Upper Aquifer)** | | | | | | | | | | | | | | | | | | | | | | | |
| 8/26/14 | 760 | 7.9 | 1.4 | 0.31 J | 1.7 | 0.18 J | 460 | 2.0 | 240 | 290 | <0.23 | <0.23 | 1.4 | 79 | <0.0056 | 210 | 0.16 | 70 | <0.017 | 8.4 | 0.0030 J | 1.8 | 69 |
| 10/23/14 | 750 | 7.9 | <0.90 | 0.23 J | <0.90 | <0.038 | 460 | 1.7 | 240 | 300 | <0.23 | <0.23 | 2.6 | 71 | <0.0056 | 230 | 0.17 | 78 | 0.32 | 7.9 | 0.052 | 1.0 | 70 |
| 2/11/15 | 800 | 8.0 | 1.9 | 0.82 | 2.7 | <0.038 | 440 | 2.4 | 260 | 320 | <0.23 | <0.23 | 2.3 | 80 | <0.0056 | 220 | 0.16 | 75 | 0.43 | 8.5 | 0.042 | 0.97 J | 70 |
| 4/27/15 | 800 | 7.9 | 1.3 | 0.61 | 2.0 | 0.11 J | 470 | 2.0 | 270 | 320 | <0.23 | <0.23 | 1.4 | 80 | <0.0056 | 240 | 0.18 | 82 | 0.63 | 8.6 | 0.054 | 1.1 | 74 |
| 7/20/15 | 810 | 7.9 | 1.3 | 0.27 J | 1.6 | 0.091 J | 480 | 2.2 | 270 | 330 | <0.23 | <0.23 | 0.75 | 79 | <0.0056 | 230 | 0.15 | 77 | <0.017 | 8.8 | 0.049 | 0.79 J | 74 |
| 10/26/15 | 810 | 7.4 | 0.96 | 0.28 | 1.2 | <0.038 | 530 | 2.0 | 280 | 350 | <0.23 | <0.23 | 3.9 | 69 | <0.0056 | 250 | 0.18 | 86 | 3.4 | 9.1 | 0.12 | 1.8 | 73 |
| 1/25/16 | 790 | 7.8 | 1.4 | 0.27 | 1.7 | <0.025 | 510 | 1.9 | 260 | 320 | <0.23 | <0.23 | 0.34 | 78 | <0.0056 | 230 | 0.16 | 79 | <0.017 | 7.6 | 0.052 | 1.1 | 71 |
| 4/12/16 | 790 | 7.2 | 2.3 | 0.78 | 3.1 | 0.093 J | 490 | 1.5 | 270 | 330 | <0.23 | <0.23 | 1.2 | 78 | <0.0056 | 240 | 0.18 | 82 | <0.017 | 7.8 | 0.054 | 1.1 | 72 |
| 7/6/16 | 750 | 7.8 | 0.55 J | 0.27 J | <2.0 | <0.038 | 470 | 1.9 | 270 | 330 | <0.23 | <0.23 | 1.0 | 71 | <0.0056 | 220 | 0.18 | 76 | <0.017 | 7.4 | 0.047 | 1.3 | 71 |
| 10/20/16 | 660 | 7.9 | 8.3 | 1.0 | 9.3 | <0.038 | 560 | 2.3 | 150 | 180 | <0.23 | <0.23 | 20 | 68 | <0.0056 | 280 | 0.22 | 96 | 0.021 J | 9.4 | 0.034 | 1.4 | 83 |
| 1/20/17 | 900 | 7.7 | 11 | 1.3 | 12 | 0.14 J | 520 | 1.7 | 270 | 320 | <0.23 | <0.23 | 2.1 | 68 | <0.0056 | 270 | 0.20 | 92 | 0.047 J | 8.9 | 0.059 | 1.2 | 79 |
| 4/20/17 | 860 | 7.7 | 14 | 5.3 | 19 | <0.019 | 540 | 1.9 | 250 | 310 | <0.23 | <0.23 | 0.85 | 68 | <0.0056 | 260 | 0.18 | 89 | <0.017 | 9.2 | 0.039 | 1.1 | 81 |
| 7/7/17 | 880 | 7.8 | 14 | 2.4 | 17 | <0.019 | 530 | <0.18 | 260 | 320 | <0.23 | <0.23 | 3.0 | 63 | <0.0056 | 270 | 0.19 | 93 | <0.017 | 9.5 | 0.029 | 1.2 | 85 |
| 10/12/17 | 870 | 7.7 | 20 | 1.4 | 22 | <0.019 | 530 | 2.3 | 240 | 290 | <0.23 | <0.23 | 0.49 | 61 | <0.0056 | 250 | 0.18 | 86 | <0.017 | 9.1 | 0.010 | 1.3 | 77 |
| 1/18/18 | 860 | 7.6 | 9.6 | 1.6 | 11 | 0.10 J | 510 | 1.3 | 240 | 290 | <0.23 | <0.23 | 3.8 | 67 | <0.0056 | 250 | 0.18 | 88 | <0.017 | 8.5 | 0.049 | 1.2 | 81 |
| 4/4/18 | 840 | 7.4 | 6.2 | 0.94 | 7.1 | <0.058 | 470 | 1.1 | 290 | 350 | <0.23 | <0.23 | 0.51 | 63 | <0.0056 | 260 | 0.19 | 90 | <0.017 | 8.6 | 0.052 | 1.2 | 80 |
| 10/5/18 | 800 | 7.5 | 10 | 3.6 | 14 | <0.18 | 510 | -- | 260 | 320 | <0.23 | <0.23 | 2.6 | 64 | -- | 270 | -- | 91 | -- | 9.3 | -- | 1.2 | 81 |
| 4/2/19 | 750 | 8.0 | 2.6 | <0.18 | 2.6 | <0.18 | 530 | -- | 240 | 300 | <0.23 | <0.23 | 1.2 | 72 | -- | 230 | -- | 78 | -- | 7.7 | -- | 1.3 J | 78 |
| **MW-S (Upper Aquifer)** | | | | | | | | | | | | | | | | | | | | | | | |
| 8/13/14 | 1,200 | 7.2 | 39 | 0.14 J | 39 | 0.47 J | 960 | NA | 270 | 330 | <0.23 | <0.23 | 7.4 | 92 | <0.0084 | 490 | 0.62 | 170 | 0.53 | 16 | 0.059 | 3.4 | 100 |
| 10/23/14 | 1,300 | 7.8 | 41 | <0.035 | 41 | <0.038 | 900 | 1.1 | 260 | 310 | <0.23 | <0.23 | 2.2 | 96 | <0.0084 | 460 | 0.091 | 160 | 0.11 | 14 | 0.0068 | 0.98 J | 88 |
| 2/10/15 | 1,300 | 7.8 | 46 | 0.63 | 46 | <0.038 | 940 | 2.0 | 280 | 340 | <0.23 | <0.23 | 1.1 | 90 | <0.0084 | 470 | 0.091 | 160 | 0.33 | 17 | 0.0086 | 0.94 J | 81 |
| 4/27/15 | 1,300 | 7.8 | 51 | 0.061 J | 51 | 0.067 J | 850 | 1.2 | 280 | 340 | <0.23 | <0.23 | 1.2 | 95 | <0.0084 | 500 | 0.082 | 170 | <0.017 | 18 | <0.00047 | 0.77 J | 84 |
| 7/21/15 | 1,300 | 7.9 | 47 | <0.035 | 47 | 0.021 J | 850 | 1.7 | 260 | 310 | <0.23 | <0.23 | 0.50 | 87 | <0.0084 | 430 | 0.099 | 150 | <0.017 | 13 | 0.00073 J | 0.65 J | 84 |
| 10/27/15 | 1,300 | 7.2 | 49 | 0.24 | 49 | <0.038 | 900 | 1.3 | 260 | 310 | <0.23 | <0.23 | 7.3 | 79 | <0.0084 | 450 | 0.10 | 160 | 0.092 J | 13 | 0.0027 J | 0.93 J | 80 |
| 1/25/16 | 1,200 | 7.8 | 50 | 0.14 J | 50 | <0.025 | 870 | 1.1 | 250 | 300 | <0.23 | <0.23 | 12 | 89 | <0.0084 | 420 | 0.089 | 150 | <0.017 | 12 | 0.00090 J | 0.93 J | 82 |
| 4/12/16 | 1,300 | 7.0 | 53 | 0.066 J | 53 | 0.042 J | 920 | 1.1 | 260 | 310 | <0.23 | <0.23 | 0.010 | 86 | <0.0084 | 470 | 0.096 | 160 | <0.017 | 16 | <0.00017 | 1.1 | 80 |
| 7/7/16 | 1,300 | 7.7 | 52 | 0.20 J | 52 | <0.038 | 1,000 | 1.1 | 250 | 310 | <0.23 | <0.23 | 1.2 | 96 | <0.0084 | 500 | 0.096 | 170 | <0.017 | 17 | 0.0011 J | 0.91 J | 84 |
| 10/21/16 | 1,100 | 7.7 | 56 | <0.035 | 56 | <0.038 | 990 | 1.4 | 100 | 130 | <0.23 | <0.23 | 13 | 93 | <0.0084 | 480 | 0.11 | 170 | 0.021 J | 15 | 0.00063 J | 1.1 | 88 |
| 1/12/17 | 1,300 | 7.5 | 53 | 0.17 J | 53 | <0.038 | 870 | 1.3 | 230 | 280 | <0.23 | <0.23 | 3.2 | 83 | <0.0084 | 460 | 0.11 | 160 | <0.017 | 14 | <0.00017 | 1.1 | 88 |
| 4/20/17 | 1,400 | 7.6 | 50 | 1.2 | 51 | <0.019 | 950 | 1.7 | 250 | 300 | <0.23 | <0.23 | 2.3 | 100 | <0.0084 | 490 | 0.094 | 170 | <0.017 | 15 | <0.00017 | 1.1 | 92 |
| 7/7/17 | 1,400 | 7.6 | 58 | 1.5 | 59 | <0.019 | 890 | 1.3 | 250 | 310 | <0.23 | <0.23 | 3.8 | 98 | <0.0084 | 520 | 0.090 | 180 | <0.017 | 20 | 0.00047 J | 1.2 | 95 |
| 10/12/17 | 1,400 | 7.4 | 58 | 0.10 J | 58 | <0.019 | 930 | 1.9 | 370 | 450 | <0.23 | <0.23 | 9.0 | 94 | <0.0084 | 470 | 0.084 | 160 | <0.017 | 18 | <0.00017 | 0.99 J | 85 |
| 1/16/18 | 1,200 | 7.5 | 59 | <0.10 | 59 | <0.019 | 880 | 0.75 J | 200 | 240 | <0.23 | <0.23 | 5.3 | 87 | <0.0084 | 470 | 0.10 | 160 | <0.017 | 18 | <0.00017 | 1.0 | 91 |
| 4/4/18 | 1,400 | 7.3 | 56 | 0.40 J | 56 | <0.058 | 850 | <1.0 | 240 | 300 | <0.23 | <0.23 | 2.1 | 89 | <0.0084 | 480 | 0.09 | 160 | <0.017 | 18 | <0.00017 | 0.98 J | 90 |
| 10/4/18 | 1,300 | 7.1 | 56 | <0.18 | 56 | 0.55 J | 930 | -- | 240 | 290 | <0.23 | <0.23 | 2.0 | 110 | -- | 530 | -- | 180 | -- | 19 | -- | 0.88 J | 85 |
| 4/9/19 | 1,300 | 7.4 | 58 | 0.84 | 59 | 0.21 J | 960 | -- | 210 | 260 | <0.23 | <0.23 | 1.1 | 100 | -- | 450 | -- | 150 | -- | 17 | -- | 0.98 J | 84 |

mg/L - milligrams per liter
EC - electrical conductivity in micro Siemens per liter
< 5 - Less than followed by the indicated laboratory detection limit (not detected), expect for total nitrogen. Prior to August 2014 all non-detect analytical results reported as less than the indicated laboratory reporting limit.
J - Detected but below the Reporting Limit; therefore, result is an estimated concentration. Same as DNQ - Detected, but Not Quantified.
* - MW-B is no longer required to be sampled after the second quarter 2014 (per the instructions VWCP received from RWQCB).
a - The sample was analyzed for nitrate + nitrite as N by method SM4500-NO3 F because method EPA 300.0 was performed outside of hold time due to instrument failure. However, Nitrite as N (by EPA 300.0) was below the detection limit, therefore it is assumed that the detected concentration of nitrate + nitrite as N is primarily nitrate as N.
HT5 - The hold time was missed due to instrument failure. The sample was later analyzed outside of hold time.
\- - Total Organic Carbon, Phosphate, Boron, Iron, and Manganese not required to be analyzed by WDR Order No. R5-2018-0046.

## DRAWINGS




| | | |
|---|---|---|
| SITE MAP<br>VISALIA WATER CONSERVATION PLANT<br>VISALIA, CALIFORNIA | FILE NO.<br>A76404.03 | DATE DRAWN:<br>12/5/18 |
| | DRAWN BY:<br>KJ | APPROVED BY: |
| | PROJECT NO.<br>A76404.03 | DRAWING NO.<br>1 |

MOORE TWINING ASSOCIATES, INC.

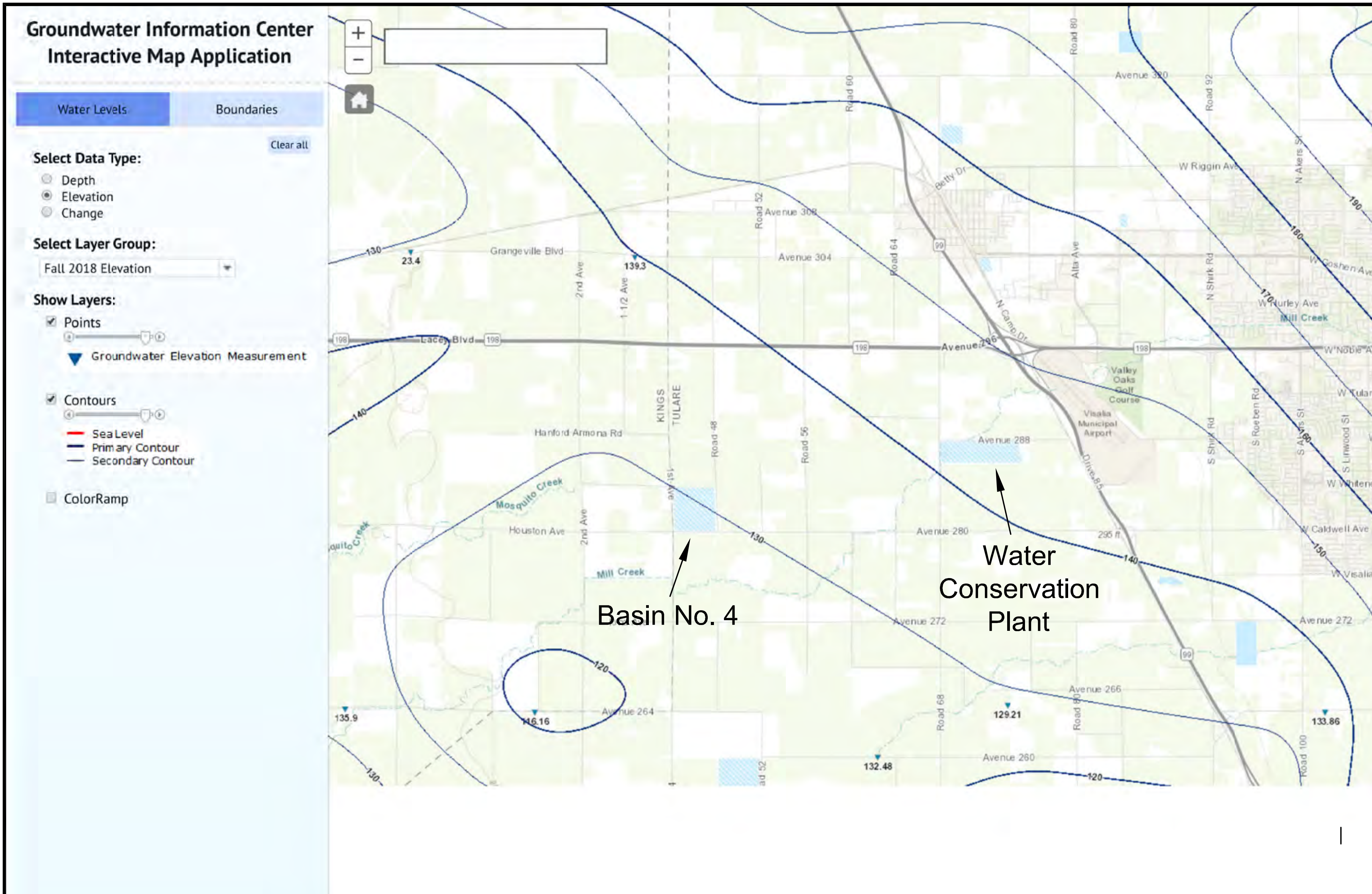
Since 1898


| SHALLOW AQUIFER GROUNDWATER ELEVATON MAP<br>APRIL 2, 2019<br>VISALIA WATER CONSERVATION PLANT<br>VISALIA, CALIFORNIA | FILE NO.<br>A76404.03 | DATE DRAWN:<br>5/14/19 | MOORE TWINING ASSOCIATES, INC. |
|---|---|---|---|
| | DRAWN BY:<br>KJ | APPROVED BY: | |
| | PROJECT NO.<br>A76404.03 | DRAWING NO.<br>2 | |


DEEP AQUIFER GROUNDWATER ELEVATON MAP
APRIL 2 , 2019
VISALIA WATER CONSERVATION PLANT
VISALIA, CALIFORNIA

| | |
|---|---|
| FILE NO. A76404.03 | DATE DRAWN: 5/14/19 |
| DRAWN BY: KJ | APPROVED BY: |
| PROJECT NO. A76404.03 | DRAWING NO. 3 |

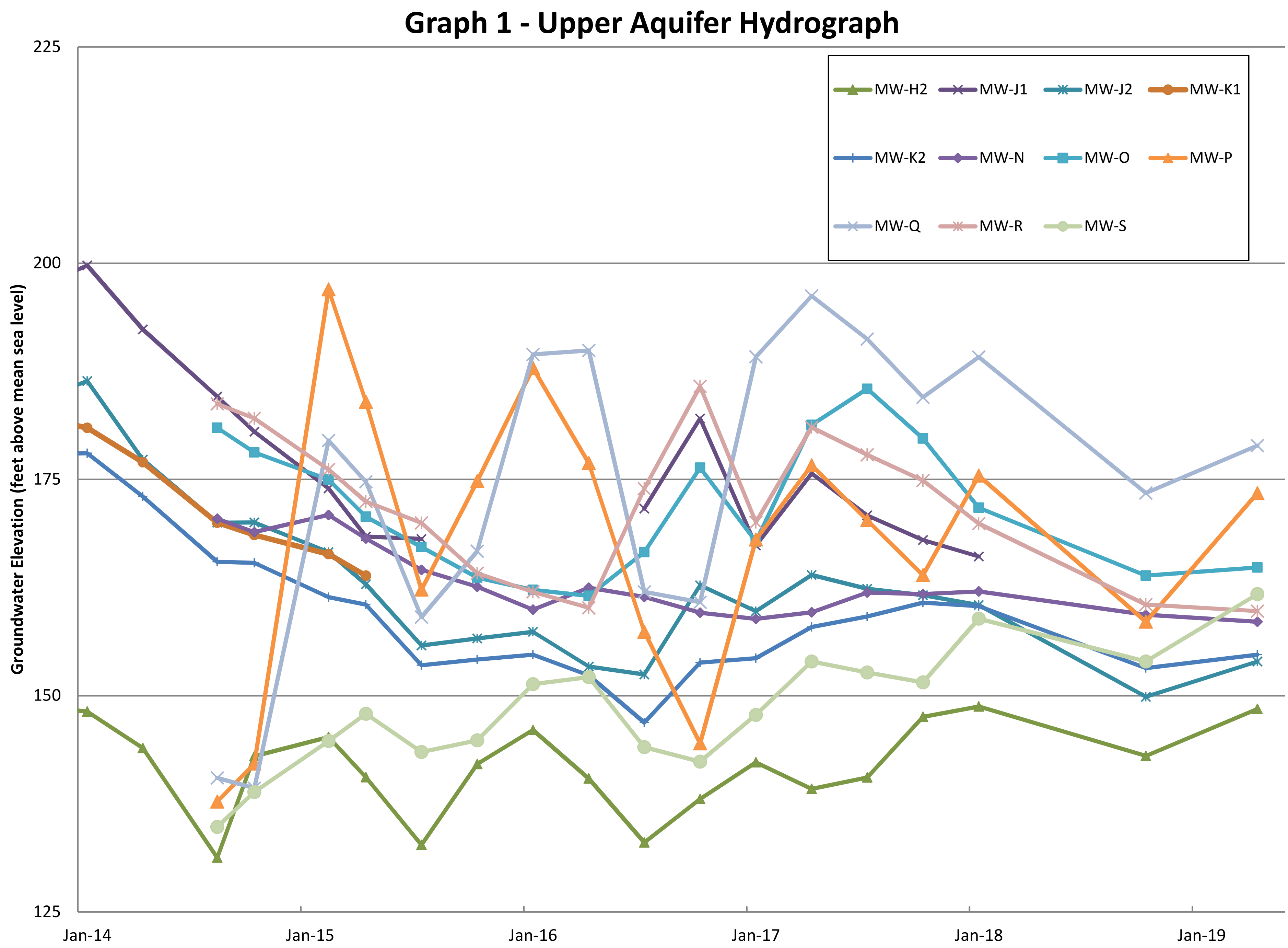
MOORE TWINING ASSOCIATES, INC.



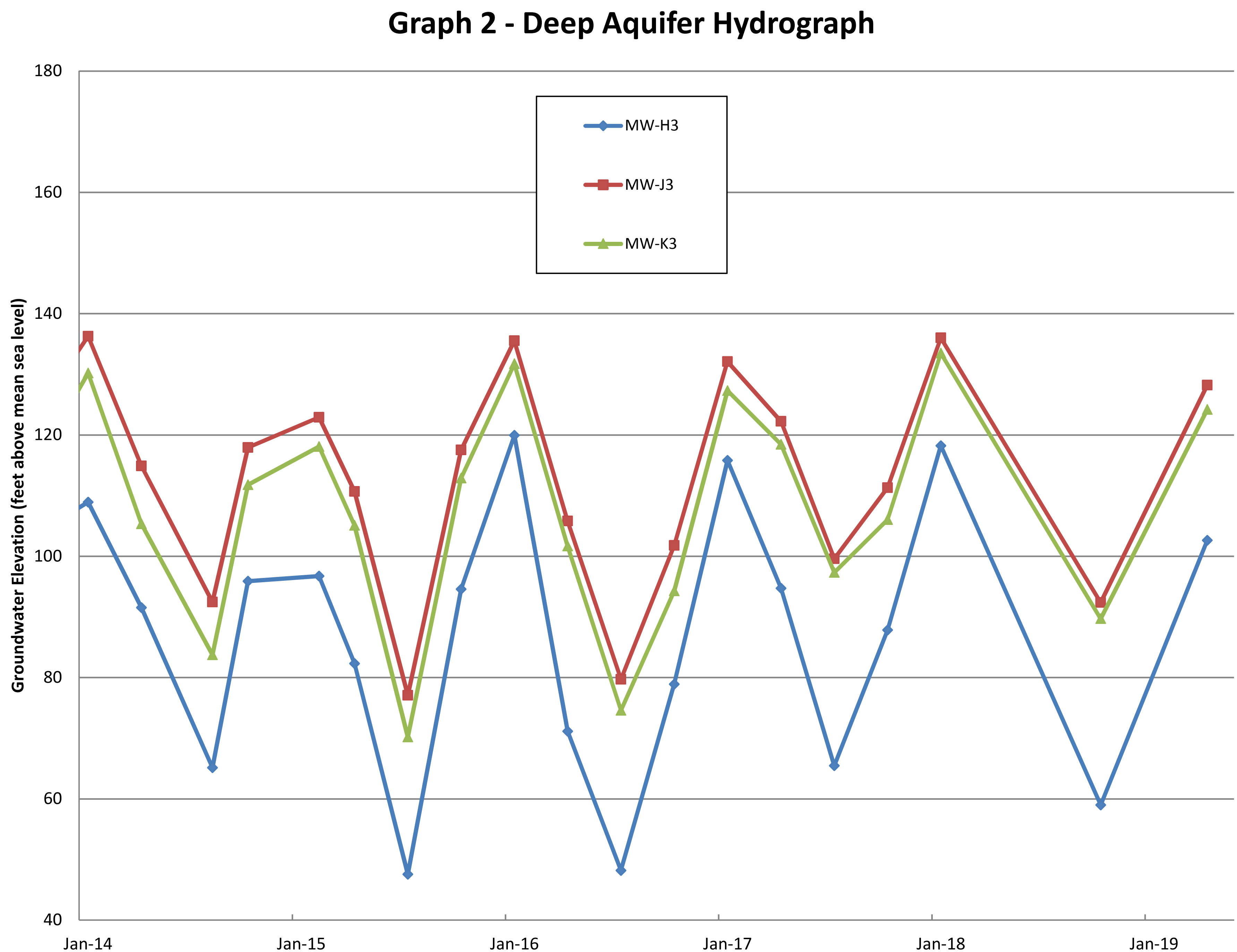

| FALL 2018 GROUNDWATER ELEVATION CONTOUR MAP<br>CALIFORNAI DEPARTMENT OF WATER RESROURCES<br>GROUNDWATER INFORMATION CENTER INTERACTIVE MAP | FILE NO.<br>A76404.03 | DATE DRAWN:<br>5/14/19 | MOORE TWINING ASSOCIATES, INC. |
|---|---|---|---|
| | DRAWN BY:<br>KJ | APPROVED BY: | |
| | PROJECT NO.<br>A76404.03 | DRAWING NO.<br>4 | |

## APPENDIX A

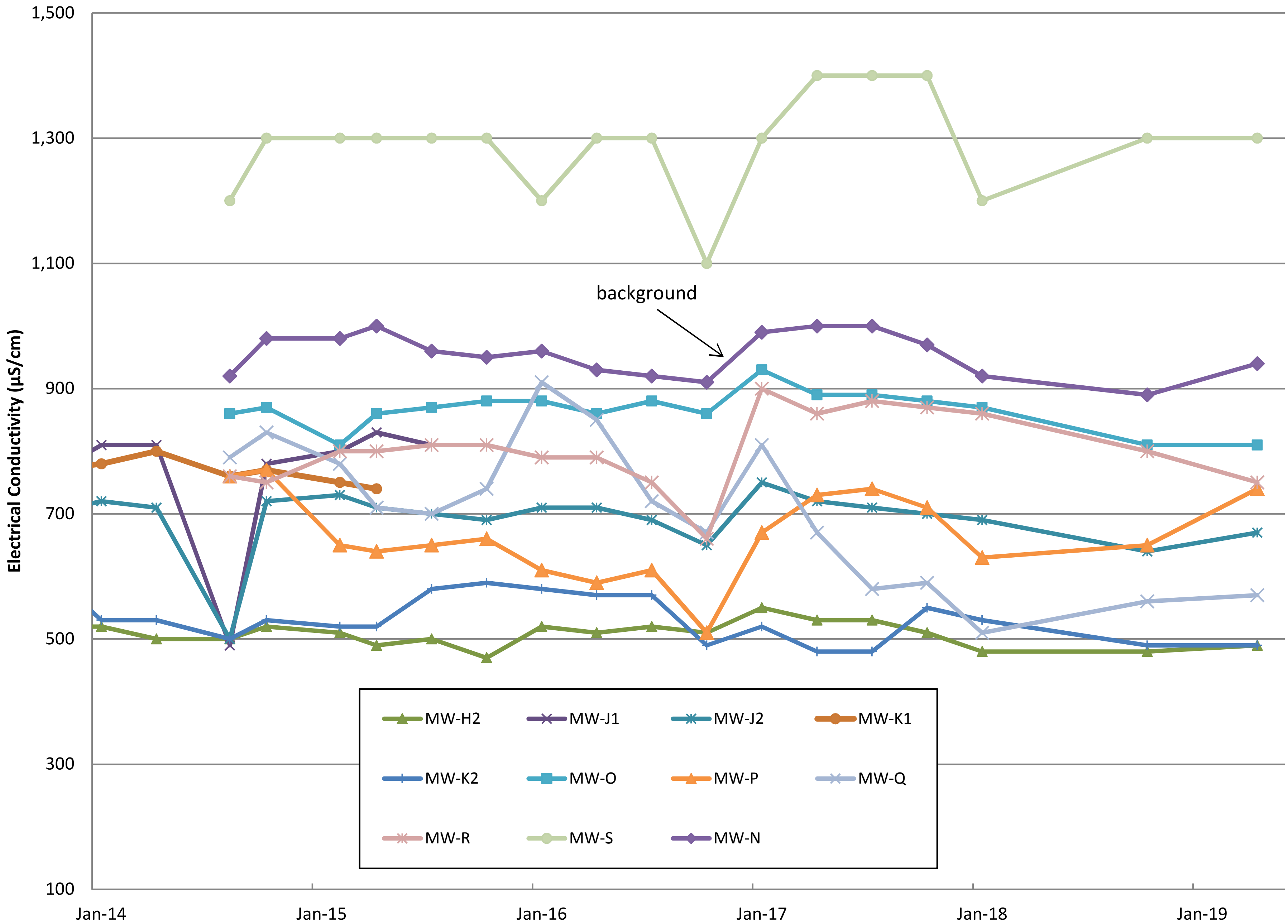
HYDROGRAPHS AND TIME-CONCENTRATION GRAPHS



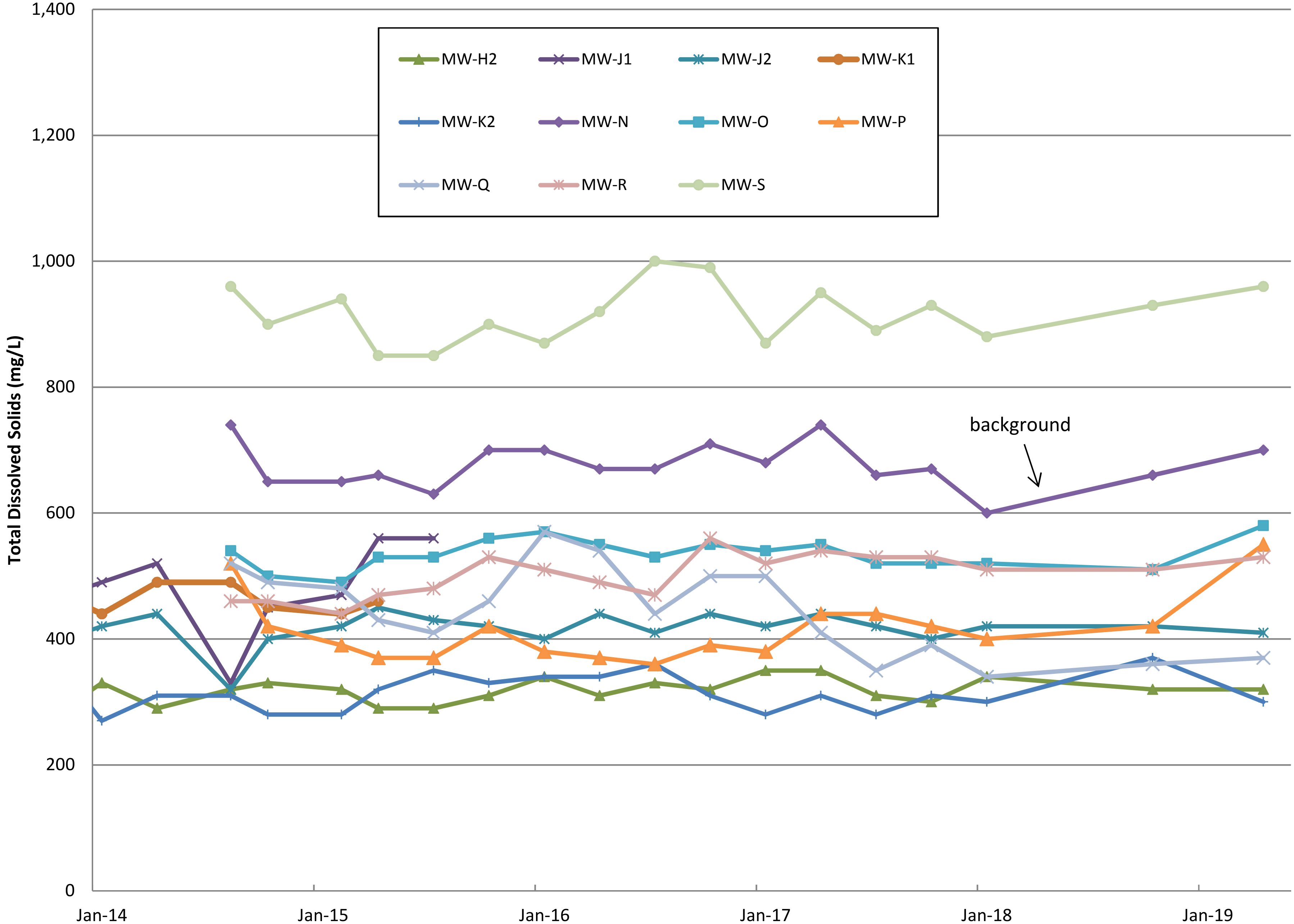
Graph 1 - Upper Aquifer Hydrograph
MW-H2
MW-J1
MW-J2
MW-K1
MW-K2
MW-N
MW-O
MW-P
MW-Q
MW-R
MW-S
Groundwater Elevation (feet above mean sea level)
225
200
175
150
125
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19


Graph 2 - Deep Aquifer Hydrograph
MW-H3
MW-J3
MW-K3
Groundwater Elevation (feet above mean sea level)
180
160
140
120
100
80
60
40
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19

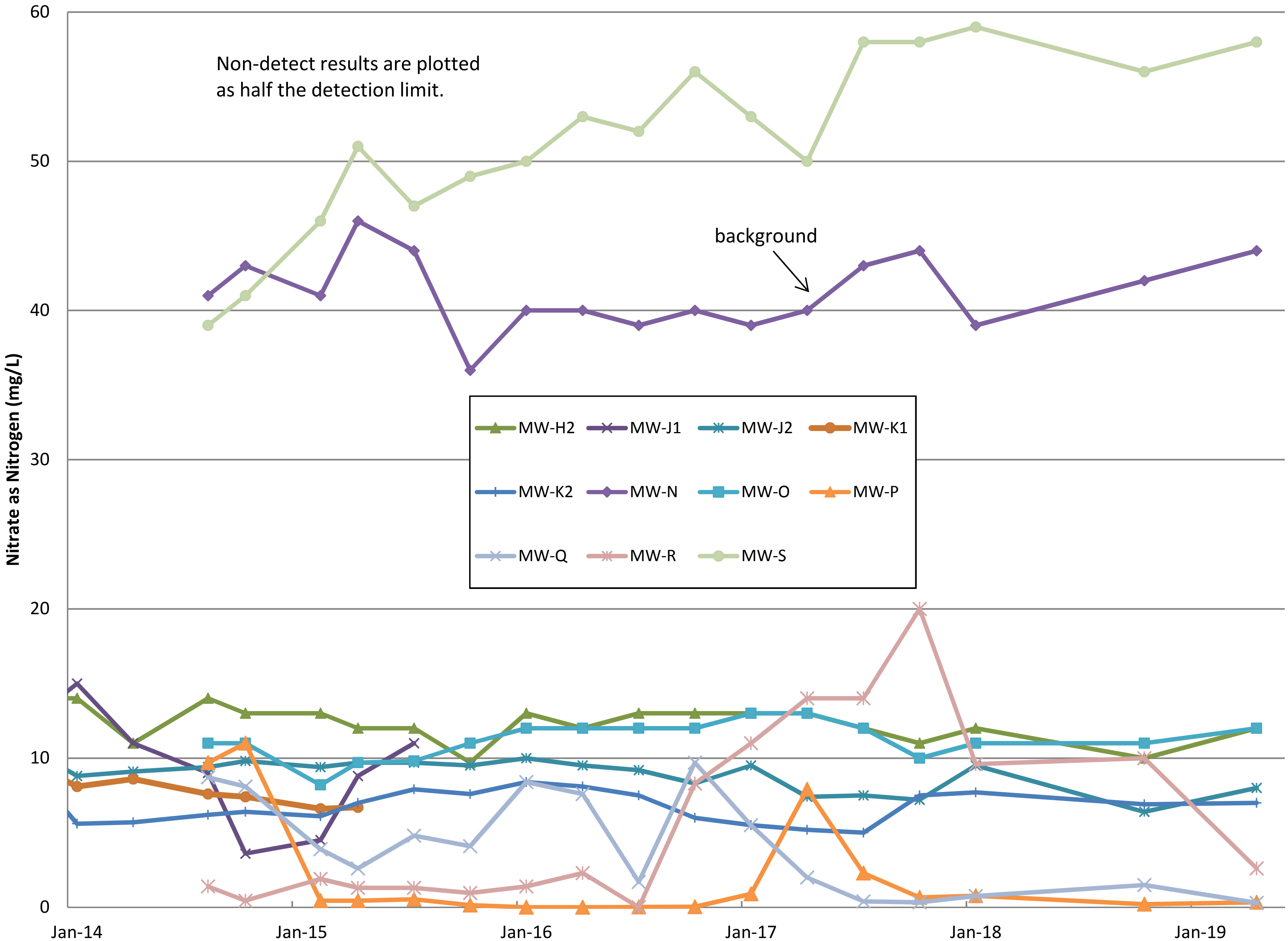
# Graph 3 - Electrical Conductivity



# Graph 4 - Total Dissolved Solids



# Graph 5 - Nitrate as Nitrogen



# APPENDIX B

LABORATORY REPORTS

MOORE TWINING ASSOCIATES, INC.
California ELAP Certificate #1371

**2527 Fresno Street**
**Fresno, CA 93721**
**(559) 268-7021 Phone**
**(559) 268-0740 Fax**

April 16, 2019

Work Order #: **FD03001**

Kirk Jacobsen
MTA Environmental Division
2527 Fresno Street
Fresno, CA 93721

**RE: City of Visalia Water Conservation Plant**

Enclosed are the analytical results for samples received by our laboratory on **04/03/19** . For your reference, these analyses have been assigned laboratory work order number **FD03001**.

All analyses have been performed according to our laboratory's quality assurance program. All results are intended to be considered in their entirety, Moore Twining Associates, Inc. (MTA) is not responsible for use of less than complete reports. Results apply only to samples analyzed.

If you have any questions, please feel free to contact us at the number listed above.

Sincerely,

**Moore Twining Associates, Inc.**

Susan Federico
Client Services Representative

MOORE TWINING ASSOCIATES, INC.
California ELAP Certificate #1371

2527 Fresno Street
Fresno, CA 93721
(559) 268-7021 Phone
(559) 268-0740 Fax

| | | |
|---|---|---|
| MTA Environmental Division<br>2527 Fresno Street<br>Fresno CA, 93721 | **Project:** City of Visalia Water Conservation Plant<br>**Project Number:** A76404.03<br>**Project Manager:** Kirk Jacobsen | **Reported:**<br>04/16/2019 |

## Analytical Report for the Following Samples

| Sample ID | Notes | Laboratory ID | Matrix | Date Sampled | Date Received |
|---|---|---|---|---|---|
| MW-N | | FD03001-01 | Ground Water | 04/02/19 15:10 | 04/03/19 08:20 |
| MW-O | | FD03001-02 | Ground Water | 04/02/19 10:14 | 04/03/19 08:20 |
| MW-R | | FD03001-03 | Ground Water | 04/02/19 11:51 | 04/03/19 08:20 |

MOORE TWINING ASSOCIATES, INC.
California ELAP Certificate #1371

2527 Fresno Street
Fresno, CA 93721
(559) 268-7021 Phone
(559) 268-0740 Fax

| | | |
|---|---|---|
| MTA Environmental Division<br>2527 Fresno Street<br>Fresno CA, 93721 | **Project:** City of Visalia Water Conservation Plant<br>**Project Number:** A76404.03<br>**Project Manager:** Kirk Jacobsen | **Reported:**<br>04/16/2019 |

## MW-N

FD03001-01 (Ground Water) Sampled: 04/02/19 15:10

| Analyte | Flag | Result | Reporting Limit | MDL | Units | Dilution | Batch | Analyst | Prepared | Analyzed | Method |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Inorganics** | | | | | | | | | | | |
| Bicarbonate Alkalinity as HCO3 | | **230** | 1.3 | 0.23 | mg/L | 1 | B9D0316 | GMC | 04/04/19 22:20 | 04/04/19 22:20 | SM 2320 B |
| Carbonate Alkalinity as CO3 | | ND | 1.0 | 0.23 | mg/L | 1 | B9D0316 | GMC | 04/04/19 22:20 | 04/04/19 22:20 | SM 2320 B |
| Hydroxide Alkalinity as OH | | ND | 1.0 | 0.23 | mg/L | 1 | B9D0316 | GMC | 04/04/19 22:20 | 04/04/19 22:20 | SM 2320 B |
| Total Alkalinity as CaCO3 | | **190** | 1.0 | 0.23 | mg/L | 1 | B9D0316 | GMC | 04/04/19 22:20 | 04/04/19 22:20 | SM 2320 B |
| Ammonia as N | | ND | 1.0 | 0.18 | mg/L | 1 | B9D0803 | JAG | 04/08/19 9:50 | 04/08/19 12:49 | EPA 350.1 |
| Cation/Anion Balance (% Difference) | | **1.0** | | | % | 1 | B9D1016 | MCM | 04/10/19 15:06 | 04/10/19 15:07 | SM 1030 F |
| Chloride | | **64** | 2.0 | 0.18 | mg/L | 1 | B9D0225 | ETH | 04/02/19 18:40 | 04/03/19 17:04 | EPA 300.0 |
| Specific Conductance (EC) | | **940** | 1.0 | 0.26 | µS/cm | 1 | B9D0316 | GMC | 04/04/19 22:20 | 04/04/19 22:20 | SM 2510 B |
| Nitrate as N | | **44** | 1.4 | 0.084 | mg/L | 3 | B9D0225 | ETH | 04/02/19 18:40 | 04/03/19 18:28 | EPA 300.0 |
| Nitrite as N | | ND | 0.30 | 0.097 | mg/L | 1 | B9D0225 | ETH | 04/02/19 18:40 | 04/03/19 17:04 | EPA 300.0 |
| pH | | **7.9** | 0.10 | 0.10 | pH Units | 1 | B9D0317 | VAC | 04/04/19 8:30 | 04/04/19 8:30 | SM 4500-H B |
| Sulfate as SO4 | | **41** | 2.0 | 0.094 | mg/L | 1 | B9D0225 | ETH | 04/02/19 18:40 | 04/03/19 17:04 | EPA 300.0 |
| Total Dissolved Solids | | **700** | 10 | 8.1 | mg/L | 1 | B9D0410 | ACY | 04/04/19 10:40 | 04/05/19 14:10 | SM 2540 C |
| Total Kjeldahl Nitrogen | | ND | 0.50 | 0.18 | mg/L | 1 | B9D0309 | JAG | 04/03/19 12:30 | 04/05/19 12:39 | EPA 351.2 |
| Total Nitrogen | | **44** | 1.4 | | mg/L | 3 | [CALC] | JAG | 04/05/19 12:39 | 04/05/19 12:39 | [CALC] |
| **Metals (Dissolved)** | | | | | | | | | | | |
| Calcium | | **130** | 0.20 | 0.096 | mg/L | 1 | B9C2933 | VAC | 04/04/19 10:35 | 04/05/19 20:22 | EPA 200.7 |
| Hardness (Dissolved) | | **400** | 1.3 | | mg equiv. CaCO3/L | 1 | [CALC] | VAC | 04/05/19 20:22 | 04/05/19 20:22 | SM 2340 B |
| Magnesium | | **16** | 0.20 | 0.050 | mg/L | 1 | B9C2933 | VAC | 04/04/19 10:35 | 04/05/19 20:22 | EPA 200.7 |
| Potassium | **J** | **1.8** | 2.0 | 0.69 | mg/L | 1 | B9C2933 | VAC | 04/04/19 10:35 | 04/05/19 20:22 | EPA 200.7 |
| Sodium | | **35** | 2.0 | 0.51 | mg/L | 1 | B9C2933 | VAC | 04/04/19 10:35 | 04/05/19 20:22 | EPA 200.7 |

## MW-O

FD03001-02 (Ground Water) Sampled: 04/02/19 10:14

| Analyte | Flag | Result | Reporting Limit | MDL | Units | Dilution | Batch | Analyst | Prepared | Analyzed | Method |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Inorganics** | | | | | | | | | | | |
| Bicarbonate Alkalinity as HCO3 | | **290** | 1.3 | 0.23 | mg/L | 1 | B9D0316 | GMC | 04/04/19 22:27 | 04/04/19 22:27 | SM 2320 B |
| Carbonate Alkalinity as CO3 | | ND | 1.0 | 0.23 | mg/L | 1 | B9D0316 | GMC | 04/04/19 22:27 | 04/04/19 22:27 | SM 2320 B |
| Hydroxide Alkalinity as OH | | ND | 1.0 | 0.23 | mg/L | 1 | B9D0316 | GMC | 04/04/19 22:27 | 04/04/19 22:27 | SM 2320 B |
| Total Alkalinity as CaCO3 | | **240** | 1.0 | 0.23 | mg/L | 1 | B9D0316 | GMC | 04/04/19 22:27 | 04/04/19 22:27 | SM 2320 B |
| Ammonia as N | | ND | 1.0 | 0.18 | mg/L | 1 | B9D0803 | JAG | 04/08/19 9:50 | 04/08/19 12:50 | EPA 350.1 |
| Cation/Anion Balance (% Difference) | | **1.4** | | | % | 1 | B9D1016 | MCM | 04/10/19 15:06 | 04/10/19 15:07 | SM 1030 F |
| Chloride | | **67** | 4.0 | 0.36 | mg/L | 2 | B9D0225 | ETH | 04/02/19 18:40 | 04/03/19 17:18 | EPA 300.0 |
| Specific Conductance (EC) | | **810** | 1.0 | 0.26 | µS/cm | 1 | B9D0316 | GMC | 04/04/19 22:27 | 04/04/19 22:27 | SM 2510 B |
| Nitrate as N | | **12** | 0.90 | 0.056 | mg/L | 2 | B9D0225 | ETH | 04/02/19 18:40 | 04/03/19 17:18 | EPA 300.0 |
| Nitrite as N | | ND | 0.60 | 0.19 | mg/L | 2 | B9D0225 | ETH | 04/02/19 18:40 | 04/03/19 17:18 | EPA 300.0 |
| pH | | **8.0** | 0.10 | 0.10 | pH Units | 1 | B9D0317 | VAC | 04/04/19 8:31 | 04/04/19 8:31 | SM 4500-H B |
| Sulfate as SO4 | | **40** | 4.0 | 0.19 | mg/L | 2 | B9D0225 | ETH | 04/02/19 18:40 | 04/03/19 17:18 | EPA 300.0 |
| Total Dissolved Solids | | **580** | 10 | 8.1 | mg/L | 1 | B9D0410 | ACY | 04/04/19 10:40 | 04/05/19 14:10 | SM 2540 C |
| Total Kjeldahl Nitrogen | | **1.5** | 0.50 | 0.18 | mg/L | 1 | B9D0309 | JAG | 04/03/19 12:30 | 04/05/19 12:41 | EPA 351.2 |
| Total Nitrogen | | **13** | 0.90 | | mg/L | 2 | [CALC] | JAG | 04/05/19 12:41 | 04/05/19 12:41 | [CALC] |
| **Metals (Dissolved)** | | | | | | | | | | | |

MOORE TWINING ASSOCIATES, INC.
California ELAP Certificate #1371

2527 Fresno Street
Fresno, CA 93721
(559) 268-7021 Phone
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| | | |
|---|---|---|
| MTA Environmental Division<br>2527 Fresno Street<br>Fresno CA, 93721 | **Project:** City of Visalia Water Conservation Plant<br>**Project Number:** A76404.03<br>**Project Manager:** Kirk Jacobsen | **Reported:**<br>04/16/2019 |

## MW-O

FD03001-02 (Ground Water) Sampled: 04/02/19 10:14

| Analyte | Flag | Result | Reporting Limit | MDL | Units | Dilution | Batch | Analyst | Prepared | Analyzed | Method |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Metals (Dissolved)** | | | | | | | | | | | |
| Calcium | | **74** | 0.20 | 0.096 | mg/L | 1 | B9C2933 | VAC | 04/04/19 10:35 | 04/05/19 20:26 | EPA 200.7 |
| Hardness (Dissolved) | | **220** | 1.3 | | mg equiv. CaCO3/L | 1 | [CALC] | VAC | 04/05/19 20:26 | 04/05/19 20:26 | SM 2340 B |
| Magnesium | | **8.1** | 0.20 | 0.050 | mg/L | 1 | B9C2933 | VAC | 04/04/19 10:35 | 04/05/19 20:26 | EPA 200.7 |
| Potassium | J | **1.4** | 2.0 | 0.69 | mg/L | 1 | B9C2933 | VAC | 04/04/19 10:35 | 04/05/19 20:26 | EPA 200.7 |
| Sodium | | **96** | 2.0 | 0.51 | mg/L | 1 | B9C2933 | VAC | 04/04/19 10:35 | 04/05/19 20:26 | EPA 200.7 |

## MW-R

FD03001-03 (Ground Water) Sampled: 04/02/19 11:51

| Analyte | Flag | Result | Reporting Limit | MDL | Units | Dilution | Batch | Analyst | Prepared | Analyzed | Method |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Inorganics** | | | | | | | | | | | |
| Bicarbonate Alkalinity as HCO3 | | **300** | 1.3 | 0.23 | mg/L | 1 | B9D0316 | GMC | 04/04/19 22:34 | 04/04/19 22:34 | SM 2320 B |
| Carbonate Alkalinity as CO3 | | ND | 1.0 | 0.23 | mg/L | 1 | B9D0316 | GMC | 04/04/19 22:34 | 04/04/19 22:34 | SM 2320 B |
| Hydroxide Alkalinity as OH | | ND | 1.0 | 0.23 | mg/L | 1 | B9D0316 | GMC | 04/04/19 22:34 | 04/04/19 22:34 | SM 2320 B |
| Total Alkalinity as CaCO3 | | **240** | 1.0 | 0.23 | mg/L | 1 | B9D0316 | GMC | 04/04/19 22:34 | 04/04/19 22:34 | SM 2320 B |
| Ammonia as N | | ND | 1.0 | 0.18 | mg/L | 1 | B9D0803 | JAG | 04/08/19 9:50 | 04/08/19 12:51 | EPA 350.1 |
| Cation/Anion Balance (% Difference) | | **1.2** | | | % | 1 | B9D1016 | MCM | 04/10/19 15:06 | 04/10/19 15:07 | SM 1030 F |
| Chloride | | **72** | 4.0 | 0.36 | mg/L | 2 | B9D0225 | ETH | 04/02/19 18:40 | 04/03/19 17:32 | EPA 300.0 |
| Specific Conductance (EC) | | **750** | 1.0 | 0.26 | µS/cm | 1 | B9D0316 | GMC | 04/04/19 22:34 | 04/04/19 22:34 | SM 2510 B |
| Nitrate as N | | **2.6** | 0.90 | 0.056 | mg/L | 2 | B9D0225 | ETH | 04/02/19 18:40 | 04/03/19 17:32 | EPA 300.0 |
| Nitrite as N | | ND | 0.60 | 0.19 | mg/L | 2 | B9D0225 | ETH | 04/02/19 18:40 | 04/03/19 17:32 | EPA 300.0 |
| pH | | **8.0** | 0.10 | 0.10 | pH Units | 1 | B9D0317 | VAC | 04/04/19 8:32 | 04/04/19 8:32 | SM 4500-H B |
| Sulfate as SO4 | | **30** | 4.0 | 0.19 | mg/L | 2 | B9D0225 | ETH | 04/02/19 18:40 | 04/03/19 17:32 | EPA 300.0 |
| Total Dissolved Solids | | **530** | 10 | 8.1 | mg/L | 1 | B9D0410 | ACY | 04/04/19 10:40 | 04/05/19 14:10 | SM 2540 C |
| Total Kjeldahl Nitrogen | | ND | 0.50 | 0.18 | mg/L | 1 | B9D0401 | JAG | 04/04/19 7:45 | 04/05/19 12:54 | EPA 351.2 |
| Total Nitrogen | | **2.6** | 0.90 | | mg/L | 2 | [CALC] | JAG | 04/05/19 12:54 | 04/05/19 12:54 | [CALC] |
| **Metals (Dissolved)** | | | | | | | | | | | |
| Calcium | | **78** | 0.20 | 0.096 | mg/L | 1 | B9C2933 | VAC | 04/04/19 10:35 | 04/05/19 20:39 | EPA 200.7 |
| Hardness (Dissolved) | | **230** | 1.3 | | mg equiv. CaCO3/L | 1 | [CALC] | VAC | 04/05/19 20:39 | 04/05/19 20:39 | SM 2340 B |
| Magnesium | | **7.7** | 0.20 | 0.050 | mg/L | 1 | B9C2933 | VAC | 04/04/19 10:35 | 04/05/19 20:39 | EPA 200.7 |
| Potassium | J | **1.3** | 2.0 | 0.69 | mg/L | 1 | B9C2933 | VAC | 04/04/19 10:35 | 04/05/19 20:39 | EPA 200.7 |
| Sodium | | **78** | 2.0 | 0.51 | mg/L | 1 | B9C2933 | VAC | 04/04/19 10:35 | 04/05/19 20:39 | EPA 200.7 |

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|---|---|---|
| MTA Environmental Division<br>2527 Fresno Street<br>Fresno CA, 93721 | **Project:** City of Visalia Water Conservation Plant<br>**Project Number:** A76404.03<br>**Project Manager:** Kirk Jacobsen | **Reported:**<br>04/16/2019 |

## Quality Control Sample Results - Inorganics

| Analyte | Flag | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch - B9D0225** | | | | | | | | | | |
| **Blank (B9D0225-BLK1)** | | Prepared: 04/02/19 Analyzed: 04/03/19 | | | | | | | | |
| **EPA 300.0** | | | | | | | | | | |
| Chloride | | ND | 2.0 | mg/L | | | | | | |
| Nitrate as N | | ND | 0.45 | mg/L | | | | | | |
| Nitrite as N | | ND | 0.30 | mg/L | | | | | | |
| Sulfate as SO4 | | ND | 2.0 | mg/L | | | | | | |
| **LCS (B9D0225-BS1)** | | Prepared: 04/02/19 Analyzed: 04/03/19 | | | | | | | | |
| **EPA 300.0** | | | | | | | | | | |
| Chloride | | 49.2 | 2.0 | mg/L | 50.0 | | 98.4 | 90-110 | | |
| Nitrate as N | | 11.1 | 0.45 | mg/L | 11.3 | | 98.4 | 90-110 | | |
| Nitrite as N | | 4.89 | 0.30 | mg/L | 5.00 | | 97.8 | 90-110 | | |
| Sulfate as SO4 | | 49.4 | 2.0 | mg/L | 50.0 | | 98.8 | 90-110 | | |
| **LCS Dup (B9D0225-BSD1)** | | Prepared: 04/02/19 Analyzed: 04/03/19 | | | | | | | | |
| **EPA 300.0** | | | | | | | | | | |
| Chloride | | 48.7 | 2.0 | mg/L | 50.0 | | 97.3 | 90-110 | 1.14 | 20 |
| Nitrate as N | | 11.0 | 0.45 | mg/L | 11.3 | | 97.1 | 90-110 | 1.30 | 20 |
| Nitrite as N | | 4.84 | 0.30 | mg/L | 5.00 | | 96.8 | 90-110 | 1.01 | 20 |
| Sulfate as SO4 | | 48.7 | 2.0 | mg/L | 50.0 | | 97.4 | 90-110 | 1.49 | 20 |
| **Matrix Spike (B9D0225-MS1)** | | Prepared: 04/02/19 Analyzed: 04/03/19 | | | | **Source: FD02069-10** | | | | |
| **EPA 300.0** | | | | | | | | | | |
| Chloride | | 117 | 4.0 | mg/L | 100 | 18.7 | 98.5 | 80-120 | | |
| Nitrate as N | | 26.6 | 0.90 | mg/L | 22.6 | 4.67 | 97.2 | 80-120 | | |
| Nitrite as N | | 9.89 | 0.60 | mg/L | 10.0 | ND | 98.9 | 80-120 | | |
| Sulfate as SO4 | | 119 | 4.0 | mg/L | 100 | 21.3 | 97.8 | 80-120 | | |
| **Matrix Spike Dup (B9D0225-MSD1)** | | Prepared: 04/02/19 Analyzed: 04/03/19 | | | | **Source: FD02069-10** | | | | |
| **EPA 300.0** | | | | | | | | | | |
| Chloride | | 116 | 4.0 | mg/L | 100 | 18.7 | 97.4 | 80-120 | 0.881 | 20 |
| Nitrate as N | | 26.4 | 0.90 | mg/L | 22.6 | 4.67 | 96.2 | 80-120 | 0.828 | 20 |
| Nitrite as N | | 9.83 | 0.60 | mg/L | 10.0 | ND | 98.3 | 80-120 | 0.576 | 20 |
| Sulfate as SO4 | | 119 | 4.0 | mg/L | 100 | 21.3 | 97.3 | 80-120 | 0.417 | 20 |
| **Matrix Spike (B9D0225-MS2)** | | Prepared: 04/02/19 Analyzed: 04/03/19 | | | | **Source: FD02089-02** | | | | |
| **EPA 300.0** | | | | | | | | | | |
| Chloride | | 107 | 4.0 | mg/L | 100 | 10.6 | 96.7 | 80-120 | | |
| Nitrate as N | | 22.8 | 0.90 | mg/L | 22.6 | 0.812 | 97.2 | 80-120 | | |
| Nitrite as N | | 9.76 | 0.60 | mg/L | 10.0 | ND | 97.6 | 80-120 | | |
| Sulfate as SO4 | | 103 | 4.0 | mg/L | 100 | 6.46 | 96.8 | 80-120 | | |
| **Matrix Spike Dup (B9D0225-MSD2)** | | Prepared: 04/02/19 Analyzed: 04/03/19 | | | | **Source: FD02089-02** | | | | |
| **EPA 300.0** | | | | | | | | | | |
| Chloride | | 103 | 4.0 | mg/L | 100 | 10.6 | 92.2 | 80-120 | 4.23 | 20 |
| Nitrate as N | | 21.8 | 0.90 | mg/L | 22.6 | 0.812 | 92.7 | 80-120 | 4.58 | 20 |
| Nitrite as N | | 9.36 | 0.60 | mg/L | 10.0 | ND | 93.6 | 80-120 | 4.18 | 20 |
| Sulfate as SO4 | | 98.7 | 4.0 | mg/L | 100 | 6.46 | 92.3 | 80-120 | 4.45 | 20 |

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## Quality Control Sample Results - Inorganics

| Analyte | Flag | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch - B9D0309** | | | | | | | | | | |
| **Blank (B9D0309-BLK1)** | | Prepared: 04/03/19 Analyzed: 04/05/19 | | | | | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | ND | 0.50 | mg/L | | | | | | |
| **LCS (B9D0309-BS1)** | | Prepared: 04/03/19 Analyzed: 04/05/19 | | | | | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 9.50 | 0.50 | mg/L | 10.0 | | 95.0 | 90-110 | | |
| **LCS Dup (B9D0309-BSD1)** | | Prepared: 04/03/19 Analyzed: 04/05/19 | | | | | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 9.89 | 0.50 | mg/L | 10.0 | | 98.9 | 90-110 | 4.04 | 20 |
| **Matrix Spike (B9D0309-MS1)** | | Prepared: 04/03/19 Analyzed: 04/05/19 | | | | **Source: FC29011-01** | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 10.1 | 0.50 | mg/L | 10.0 | 0.623 | 94.5 | 80-120 | | |
| **Matrix Spike Dup (B9D0309-MSD1)** | | Prepared: 04/03/19 Analyzed: 04/05/19 | | | | **Source: FC29011-01** | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 10.8 | 0.50 | mg/L | 10.0 | 0.623 | 102 | 80-120 | 6.77 | 20 |
| **Matrix Spike (B9D0309-MS2)** | | Prepared: 04/03/19 Analyzed: 04/05/19 | | | | **Source: FD03002-01** | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 12.8 | 0.50 | mg/L | 10.0 | 3.79 | 89.6 | 80-120 | | |
| **Matrix Spike Dup (B9D0309-MSD2)** | | Prepared: 04/03/19 Analyzed: 04/05/19 | | | | **Source: FD03002-01** | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 13.3 | 0.50 | mg/L | 10.0 | 3.79 | 94.7 | 80-120 | 3.91 | 20 |
| **Batch - B9D0316** | | | | | | | | | | |
| **Blank (B9D0316-BLK1)** | | Prepared & Analyzed: 04/04/19 | | | | | | | | |
| **SM 2320 B** | | | | | | | | | | |
| Bicarbonate Alkalinity as HCO3 | J | 0.280 | 1.3 | mg/L | | | | | | |
| Carbonate Alkalinity as CO3 | | ND | 1.0 | mg/L | | | | | | |
| Hydroxide Alkalinity as OH | | ND | 1.0 | mg/L | | | | | | |
| Total Alkalinity as CaCO3 | J | 0.230 | 1.0 | mg/L | | | | | | |
| **SM 2510 B** | | | | | | | | | | |
| Specific Conductance (EC) | | ND | 1.0 | µS/cm | | | | | | |
| **LCS (B9D0316-BS1)** | | Prepared & Analyzed: 04/04/19 | | | | | | | | |
| **SM 2510 B** | | | | | | | | | | |
| Specific Conductance (EC) | | 484 | 1.0 | µS/cm | 500 | | 96.8 | 80-120 | | |
| **LCS (B9D0316-BS3)** | | Prepared & Analyzed: 04/04/19 | | | | | | | | |
| **SM 2320 B** | | | | | | | | | | |
| Total Alkalinity as CaCO3 | | 227 | 1.0 | mg/L | 250 | | 90.8 | 80-120 | | |
| **LCS Dup (B9D0316-BSD1)** | | Prepared & Analyzed: 04/04/19 | | | | | | | | |
| **SM 2510 B** | | | | | | | | | | |
| Specific Conductance (EC) | | 483 | 1.0 | µS/cm | 500 | | 96.6 | 80-120 | 0.209 | 20 |
| **LCS Dup (B9D0316-BSD3)** | | Prepared & Analyzed: 04/04/19 | | | | | | | | |
| **SM 2320 B** | | | | | | | | | | |
| Total Alkalinity as CaCO3 | | 226 | 1.0 | mg/L | 250 | | 90.3 | 80-120 | 0.614 | 20 |

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## Quality Control Sample Results - Inorganics

| Analyte | Flag | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch - B9D0316** | | | | | | | | | | |
| **Duplicate (B9D0316-DUP1)** | | Prepared & Analyzed: 04/04/19 | | | | **Source: FD02043-02** | | | | |
| **SM 2320 B** | | | | | | | | | | |
| Bicarbonate Alkalinity as HCO3 | | 201 | 1.3 | mg/L | | 202 | | | 0.218 | 20 |
| Carbonate Alkalinity as CO3 | | ND | 1.0 | mg/L | | ND | | | | |
| Hydroxide Alkalinity as OH | | ND | 1.0 | mg/L | | ND | | | | |
| Total Alkalinity as CaCO3 | | 165 | 1.0 | mg/L | | 165 | | | 0.218 | 20 |
| **SM 2510 B** | | | | | | | | | | |
| Specific Conductance (EC) | | 705 | 1.0 | µS/cm | | 707 | | | 0.289 | 20 |
| **Duplicate (B9D0316-DUP2)** | | Prepared & Analyzed: 04/04/19 | | | | **Source: FD04012-01** | | | | |
| **SM 2320 B** | | | | | | | | | | |
| Bicarbonate Alkalinity as HCO3 | | 58.3 | 1.3 | mg/L | | 53.5 | | | 8.50 | 20 |
| Carbonate Alkalinity as CO3 | | ND | 1.0 | mg/L | | ND | | | | |
| Hydroxide Alkalinity as OH | | ND | 1.0 | mg/L | | ND | | | | |
| Total Alkalinity as CaCO3 | | 47.8 | 1.0 | mg/L | | 43.9 | | | 8.49 | 20 |
| **SM 2510 B** | | | | | | | | | | |
| Specific Conductance (EC) | | 604 | 1.0 | µS/cm | | 601 | | | 0.505 | 20 |
| **Batch - B9D0317** | | | | | | | | | | |
| **LCS (B9D0317-BS1)** | | Prepared & Analyzed: 04/04/19 | | | | | | | | |
| **SM 4500-H B** | | | | | | | | | | |
| pH | | 6.98 | 0.10 | pH Units | 7.00 | | 99.7 | 97-103 | | |
| **LCS Dup (B9D0317-BSD1)** | | Prepared & Analyzed: 04/04/19 | | | | | | | | |
| **SM 4500-H B** | | | | | | | | | | |
| pH | | 6.98 | 0.10 | pH Units | 7.00 | | 99.7 | 97-103 | 0.00 | 20 |
| **Duplicate (B9D0317-DUP1)** | | Prepared & Analyzed: 04/04/19 | | | | **Source: FD02073-01** | | | | |
| **SM 4500-H B** | | | | | | | | | | |
| pH | | 8.26 | 0.10 | pH Units | | 8.24 | | | 0.242 | 20 |
| **Duplicate (B9D0317-DUP2)** | | Prepared & Analyzed: 04/04/19 | | | | **Source: FD03053-01** | | | | |
| **SM 4500-H B** | | | | | | | | | | |
| pH | | 5.84 | 0.10 | pH Units | | 5.78 | | | 1.03 | 20 |
| **Batch - B9D0401** | | | | | | | | | | |
| **Blank (B9D0401-BLK1)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | ND | 0.50 | mg/L | | | | | | |
| **LCS (B9D0401-BS1)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 9.88 | 0.50 | mg/L | 10.0 | | 98.8 | 90-110 | | |
| **LCS Dup (B9D0401-BSD1)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 9.50 | 0.50 | mg/L | 10.0 | | 95.0 | 90-110 | 3.93 | 20 |
| **Matrix Spike (B9D0401-MS1)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | **Source: FD03001-03** | | | | |
| **EPA 351.2** | | | | | | | | | | |

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## Quality Control Sample Results - Inorganics

| Analyte | Flag | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch - B9D0401** | | | | | | | | | | |
| **Matrix Spike (B9D0401-MS1)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | **Source: FD03001-03** | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 10.6 | 0.50 | mg/L | 10.0 | ND | 106 | 80-120 | | |
| **Matrix Spike Dup (B9D0401-MSD1)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | **Source: FD03001-03** | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 10.4 | 0.50 | mg/L | 10.0 | ND | 104 | 80-120 | 1.99 | 20 |
| **Matrix Spike (B9D0401-MS2)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | **Source: FD03035-01** | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 10.0 | 0.50 | mg/L | 10.0 | ND | 100 | 80-120 | | |
| **Matrix Spike Dup (B9D0401-MSD2)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | **Source: FD03035-01** | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 9.79 | 0.50 | mg/L | 10.0 | ND | 97.9 | 80-120 | 2.56 | 20 |
| **Batch - B9D0410** | | | | | | | | | | |
| **Blank (B9D0410-BLK1)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | | | | | |
| **SM 2540 C** | | | | | | | | | | |
| Total Dissolved Solids | | ND | 10 | mg/L | | | | | | |
| **LCS (B9D0410-BS1)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | | | | | |
| **SM 2540 C** | | | | | | | | | | |
| Total Dissolved Solids | | 258 | 10 | mg/L | 240 | | 108 | 80-120 | | |
| **LCS Dup (B9D0410-BSD1)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | | | | | |
| **SM 2540 C** | | | | | | | | | | |
| Total Dissolved Solids | | 250 | 10 | mg/L | 240 | | 104 | 80-120 | 3.35 | 20 |
| **Duplicate (B9D0410-DUP1)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | **Source: FD02051-01** | | | | |
| **SM 2540 C** | | | | | | | | | | |
| Total Dissolved Solids | | 330 | 10 | mg/L | | 320 | | | 3.07 | 20 |
| **Duplicate (B9D0410-DUP2)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | **Source: FD03013-01** | | | | |
| **SM 2540 C** | | | | | | | | | | |
| Total Dissolved Solids | | 1190 | 10 | mg/L | | 1130 | | | 5.27 | 20 |
| **Batch - B9D0803** | | | | | | | | | | |
| **Blank (B9D0803-BLK1)** | | Prepared & Analyzed: 04/08/19 | | | | | | | | |
| **EPA 350.1** | | | | | | | | | | |
| Ammonia as N | | ND | 1.0 | mg/L | | | | | | |
| **LCS (B9D0803-BS1)** | | Prepared & Analyzed: 04/08/19 | | | | | | | | |
| **EPA 350.1** | | | | | | | | | | |
| Ammonia as N | | 9.60 | 1.0 | mg/L | 10.0 | | 96.0 | 90-110 | | |
| **LCS Dup (B9D0803-BSD1)** | | Prepared & Analyzed: 04/08/19 | | | | | | | | |
| **EPA 350.1** | | | | | | | | | | |
| Ammonia as N | | 10.2 | 1.0 | mg/L | 10.0 | | 102 | 90-110 | 5.83 | 20 |
| **Matrix Spike (B9D0803-MS1)** | | Prepared & Analyzed: 04/08/19 | | | | **Source: FD02042-01** | | | | |
| **EPA 350.1** | | | | | | | | | | |
| Ammonia as N | | 9.59 | 1.0 | mg/L | 10.0 | ND | 95.9 | 80-120 | | |

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| | | |
|---|---|---|
| MTA Environmental Division | **Project:** City of Visalia Water Conservation Plant | **Reported:** |
| 2527 Fresno Street | **Project Number:** A76404.03 | 04/16/2019 |
| Fresno CA, 93721 | **Project Manager:** Kirk Jacobsen | |

## Quality Control Sample Results - Inorganics

| Analyte | Flag | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch - B9D0803** | | | | | | | | | | |
| **Matrix Spike Dup (B9D0803-MSD1)** | | Prepared & Analyzed: 04/08/19 | | | | **Source: FD02042-01** | | | | |
| **EPA 350.1** | | | | | | | | | | |
| Ammonia as N | | 9.88 | 1.0 | mg/L | 10.0 | ND | 98.8 | 80-120 | 2.95 | 20 |
| **Matrix Spike (B9D0803-MS2)** | | Prepared & Analyzed: 04/08/19 | | | | **Source: FD03019-01** | | | | |
| **EPA 350.1** | | | | | | | | | | |
| Ammonia as N | | 10.6 | 1.0 | mg/L | 10.0 | 0.219 | 104 | 80-120 | | |
| **Matrix Spike Dup (B9D0803-MSD2)** | | Prepared & Analyzed: 04/08/19 | | | | **Source: FD03019-01** | | | | |
| **EPA 350.1** | | | | | | | | | | |
| Ammonia as N | | 10.5 | 1.0 | mg/L | 10.0 | 0.219 | 102 | 80-120 | 1.25 | 20 |

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|---|---|---|
| MTA Environmental Division | **Project:** City of Visalia Water Conservation Plant | **Reported:** |
| 2527 Fresno Street | **Project Number:** A76404.03 | 04/16/2019 |
| Fresno CA, 93721 | **Project Manager:** Kirk Jacobsen | |

## Quality Control Sample Results - Metals (Dissolved)

| Analyte | Flag | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch - B9C2933** | | | | | | | | | | |
| **Blank (B9C2933-BLK1)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | | | | | |
| **EPA 200.7** | | | | | | | | | | |
| Calcium | | ND | 0.10 | mg/L | | | | | | |
| Magnesium | | ND | 0.10 | mg/L | | | | | | |
| Potassium | | ND | 1.0 | mg/L | | | | | | |
| Sodium | | ND | 1.0 | mg/L | | | | | | |
| **LCS (B9C2933-BS1)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | | | | | |
| **EPA 200.7** | | | | | | | | | | |
| Calcium | | 0.962 | 0.10 | mg/L | 1.00 | | 96.2 | 85-115 | | |
| Magnesium | | 1.98 | 0.10 | mg/L | 2.00 | | 98.9 | 85-115 | | |
| Potassium | | 2.01 | 1.0 | mg/L | 2.00 | | 101 | 85-115 | | |
| Sodium | | 2.03 | 1.0 | mg/L | 2.00 | | 102 | 85-115 | | |
| **LCS Dup (B9C2933-BSD1)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | | | | | |
| **EPA 200.7** | | | | | | | | | | |
| Calcium | | 0.971 | 0.10 | mg/L | 1.00 | | 97.1 | 85-115 | 0.860 | 20 |
| Magnesium | | 1.96 | 0.10 | mg/L | 2.00 | | 97.9 | 85-115 | 1.07 | 20 |
| Potassium | | 1.98 | 1.0 | mg/L | 2.00 | | 99.0 | 85-115 | 1.79 | 20 |
| Sodium | | 2.09 | 1.0 | mg/L | 2.00 | | 104 | 85-115 | 2.76 | 20 |

## Notes and Definitions

| | |
|---|---|
| J | Detected but below the Reporting Limit; therefore, result is an estimated concentration ( CLP J-Flag). Same as DNQ - Detected, but Not Quantified. |
| µg/L | micrograms per liter (parts per billion concentration units) |
| mg/L | milligrams per liter (parts per million concentration units) |
| mg/kg | milligrams per kilogram (parts per million concentration units) |
| ND | Analyte NOT DETECTED at or above the reporting limit |
| RPD | Relative Percent Difference |
| | Analysis of pH, filtration, and residual chlorine is to take place immediately after sampling in the field. If the test was performed in the laboratory, the hold time was exceeded. **(for aqueous matrices only)** |

# MOORE TWINING ASSOCIATES, INC.

ANALYTICAL CHEMISTRY DIVISION
CALIFORNIA ELAP CERTIFICATION # 1371

# CHAIN OF CUSTODY/ANALYSIS REQUEST

2527 FRESNO STREET • FRESNO, CA 93721 • PHONE (559) 268-7021 • FAX: (559) 268-0740

**WORK ORDER #:** FD03001
**PAGE** 1 **OF** 2

| REPORT TO: | X INVOICE TO: X REPORT COPY TO: | REPORTING: |
|---|---|---|
| ATTENTION: Kirk Jacobsen | ATTENTION: Kirk Jacobsen | X STANDARD FORMAT |
| NAME: Moore Twining Associates | NAME: Moore Twining Associates | ☐ EDT (STATE FORM) |
| ADDRESS: 2527 Fresno Street | ADDRESS: 2527 Fresno Street | ☐ GEOTRACKER/COELT (LUFT) |
| Fresno, CA 93721 | Fresno, California 93721 | ☐ PDF ☐ EXCEL |
| PHONE: (559)268-7021 | PHONE: 559-268-7021 | ☐ County DHS : |
| FAX: (559)268-7126 | FAX: 559-268-7126 | ☐ Environmental Health Agency : |
| | | X OTHER: J Flag Report/Standard Excel |

**SAMPLE INFORMATION**

SAMPLED BY (PRINT): Joe Clark

SIGNATURE: [signature]

☐ PUBLIC SYSTEM ☐ ROUTINE
☐ PRIVATE WELL ☐ REPEAT
☐ OTHER ☐ REPLACEMENT

TURN AROUND TIME: ☐ RUSH, DUE ON:
☐ STANDARD

**SAMPLE TYPES:**

SOLID:
BS – BIOSOLID
CR – CERAMIC
SL – SOIL/SOLID

LIQUID:
DW - DRINKING WATER
GW - GROUND WATER
OL - OIL
SF - SURFACE WATER
ST - STORM WATER
WW – WASTE WATER

**PROJECT INFORMATION**

CONTRACT/P.O. NO.:

PROJECT: City of Visalia Water Conservation Plant

PROJECT NUMBER: A76404.03

CRWA MEMBER? YES ☐ NO☐

**NOTES ON RECEIVED CONDITION:**

☐ CUSTODY SEAL(S) BROKEN ☐ SAMPLE(S) DAMAGED

☑ ON ICE ☐ AMBIENT TEMP. ☐ INCORRECT PRESERVATION

3.2°C

**ANALYSIS REQUESTED**

| LAB USE | CLIENT SAMPLE ID | DATE | TIME | TYPE | pH, EC, TDS, TN | Ammonia | General Minerals (dissolved)* | | | | | | | | System Number / Station Code |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MW-N | 4/2/19 | 1510 | GW | X | X | X | | | | | | | | |
| 2 | MW-O | 4/2/19 | 1014 | GW | X | X | X | | | | | | | | |
| 3 | MW-R | 4/2/19 | 1151 | GW | X | X | X | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

COMMENTS/ADDITIONAL INSTRUCTIONS: **Laboratory filter and preserve for metals upon receipt.** Samples held in lab fridge overnight

* General Minerals – Total Alkalinity, Calcium, Chloride, Hardness, Potassium, Sodium, Sulfate, TDS, Nitrate, Cation/Anion Balance.

| RELINQUISHED BY | COMPANY | DATE | TIME | RECEIVED BY | COMPANY |
|---|---|---|---|---|---|
| [signature] | MTA | 4.3.19 | 0830 | Blake Hinckley | MTA |
| | | | | | |

Moore Twining Associates

Sample Integrity Page 2 of 2 WO# FD03001 MTA Bottles: (Yes) or No

| COC Info | | | | | | |
|---|---|---|---|---|---|---|
| Was temperature within range? Chemistry ≤6°C Micro <10°C Temp____°C | (Yes) No N/A | Did all bottle labels agree with COC? | (Yes) No N/A | Were there bubbles in VOA vials? **(Volatiles Only)** | Yes No (N/A) |
| If samples were taken today, is there evidence that chilling has begun? Recvd____C° | (Yes) No N/A | Was a sufficient amount of sample received? | (Yes) No N/A | Was PM notified of discrepancies? PM: By/Time: | Yes No (N/A) |
| Did all bottles arrive unbroken and intact? | (Yes) No N/A | Were correct containers and preservatives received for the tests requested? | (Yes) No N/A | | |
| Do samples have a hold time <72 hours? | (Yes) No N/A | | | | |

| Bottles Received | | |
|---|---|---|
| 125ml (A) 250ml (B) 1Liter (C) 40ml VOA (V) | 1-3 | |
| Bacti $Na_2S_2O_3$ | | |
| None (P) | 1-B1-C | |
| Cr6 Buffer (P) Borate Carbonate Buffer | | |
| $HNO_3$ (P) | 1-A | |
| $H_2SO_4$ (P) | | |
| NaOH (P) | | |
| NaOH+ZnAc (P) | | |
| Dissolved Oxygen 300ml (P) | | |
| None (AG) | | |
| None (CG) 500ml | | |
| $Na_2S_2O_3$ 250ml (Brown P) 549 | | |
| $Na_2S_2O_3$ (AG) | | |
| $Na_2S_2O_3$ (AG) | | |
| Thio/K Citrate | | |
| $NH_4Cl$ (AG) 552 | | |
| HCl (AG) | | |
| None (CG) 500ml | | |
| $H_3PO_4$ (AG) | | |
| Other: | | |
| Plastic Bag | | |
| Low Level Hg/Metals Double Bag | | |
| Client Own | | |
| Glass Jar: 125/ 250/ 500 | | |
| Soil Tube: Brass/ Steel/ Plastic | | |
| 5 g Encore | | |

Comments

| Filter or Split | Container | Preservative | Date/Time/Initials |
|---|---|---|---|
| S P (F) | 125 mL | HNO3 | 4.3.29 1000 [initials] |
| S P F | | | |
| S P F | | | |
| S P F | | | |
| S P F | | | |

Labeled by: [initials] @ 0843 Labels checked by: [initials] @ 0844

MOORE TWINING ASSOCIATES, INC.
California ELAP Certificate #1371

**2527 Fresno Street**
**Fresno, CA 93721**
**(559) 268-7021 Phone**
**(559) 268-0740 Fax**

April 16, 2019

Work Order #: **FD03035**

Kirk Jacobsen
MTA Environmental Division
2527 Fresno Street
Fresno, CA 93721

**RE: City of Visalia Water Conservation Plant**

Enclosed are the analytical results for samples received by our laboratory on **04/03/19** . For your reference, these analyses have been assigned laboratory work order number **FD03035**.

All analyses have been performed according to our laboratory's quality assurance program. All results are intended to be considered in their entirety, Moore Twining Associates, Inc. (MTA) is not responsible for use of less than complete reports. Results apply only to samples analyzed.

If you have any questions, please feel free to contact us at the number listed above.

Sincerely,

**Moore Twining Associates, Inc.**

Susan Federico
Client Services Representative

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Fresno, CA 93721
(559) 268-7021 Phone
(559) 268-0740 Fax

| | | | |
|---|---|---|---|
| MTA Environmental Division | **Project:** | City of Visalia Water Conservation Plant | **Reported:** |
| 2527 Fresno Street | **Project Number:** | A76404.03 | 04/16/2019 |
| Fresno CA, 93721 | **Project Manager:** | Kirk Jacobsen | |

## Analytical Report for the Following Samples

| Sample ID | Notes | Laboratory ID | Matrix | Date Sampled | Date Received |
|---|---|---|---|---|---|
| MW-P | | FD03035-01 | Ground Water | 04/03/19 09:53 | 04/03/19 14:45 |

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| | | |
|---|---|---|
| MTA Environmental Division<br>2527 Fresno Street<br>Fresno CA, 93721 | **Project:** City of Visalia Water Conservation Plant<br>**Project Number:** A76404.03<br>**Project Manager:** Kirk Jacobsen | **Reported:**<br>04/16/2019 |

## MW-P

FD03035-01 (Ground Water) Sampled: 04/03/19 09:53

| Analyte | Flag | Result | Reporting Limit | MDL | Units | Dilution | Batch | Analyst | Prepared | Analyzed | Method |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Inorganics** | | | | | | | | | | | |
| Bicarbonate Alkalinity as HCO3 | | **230** | 1.3 | 0.23 | mg/L | 1 | B9D0315 | GMC | 04/04/19 20:41 | 04/04/19 20:41 | SM 2320 B |
| Carbonate Alkalinity as CO3 | | ND | 1.0 | 0.23 | mg/L | 1 | B9D0315 | GMC | 04/04/19 20:41 | 04/04/19 20:41 | SM 2320 B |
| Hydroxide Alkalinity as OH | | ND | 1.0 | 0.23 | mg/L | 1 | B9D0315 | GMC | 04/04/19 20:41 | 04/04/19 20:41 | SM 2320 B |
| Total Alkalinity as CaCO3 | | **190** | 1.0 | 0.23 | mg/L | 1 | B9D0315 | GMC | 04/04/19 20:41 | 04/04/19 20:41 | SM 2320 B |
| Ammonia as N | | ND | 1.0 | 0.18 | mg/L | 1 | B9D0804 | JAG | 04/08/19 11:30 | 04/08/19 16:16 | EPA 350.1 |
| Cation/Anion Balance (% Difference) | | **1.4** | | | % | 1 | B9D1520 | MCM | 04/15/19 14:48 | 04/15/19 14:49 | SM 1030 F |
| Chloride | | **68** | 4.0 | 0.36 | mg/L | 2 | B9D0408 | CMF | 04/04/19 10:12 | 04/05/19 1:04 | EPA 300.0 |
| Specific Conductance (EC) | | **740** | 1.0 | 0.26 | µS/cm | 1 | B9D0315 | GMC | 04/04/19 20:41 | 04/04/19 20:41 | SM 2510 B |
| Nitrate as N | J | **0.34** | 0.90 | 0.056 | mg/L | 2 | B9D0408 | CMF | 04/04/19 10:12 | 04/05/19 1:04 | EPA 300.0 |
| Nitrite as N | | ND | 0.60 | 0.19 | mg/L | 2 | B9D0408 | CMF | 04/04/19 10:12 | 04/05/19 1:04 | EPA 300.0 |
| pH | | **7.7** | 0.10 | 0.10 | pH Units | 1 | B9D0315 | GMC | 04/04/19 20:41 | 04/04/19 20:41 | SM 4500-H B |
| Sulfate as SO4 | | **99** | 4.0 | 0.19 | mg/L | 2 | B9D0408 | CMF | 04/04/19 10:12 | 04/05/19 1:04 | EPA 300.0 |
| Total Dissolved Solids | | **550** | 10 | 8.1 | mg/L | 1 | B9D1006 | ACY | 04/10/19 10:14 | 04/11/19 13:10 | SM 2540 C |
| Total Kjeldahl Nitrogen | | ND | 0.50 | 0.18 | mg/L | 1 | B9D0401 | JAG | 04/04/19 7:45 | 04/05/19 13:20 | EPA 351.2 |
| Total Nitrogen | | ND | 0.90 | | mg/L | 2 | [CALC] | JAG | 04/05/19 13:20 | 04/05/19 13:20 | [CALC] |
| **Metals (Dissolved)** | | | | | | | | | | | |
| Calcium | | **74** | 0.10 | 0.048 | mg/L | 1 | B9D0318 | VAC | 04/11/19 7:35 | 04/12/19 16:01 | EPA 200.7 |
| Hardness (Dissolved) | | **220** | 0.66 | | mg equiv. CaCO3/L | 1 | [CALC] | VAC | 04/12/19 16:01 | 04/12/19 16:01 | SM 2340 B |
| Magnesium | | **8.3** | 0.10 | 0.025 | mg/L | 1 | B9D0318 | VAC | 04/11/19 7:35 | 04/12/19 16:01 | EPA 200.7 |
| Potassium | J | **0.49** | 1.0 | 0.34 | mg/L | 1 | B9D0318 | VAC | 04/11/19 7:35 | 04/12/19 16:01 | EPA 200.7 |
| Sodium | | **73** | 1.0 | 0.26 | mg/L | 1 | B9D0318 | VAC | 04/11/19 7:35 | 04/12/19 16:01 | EPA 200.7 |

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|---|---|---|
| MTA Environmental Division<br>2527 Fresno Street<br>Fresno CA, 93721 | **Project:** City of Visalia Water Conservation Plant<br>**Project Number:** A76404.03<br>**Project Manager:** Kirk Jacobsen | **Reported:**<br>04/16/2019 |

## Quality Control Sample Results - Inorganics

| Analyte | Flag | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch - B9D0315** | | | | | | | | | | |
| **Blank (B9D0315-BLK1)** | | Prepared & Analyzed: 04/04/19 | | | | | | | | |
| **SM 2320 B** | | | | | | | | | | |
| Bicarbonate Alkalinity as HCO3 | | ND | 1.3 | mg/L | | | | | | |
| Carbonate Alkalinity as CO3 | | ND | 1.0 | mg/L | | | | | | |
| Hydroxide Alkalinity as OH | | ND | 1.0 | mg/L | | | | | | |
| Total Alkalinity as CaCO3 | | ND | 1.0 | mg/L | | | | | | |
| **SM 2510 B** | | | | | | | | | | |
| Specific Conductance (EC) | | ND | 1.0 | µS/cm | | | | | | |
| **LCS (B9D0315-BS1)** | | Prepared & Analyzed: 04/04/19 | | | | | | | | |
| **SM 2510 B** | | | | | | | | | | |
| Specific Conductance (EC) | | 483 | 1.0 | µS/cm | | | | 80-120 | | |
| **LCS (B9D0315-BS2)** | | Prepared & Analyzed: 04/04/19 | | | | | | | | |
| **SM 4500-H B** | | | | | | | | | | |
| pH | | 7.09 | 0.10 | pH Units | | | | 97-103 | | |
| **LCS (B9D0315-BS3)** | | Prepared & Analyzed: 04/04/19 | | | | | | | | |
| **SM 2320 B** | | | | | | | | | | |
| Total Alkalinity as CaCO3 | | 231 | 1.0 | mg/L | 250 | | 92.6 | 80-120 | | |
| **LCS Dup (B9D0315-BSD1)** | | Prepared & Analyzed: 04/04/19 | | | | | | | | |
| **SM 2510 B** | | | | | | | | | | |
| Specific Conductance (EC) | | 483 | 1.0 | µS/cm | | | | 80-120 | 0.00 | 20 |
| **LCS Dup (B9D0315-BSD2)** | | Prepared & Analyzed: 04/04/19 | | | | | | | | |
| **SM 4500-H B** | | | | | | | | | | |
| pH | | 7.06 | 0.10 | pH Units | | | | 97-103 | 0.424 | 20 |
| **LCS Dup (B9D0315-BSD3)** | | Prepared & Analyzed: 04/04/19 | | | | | | | | |
| **SM 2320 B** | | | | | | | | | | |
| Total Alkalinity as CaCO3 | | 226 | 1.0 | mg/L | 250 | | 90.5 | 80-120 | 2.24 | 20 |
| **Duplicate (B9D0315-DUP1)** | | Prepared & Analyzed: 04/04/19 | | | | **Source: FD03019-01** | | | | |
| **SM 2320 B** | | | | | | | | | | |
| Bicarbonate Alkalinity as HCO3 | | 110 | 1.3 | mg/L | | 109 | | | 0.895 | 20 |
| Carbonate Alkalinity as CO3 | | ND | 1.0 | mg/L | | ND | | | | |
| Hydroxide Alkalinity as OH | | ND | 1.0 | mg/L | | ND | | | | |
| Total Alkalinity as CaCO3 | | 90.2 | 1.0 | mg/L | | 89.4 | | | 0.880 | 20 |
| **SM 2510 B** | | | | | | | | | | |
| Specific Conductance (EC) | | 1050 | 1.0 | µS/cm | | 1050 | | | 0.193 | 20 |
| **SM 4500-H B** | | | | | | | | | | |
| pH | | 7.59 | 0.10 | pH Units | | 7.50 | | | 1.19 | 20 |
| **Duplicate (B9D0315-DUP2)** | | Prepared & Analyzed: 04/04/19 | | | | **Source: FD03023-01** | | | | |
| **SM 2320 B** | | | | | | | | | | |
| Bicarbonate Alkalinity as HCO3 | | 25.3 | 1.3 | mg/L | | 25.3 | | | 0.158 | 20 |
| Carbonate Alkalinity as CO3 | | ND | 1.0 | mg/L | | ND | | | | |
| Hydroxide Alkalinity as OH | | ND | 1.0 | mg/L | | ND | | | | |
| Total Alkalinity as CaCO3 | | 20.8 | 1.0 | mg/L | | 20.7 | | | 0.145 | 20 |

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| | | |
|---|---|---|
| MTA Environmental Division<br>2527 Fresno Street<br>Fresno CA, 93721 | **Project:** City of Visalia Water Conservation Plant<br>**Project Number:** A76404.03<br>**Project Manager:** Kirk Jacobsen | **Reported:**<br>04/16/2019 |

## Quality Control Sample Results - Inorganics

| Analyte | Flag | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch - B9D0315** | | | | | | | | | | |
| **Duplicate (B9D0315-DUP2)** | | Prepared & Analyzed: 04/04/19 | | | | **Source: FD03023-01** | | | | |
| **SM 2510 B** | | | | | | | | | | |
| Specific Conductance (EC) | | 82.3 | 1.0 | µS/cm | | 83.1 | | | 0.955 | 20 |
| **SM 4500-H B** | | | | | | | | | | |
| pH | | 6.74 | 0.10 | pH Units | | 6.82 | | | 1.18 | 20 |
| **Batch - B9D0401** | | | | | | | | | | |
| **Blank (B9D0401-BLK1)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | ND | 0.50 | mg/L | | | | | | |
| **LCS (B9D0401-BS1)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 9.88 | 0.50 | mg/L | 10.0 | | 98.8 | 90-110 | | |
| **LCS Dup (B9D0401-BSD1)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 9.50 | 0.50 | mg/L | 10.0 | | 95.0 | 90-110 | 3.93 | 20 |
| **Matrix Spike (B9D0401-MS1)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | **Source: FD03001-03** | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 10.6 | 0.50 | mg/L | 10.0 | ND | 106 | 80-120 | | |
| **Matrix Spike Dup (B9D0401-MSD1)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | **Source: FD03001-03** | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 10.4 | 0.50 | mg/L | 10.0 | ND | 104 | 80-120 | 1.99 | 20 |
| **Matrix Spike (B9D0401-MS2)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | **Source: FD03035-01** | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 10.0 | 0.50 | mg/L | 10.0 | ND | 100 | 80-120 | | |
| **Matrix Spike Dup (B9D0401-MSD2)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | **Source: FD03035-01** | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 9.79 | 0.50 | mg/L | 10.0 | ND | 97.9 | 80-120 | 2.56 | 20 |
| **Batch - B9D0408** | | | | | | | | | | |
| **Blank (B9D0408-BLK1)** | | Prepared & Analyzed: 04/04/19 | | | | | | | | |
| **EPA 300.0** | | | | | | | | | | |
| Chloride | | ND | 2.0 | mg/L | | | | | | |
| Nitrate as N | | ND | 0.45 | mg/L | | | | | | |
| Nitrite as N | | ND | 0.30 | mg/L | | | | | | |
| Sulfate as SO4 | | ND | 2.0 | mg/L | | | | | | |
| **LCS (B9D0408-BS1)** | | Prepared & Analyzed: 04/04/19 | | | | | | | | |
| **EPA 300.0** | | | | | | | | | | |
| Chloride | | 49.7 | 2.0 | mg/L | 50.0 | | 99.4 | 90-110 | | |
| Nitrate as N | | 11.2 | 0.45 | mg/L | 11.3 | | 99.2 | 90-110 | | |
| Nitrite as N | | 4.95 | 0.30 | mg/L | 5.00 | | 99.1 | 90-110 | | |
| Sulfate as SO4 | | 50.0 | 2.0 | mg/L | 50.0 | | 100 | 90-110 | | |
| **LCS Dup (B9D0408-BSD1)** | | Prepared & Analyzed: 04/04/19 | | | | | | | | |

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Fresno, CA 93721
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(559) 268-0740 Fax

| MTA Environmental Division | Project: | City of Visalia Water Conservation Plant | Reported: |
|---|---|---|---|
| 2527 Fresno Street | Project Number: | A76404.03 | 04/16/2019 |
| Fresno CA, 93721 | Project Manager: | Kirk Jacobsen | |

## Quality Control Sample Results - Inorganics

| Analyte | Flag | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch - B9D0408** | | | | | | | | | | |
| **LCS Dup (B9D0408-BSD1)** | | Prepared & Analyzed: 04/04/19 | | | | | | | | |
| **EPA 300.0** | | | | | | | | | | |
| Chloride | | 48.5 | 2.0 | mg/L | 50.0 | | 97.1 | 90-110 | 2.32 | 20 |
| Nitrate as N | | 11.0 | 0.45 | mg/L | 11.3 | | 97.2 | 90-110 | 2.03 | 20 |
| Nitrite as N | | 4.87 | 0.30 | mg/L | 5.00 | | 97.3 | 90-110 | 1.79 | 20 |
| Sulfate as SO4 | | 48.9 | 2.0 | mg/L | 50.0 | | 97.8 | 90-110 | 2.20 | 20 |
| **Matrix Spike (B9D0408-MS1)** | | Prepared & Analyzed: 04/04/19 | | | | Source: FD03021-01 | | | | |
| **EPA 300.0** | | | | | | | | | | |
| Chloride | | 260 | 8.0 | mg/L | 200 | 61.4 | 99.5 | 80-120 | | |
| Nitrate as N | | 51.8 | 1.8 | mg/L | 45.2 | 8.27 | 96.4 | 80-120 | | |
| Nitrite as N | | 19.4 | 1.2 | mg/L | 20.0 | ND | 97.1 | 80-120 | | |
| Sulfate as SO4 | | 237 | 8.0 | mg/L | 200 | 40.8 | 97.8 | 80-120 | | |
| **Matrix Spike Dup (B9D0408-MSD1)** | | Prepared & Analyzed: 04/04/19 | | | | Source: FD03021-01 | | | | |
| **EPA 300.0** | | | | | | | | | | |
| Chloride | | 262 | 8.0 | mg/L | 200 | 61.4 | 100 | 80-120 | 0.471 | 20 |
| Nitrate as N | | 52.1 | 1.8 | mg/L | 45.2 | 8.27 | 97.0 | 80-120 | 0.574 | 20 |
| Nitrite as N | | 19.5 | 1.2 | mg/L | 20.0 | ND | 97.4 | 80-120 | 0.292 | 20 |
| Sulfate as SO4 | | 237 | 8.0 | mg/L | 200 | 40.8 | 98.1 | 80-120 | 0.249 | 20 |
| **Matrix Spike (B9D0408-MS2)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | Source: FD03032-01 | | | | |
| **EPA 300.0** | | | | | | | | | | |
| Chloride | | 105 | 4.0 | mg/L | 100 | 3.54 | 102 | 80-120 | | |
| Nitrate as N | | 22.1 | 0.90 | mg/L | 22.6 | ND | 97.6 | 80-120 | | |
| Nitrite as N | | 9.76 | 0.60 | mg/L | 10.0 | ND | 97.6 | 80-120 | | |
| Sulfate as SO4 | | 97.9 | 4.0 | mg/L | 100 | ND | 97.9 | 80-120 | | |
| **Matrix Spike Dup (B9D0408-MSD2)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | Source: FD03032-01 | | | | |
| **EPA 300.0** | | | | | | | | | | |
| Chloride | | 105 | 4.0 | mg/L | 100 | 3.54 | 102 | 80-120 | 0.0365 | 20 |
| Nitrate as N | | 22.1 | 0.90 | mg/L | 22.6 | ND | 97.8 | 80-120 | 0.264 | 20 |
| Nitrite as N | | 9.77 | 0.60 | mg/L | 10.0 | ND | 97.7 | 80-120 | 0.182 | 20 |
| Sulfate as SO4 | | 98.1 | 4.0 | mg/L | 100 | ND | 98.1 | 80-120 | 0.226 | 20 |
| **Batch - B9D0804** | | | | | | | | | | |
| **Blank (B9D0804-BLK1)** | | Prepared & Analyzed: 04/08/19 | | | | | | | | |
| **EPA 350.1** | | | | | | | | | | |
| Ammonia as N | | ND | 1.0 | mg/L | | | | | | |
| **LCS (B9D0804-BS1)** | | Prepared & Analyzed: 04/08/19 | | | | | | | | |
| **EPA 350.1** | | | | | | | | | | |
| Ammonia as N | BS2 | 8.89 | 1.0 | mg/L | 10.0 | | 88.9 | 90-110 | | |
| **LCS Dup (B9D0804-BSD1)** | | Prepared & Analyzed: 04/08/19 | | | | | | | | |
| **EPA 350.1** | | | | | | | | | | |
| Ammonia as N | | 9.52 | 1.0 | mg/L | 10.0 | | 95.2 | 90-110 | 6.84 | 20 |
| **Matrix Spike (B9D0804-MS1)** | | Prepared & Analyzed: 04/08/19 | | | | Source: FD03021-01 | | | | |

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| | | |
|---|---|---|
| MTA Environmental Division<br>2527 Fresno Street<br>Fresno CA, 93721 | **Project:** City of Visalia Water Conservation Plant<br>**Project Number:** A76404.03<br>**Project Manager:** Kirk Jacobsen | **Reported:**<br>04/16/2019 |

## Quality Control Sample Results - Inorganics

| Analyte | Flag | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch - B9D0804** | | | | | | | | | | |
| **Matrix Spike (B9D0804-MS1)** | | Prepared & Analyzed: 04/08/19 | | | | **Source: FD03021-01** | | | | |
| **EPA 350.1** | | | | | | | | | | |
| Ammonia as N | | 9.72 | 1.0 | mg/L | 10.0 | ND | 97.2 | 80-120 | | |
| **Matrix Spike Dup (B9D0804-MSD1)** | | Prepared & Analyzed: 04/08/19 | | | | **Source: FD03021-01** | | | | |
| **EPA 350.1** | | | | | | | | | | |
| Ammonia as N | | 9.99 | 1.0 | mg/L | 10.0 | ND | 99.9 | 80-120 | 2.69 | 20 |
| **Matrix Spike (B9D0804-MS2)** | | Prepared & Analyzed: 04/08/19 | | | | **Source: FD04006-02** | | | | |
| **EPA 350.1** | | | | | | | | | | |
| Ammonia as N | | 10.4 | 1.0 | mg/L | 10.0 | ND | 104 | 80-120 | | |
| **Matrix Spike Dup (B9D0804-MSD2)** | | Prepared & Analyzed: 04/08/19 | | | | **Source: FD04006-02** | | | | |
| **EPA 350.1** | | | | | | | | | | |
| Ammonia as N | | 10.7 | 1.0 | mg/L | 10.0 | ND | 107 | 80-120 | 3.09 | 20 |
| **Batch - B9D1006** | | | | | | | | | | |
| **Blank (B9D1006-BLK1)** | | Prepared: 04/10/19 Analyzed: 04/11/19 | | | | | | | | |
| **SM 2540 C** | | | | | | | | | | |
| Total Dissolved Solids | | ND | 10 | mg/L | | | | | | |
| **LCS (B9D1006-BS1)** | | Prepared: 04/10/19 Analyzed: 04/11/19 | | | | | | | | |
| **SM 2540 C** | | | | | | | | | | |
| Total Dissolved Solids | | 238 | 10 | mg/L | 240 | | 99.2 | 80-120 | | |
| **LCS Dup (B9D1006-BSD1)** | | Prepared: 04/10/19 Analyzed: 04/11/19 | | | | | | | | |
| **SM 2540 C** | | | | | | | | | | |
| Total Dissolved Solids | | 251 | 10 | mg/L | 240 | | 105 | 80-120 | 5.32 | 20 |
| **Duplicate (B9D1006-DUP1)** | | Prepared: 04/10/19 Analyzed: 04/11/19 | | | | **Source: FD03038-01** | | | | |
| **SM 2540 C** | | | | | | | | | | |
| Total Dissolved Solids | | 1720 | 20 | mg/L | | 1740 | | | 1.15 | 20 |
| **Duplicate (B9D1006-DUP2)** | | Prepared: 04/10/19 Analyzed: 04/11/19 | | | | **Source: FD05009-01** | | | | |
| **SM 2540 C** | | | | | | | | | | |
| Total Dissolved Solids | | 508 | 10 | mg/L | | 521 | | | 2.43 | 20 |

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| | | |
|---|---|---|
| MTA Environmental Division | **Project:** City of Visalia Water Conservation Plant | **Reported:** |
| 2527 Fresno Street | **Project Number:** A76404.03 | 04/16/2019 |
| Fresno CA, 93721 | **Project Manager:** Kirk Jacobsen | |

## Quality Control Sample Results - Metals (Dissolved)

| Analyte | Flag | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch - B9D0318** | | | | | | | | | | |
| **Blank (B9D0318-BLK1)** | Prepared: 04/11/19 Analyzed: 04/12/19 | | | | | | | | | |
| **EPA 200.7** | | | | | | | | | | |
| Calcium | | ND | 0.10 | mg/L | | | | | | |
| Magnesium | | ND | 0.10 | mg/L | | | | | | |
| Potassium | | ND | 1.0 | mg/L | | | | | | |
| Sodium | | ND | 1.0 | mg/L | | | | | | |
| **LCS (B9D0318-BS1)** | Prepared: 04/11/19 Analyzed: 04/12/19 | | | | | | | | | |
| **EPA 200.7** | | | | | | | | | | |
| Calcium | | 0.955 | 0.10 | mg/L | 1.00 | | 95.5 | 85-115 | | |
| Magnesium | | 1.97 | 0.10 | mg/L | 2.00 | | 98.4 | 85-115 | | |
| Potassium | | 2.04 | 1.0 | mg/L | 2.00 | | 102 | 85-115 | | |
| Sodium | | 2.05 | 1.0 | mg/L | 2.00 | | 103 | 85-115 | | |
| **LCS Dup (B9D0318-BSD1)** | Prepared: 04/11/19 Analyzed: 04/12/19 | | | | | | | | | |
| **EPA 200.7** | | | | | | | | | | |
| Calcium | | 0.954 | 0.10 | mg/L | 1.00 | | 95.4 | 85-115 | 0.120 | 20 |
| Magnesium | | 1.98 | 0.10 | mg/L | 2.00 | | 99.0 | 85-115 | 0.640 | 20 |
| Potassium | | 2.02 | 1.0 | mg/L | 2.00 | | 101 | 85-115 | 0.906 | 20 |
| Sodium | | 2.08 | 1.0 | mg/L | 2.00 | | 104 | 85-115 | 1.24 | 20 |

## Notes and Definitions

| | |
|---|---|
| BS2 | Recovery for this analyte was biased low. Results were accepted based on duplicate results. |
| J | Detected but below the Reporting Limit; therefore, result is an estimated concentration ( CLP J-Flag). Same as DNQ - Detected, but Not Quantified. |
| µg/L | micrograms per liter (parts per billion concentration units) |
| mg/L | milligrams per liter (parts per million concentration units) |
| mg/kg | milligrams per kilogram (parts per million concentration units) |
| ND | Analyte NOT DETECTED at or above the reporting limit |
| RPD | Relative Percent Difference |
| | Analysis of pH, filtration, and residual chlorine is to take place immediately after sampling in the field. If the test was performed in the laboratory, the hold time was exceeded. **(for aqueous matrices only)** |

MOORE TWINING ASSOCIATES, INC.

ANALYTICAL CHEMISTRY DIVISION
CALIFORNIA ELAP CERTIFICATION # 1371

# CHAIN OF CUSTODY/ANALYSIS REQUEST

2527 FRESNO STREET • FRESNO, CA 93721 • PHONE (559) 268-7021 • FAX: (559) 268-0740

**WORK ORDER #:** FD03035
**PAGE** 1 **OF** 2

| REPORT TO: | X INVOICE TO: X REPORT COPY TO: | REPORTING: |
|---|---|---|
| ATTENTION: Kirk Jacobsen | ATTENTION: Kirk Jacobsen | X STANDARD FORMAT |
| NAME: Moore Twining Associates | NAME: Moore Twining Associates | ☐ EDT (STATE FORM) |
| ADDRESS: 2527 Fresno Street | ADDRESS: 2527 Fresno Street | ☐ GEOTRACKER/COELT (LUFT) |
| Fresno, CA 93721 | Fresno, California 93721 | ☐ PDF ☐ EXCEL |
| PHONE: (559)268-7021 | PHONE: 559-268-7021 | ☐ County DHS : ☐ Environmental Health Agency : |
| FAX: (559)268-7126 | FAX: 559-268-7126 | X OTHER: J Flag Report/Standard Excel |

**SAMPLE INFORMATION**

SAMPLED BY (PRINT): Joe Clark

SIGNATURE: [signature]

☐ PUBLIC SYSTEM ☐ ROUTINE
☒ PRIVATE WELL ☐ REPEAT
☐ OTHER ☐ REPLACEMENT

TURN AROUND TIME: ☐ RUSH, DUE ON: ____
☐ STANDARD

**SAMPLE TYPES:**

SOLID:
BS – BIOSOLID
CR – CERAMIC
SL – SOIL/SOLID

LIQUID:
DW - DRINKING WATER
GW - GROUND WATER
OL - OIL
SF - SURFACE WATER
ST - STORM WATER
WW – WASTE WATER

**PROJECT INFORMATION**

CONTRACT/P.O. NO.:

PROJECT: City of Visalia Water Conservation Plant

PROJECT NUMBER: A76404.03

CRWA MEMBER? YES ☐ NO☐

LAB USE — NOTES ON RECEIVED CONDITION:

☐ CUSTODY SEAL(S) BROKEN ☐ SAMPLE(S) DAMAGED
☒ ON ICE ☐ AMBIENT TEMP. ☐ INCORRECT PRESERVATION
Wet

**ANALYSIS REQUESTED**

| LAB USE | CLIENT SAMPLE ID | DATE | TIME | TYPE | pH, EC, TDS, TN | Ammonia | General Minerals (dissolved)* | | | | | | | | System Number / Station Code |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MW-P | 4/3/19 | 0953 | GW | X | X | X | | | | | | | | |

COMMENTS/ADDITIONAL INSTRUCTIONS: **Laboratory filter and preserve for metals upon receipt.**

* General Minerals – Total Alkalinity, Calcium, Chloride, Hardness, Potassium, Sodium, Sulfate, TDS, Nitrate, Cation/Anion Balance.

| RELINQUISHED BY | COMPANY | DATE | TIME | RECEIVED BY | COMPANY |
|---|---|---|---|---|---|
| [signature] | MTA | 4.3.19 | 1445 | [signature] | MTA |

Moore Twining Associates

Sample Integrity — Page 2 of 2 — WO# FD03035 — MTA Bottles: Yes or No

| COC Info | | | | |
|---|---|---|---|---|
| Was temperature within range? Chemistry ≤6°C Micro <10°C Temp_____°C | Yes No N/A | Did all bottle labels agree with COC? | Yes No N/A | Were there bubbles in VOA vials? (**Volatiles Only**) — Yes No N/A |
| If samples were taken today, is there evidence that chilling has begun? Recvd 10.0 C° | Yes No N/A | Was a sufficient amount of sample received? | Yes No N/A | Was PM notified of discrepancies? — Yes No N/A |
| Did all bottles arrive unbroken and intact? | Yes No N/A | Were correct containers and preservatives received for the tests requested? | Yes No N/A | PM: |
| Do samples have a hold time <72 hours? | Yes No N/A | | | By/Time: |

| Bottles Received: 125ml (A) 250ml (B) 1Liter (C) 40ml VOA (V) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bacti $Na_2S_2O_3$ | | | | | | | | | | | | | | | |
| None (P) | 1-C 1-B | | | | | | | | | | | | | | |
| Cr6 Buffer (P) Borate Carbonate Buffer | | | | | | | | | | | | | | | |
| $HNO_3$ (P) | 1-A | | | | | | | | | | | | | | |
| $H_2SO_4$ (P) | 1-A | | | | | | | | | | | | | | |
| NaOH (P) | | | | | | | | | | | | | | | |
| NaOH+ZnAc (P) | | | | | | | | | | | | | | | |
| Dissolved Oxygen 300ml (P) | | | | | | | | | | | | | | | |
| None (AG) | | | | | | | | | | | | | | | |
| None (CG) 500ml | | | | | | | | | | | | | | | |
| $Na_2S_2O_3$ 250ml (Brown P) 549 | | | | | | | | | | | | | | | |
| $Na_2S_2O_3$ (AG) | | | | | | | | | | | | | | | |
| $Na_2S_2O_3$ (AG) | | | | | | | | | | | | | | | |
| Thio/K Citrate | | | | | | | | | | | | | | | |
| $NH_4Cl$ (AG) 552 | | | | | | | | | | | | | | | |
| HCl (AG) | | | | | | | | | | | | | | | |
| None (CG) 500ml | | | | | | | | | | | | | | | |
| $H_3PO_4$ (AG) | | | | | | | | | | | | | | | |
| Other: | | | | | | | | | | | | | | | |
| Plastic Bag | | | | | | | | | | | | | | | |
| Low Level Hg/Metals Double Bag | | | | | | | | | | | | | | | |
| Client Own | | | | | | | | | | | | | | | |
| Glass Jar: 125/ 250/ 500 | | | | | | | | | | | | | | | |
| Soil Tube: Brass/ Steel/ Plastic | | | | | | | | | | | | | | | |
| 5g Encore | | | | | | | | | | | | | | | |

| Filter or Split | Container | Preservative | Date/Time/Initials |
|---|---|---|---|
| S P F | 125 mL | HNO3 | 4-3-19 |
| S P F | | | |
| S P F | | | |
| S P F | | | |
| S P F | | | |

Labeled by: M @ 1536 Labels checked by: M @ 1322

FL-SC-0003-06

**MOORE TWINING ASSOCIATES, INC.**
*California ELAP Certificate #1371*

**2527 Fresno Street**
**Fresno, CA 93721**
**(559) 268-7021 Phone**
**(559) 268-0740 Fax**

April 17, 2019

Work Order #: **FD04035**

Kirk Jacobsen
MTA Environmental Division
2527 Fresno Street
Fresno, CA 93721

**RE: City of Visalia Water Conservation Plant**

Enclosed are the analytical results for samples received by our laboratory on **04/04/19** . For your reference, these analyses have been assigned laboratory work order number **FD04035**.

All analyses have been performed according to our laboratory's quality assurance program. All results are intended to be considered in their entirety, Moore Twining Associates, Inc. (MTA) is not responsible for use of less than complete reports. Results apply only to samples analyzed.

If you have any questions, please feel free to contact us at the number listed above.

Sincerely,

**Moore Twining Associates, Inc.**

Susan Federico
Client Services Representative

California ELAP Certificate #1371

2527 Fresno Street
Fresno, CA 93721
(559) 268-7021 Phone
(559) 268-0740 Fax

| MTA Environmental Division | **Project:** | City of Visalia Water Conservation Plant | **Reported:** |
|---|---|---|---|
| 2527 Fresno Street | **Project Number:** | A76404.03 | 04/17/2019 |
| Fresno CA, 93721 | **Project Manager:** | Kirk Jacobsen | |

## Analytical Report for the Following Samples

| Sample ID | Notes | Laboratory ID | Matrix | Date Sampled | Date Received |
|---|---|---|---|---|---|
| MW-H2 | | FD04035-01 | Ground Water | 04/04/19 12:00 | 04/04/19 16:00 |
| MW-H3 | | FD04035-02 | Ground Water | 04/04/19 14:21 | 04/04/19 16:00 |
| MW-Q | | FD04035-03 | Ground Water | 04/04/19 10:18 | 04/04/19 16:00 |

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| | | |
|---|---|---|
| MTA Environmental Division<br>2527 Fresno Street<br>Fresno CA, 93721 | **Project:** City of Visalia Water Conservation Plant<br>**Project Number:** A76404.03<br>**Project Manager:** Kirk Jacobsen | **Reported:**<br>04/17/2019 |

## MW-H2

FD04035-01 (Ground Water) Sampled: 04/04/19 12:00

| Analyte | Flag | Result | Reporting Limit | MDL | Units | Dilution | Batch | Analyst | Prepared | Analyzed | Method |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Inorganics** | | | | | | | | | | | |
| Bicarbonate Alkalinity as HCO3 | | **41** | 1.3 | 0.23 | mg/L | 1 | B9D0509 | DLW | 04/05/19 18:43 | 04/05/19 18:43 | SM 2320 B |
| Carbonate Alkalinity as CO3 | | ND | 1.0 | 0.23 | mg/L | 1 | B9D0509 | DLW | 04/05/19 18:43 | 04/05/19 18:43 | SM 2320 B |
| Hydroxide Alkalinity as OH | | ND | 1.0 | 0.23 | mg/L | 1 | B9D0509 | DLW | 04/05/19 18:43 | 04/05/19 18:43 | SM 2320 B |
| Total Alkalinity as CaCO3 | | **34** | 1.0 | 0.23 | mg/L | 1 | B9D0509 | DLW | 04/05/19 18:43 | 04/05/19 18:43 | SM 2320 B |
| Ammonia as N | | ND | 1.0 | 0.18 | mg/L | 1 | B9D0805 | JAG | 04/08/19 13:05 | 04/08/19 16:36 | EPA 350.1 |
| Cation/Anion Balance (% Difference) | | **2.2** | | | % | 1 | B9D1520 | MCM | 04/15/19 14:48 | 04/15/19 14:49 | SM 1030 F |
| Chloride | | **71** | 2.0 | 0.18 | mg/L | 1 | B9D0428 | ETH | 04/04/19 17:13 | 04/05/19 8:47 | EPA 300.0 |
| Specific Conductance (EC) | | **490** | 1.0 | 0.26 | µS/cm | 1 | B9D0509 | DLW | 04/05/19 18:43 | 04/05/19 18:43 | SM 2510 B |
| Nitrate as N | | **12** | 0.45 | 0.028 | mg/L | 1 | B9D0428 | ETH | 04/04/19 17:13 | 04/05/19 8:47 | EPA 300.0 |
| Nitrite as N | | ND | 0.30 | 0.097 | mg/L | 1 | B9D0428 | ETH | 04/04/19 17:13 | 04/05/19 8:47 | EPA 300.0 |
| pH | | **7.5** | 0.10 | 0.10 | pH Units | 1 | B9D0509 | DLW | 04/05/19 18:43 | 04/05/19 18:43 | SM 4500-H B |
| Sulfate as SO4 | | **47** | 2.0 | 0.094 | mg/L | 1 | B9D0428 | ETH | 04/04/19 17:13 | 04/05/19 8:47 | EPA 300.0 |
| Total Dissolved Solids | | **320** | 10 | 8.1 | mg/L | 1 | B9D1006 | ACY | 04/10/19 10:14 | 04/11/19 13:10 | SM 2540 C |
| Total Kjeldahl Nitrogen | | **1.2** | 0.50 | 0.18 | mg/L | 1 | B9D0513 | JAG | 04/06/19 6:30 | 04/10/19 16:59 | EPA 351.2 |
| Total Nitrogen | | **13** | 0.50 | | mg/L | 1 | [CALC] | JAG | 04/10/19 16:59 | 04/10/19 16:59 | [CALC] |
| **Metals (Dissolved)** | | | | | | | | | | | |
| Calcium | | **26** | 0.10 | 0.048 | mg/L | 1 | B9D0318 | VAC | 04/11/19 7:35 | 04/12/19 16:18 | EPA 200.7 |
| Hardness (Dissolved) | | **65** | 0.66 | | mg equiv. CaCO3/L | 1 | [CALC] | VAC | 04/12/19 16:18 | 04/12/19 16:18 | SM 2340 B |
| Magnesium | | **0.12** | 0.10 | 0.025 | mg/L | 1 | B9D0318 | VAC | 04/11/19 7:35 | 04/12/19 16:18 | EPA 200.7 |
| Potassium | J | **0.39** | 1.0 | 0.34 | mg/L | 1 | B9D0318 | VAC | 04/11/19 7:35 | 04/12/19 16:18 | EPA 200.7 |
| Sodium | | **69** | 1.0 | 0.26 | mg/L | 1 | B9D0318 | VAC | 04/11/19 7:35 | 04/12/19 16:18 | EPA 200.7 |

## MW-H3

FD04035-02 (Ground Water) Sampled: 04/04/19 14:21

| Analyte | Flag | Result | Reporting Limit | MDL | Units | Dilution | Batch | Analyst | Prepared | Analyzed | Method |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Inorganics** | | | | | | | | | | | |
| Bicarbonate Alkalinity as HCO3 | | **36** | 1.3 | 0.23 | mg/L | 1 | B9D0509 | DLW | 04/05/19 18:51 | 04/05/19 18:51 | SM 2320 B |
| Carbonate Alkalinity as CO3 | | **10** | 1.0 | 0.23 | mg/L | 1 | B9D0509 | DLW | 04/05/19 18:51 | 04/05/19 18:51 | SM 2320 B |
| Hydroxide Alkalinity as OH | | ND | 1.0 | 0.23 | mg/L | 1 | B9D0509 | DLW | 04/05/19 18:51 | 04/05/19 18:51 | SM 2320 B |
| Total Alkalinity as CaCO3 | | **47** | 1.0 | 0.23 | mg/L | 1 | B9D0509 | DLW | 04/05/19 18:51 | 04/05/19 18:51 | SM 2320 B |
| Ammonia as N | | ND | 1.0 | 0.18 | mg/L | 1 | B9D0805 | JAG | 04/08/19 13:05 | 04/08/19 16:37 | EPA 350.1 |
| Cation/Anion Balance (% Difference) | | **7.0** | | | % | 1 | B9D1520 | MCM | 04/15/19 14:48 | 04/15/19 14:49 | SM 1030 F |
| Chloride | | **2.8** | 2.0 | 0.18 | mg/L | 1 | B9D0428 | ETH | 04/04/19 17:13 | 04/05/19 9:01 | EPA 300.0 |
| Specific Conductance (EC) | | **120** | 1.0 | 0.26 | µS/cm | 1 | B9D0509 | DLW | 04/05/19 18:51 | 04/05/19 18:51 | SM 2510 B |
| Nitrate as N | | ND | 0.45 | 0.028 | mg/L | 1 | B9D0428 | ETH | 04/04/19 17:13 | 04/05/19 9:01 | EPA 300.0 |
| Nitrite as N | | ND | 0.30 | 0.097 | mg/L | 1 | B9D0428 | ETH | 04/04/19 17:13 | 04/05/19 9:01 | EPA 300.0 |
| pH | | **8.9** | 0.10 | 0.10 | pH Units | 1 | B9D0509 | DLW | 04/05/19 18:51 | 04/05/19 18:51 | SM 4500-H B |
| Sulfate as SO4 | | **3.9** | 2.0 | 0.094 | mg/L | 1 | B9D0428 | ETH | 04/04/19 17:13 | 04/05/19 9:01 | EPA 300.0 |
| Total Dissolved Solids | | **180** | 10 | 8.1 | mg/L | 1 | B9D1006 | ACY | 04/10/19 10:14 | 04/11/19 13:10 | SM 2540 C |
| Total Kjeldahl Nitrogen | J | **0.26** | 0.50 | 0.18 | mg/L | 1 | B9D0513 | JAG | 04/06/19 6:30 | 04/10/19 17:01 | EPA 351.2 |
| Total Nitrogen | | ND | 0.50 | | mg/L | 1 | [CALC] | JAG | 04/10/19 17:01 | 04/10/19 17:01 | [CALC] |
| **Metals (Dissolved)** | | | | | | | | | | | |

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| MTA Environmental Division | Project: | City of Visalia Water Conservation Plant | Reported: |
|---|---|---|---|
| 2527 Fresno Street | Project Number: | A76404.03 | 04/17/2019 |
| Fresno CA, 93721 | Project Manager: | Kirk Jacobsen | |

## MW-H3

FD04035-02 (Ground Water) Sampled: 04/04/19 14:21

| Analyte | Flag | Result | Reporting Limit | MDL | Units | Dilution | Batch | Analyst | Prepared | Analyzed | Method |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Metals (Dissolved)** | | | | | | | | | | | |
| Calcium | | **2.3** | 0.10 | 0.048 | mg/L | 1 | B9D0318 | VAC | 04/11/19 7:35 | 04/12/19 16:27 | EPA 200.7 |
| Hardness (Dissolved) | | **5.7** | 0.66 | | mg equiv. CaCO3/L | 1 | [CALC] | VAC | 04/12/19 16:27 | 04/12/19 16:27 | SM 2340 B |
| Magnesium | | ND | 0.10 | 0.025 | mg/L | 1 | B9D0318 | VAC | 04/11/19 7:35 | 04/12/19 16:27 | EPA 200.7 |
| Potassium | | ND | 1.0 | 0.34 | mg/L | 1 | B9D0318 | VAC | 04/11/19 7:35 | 04/12/19 16:27 | EPA 200.7 |
| Sodium | | **26** | 1.0 | 0.26 | mg/L | 1 | B9D0318 | VAC | 04/11/19 7:35 | 04/12/19 16:27 | EPA 200.7 |

## MW-Q

FD04035-03 (Ground Water) Sampled: 04/04/19 10:18

| Analyte | Flag | Result | Reporting Limit | MDL | Units | Dilution | Batch | Analyst | Prepared | Analyzed | Method |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Inorganics** | | | | | | | | | | | |
| Bicarbonate Alkalinity as HCO3 | | **220** | 1.3 | 0.23 | mg/L | 1 | B9D0509 | DLW | 04/05/19 18:58 | 04/05/19 18:58 | SM 2320 B |
| Carbonate Alkalinity as CO3 | | ND | 1.0 | 0.23 | mg/L | 1 | B9D0509 | DLW | 04/05/19 18:58 | 04/05/19 18:58 | SM 2320 B |
| Hydroxide Alkalinity as OH | | ND | 1.0 | 0.23 | mg/L | 1 | B9D0509 | DLW | 04/05/19 18:58 | 04/05/19 18:58 | SM 2320 B |
| Total Alkalinity as CaCO3 | | **180** | 1.0 | 0.23 | mg/L | 1 | B9D0509 | DLW | 04/05/19 18:58 | 04/05/19 18:58 | SM 2320 B |
| Ammonia as N | | ND | 1.0 | 0.18 | mg/L | 1 | B9D0805 | JAG | 04/08/19 13:05 | 04/08/19 16:38 | EPA 350.1 |
| Cation/Anion Balance (% Difference) | | **0.17** | | | % | 1 | B9D1520 | MCM | 04/15/19 14:48 | 04/15/19 14:49 | SM 1030 F |
| Chloride | | **56** | 2.0 | 0.18 | mg/L | 1 | B9D0428 | ETH | 04/04/19 17:13 | 04/05/19 9:15 | EPA 300.0 |
| Specific Conductance (EC) | | **570** | 1.0 | 0.26 | µS/cm | 1 | B9D0509 | DLW | 04/05/19 18:58 | 04/05/19 18:58 | SM 2510 B |
| Nitrate as N | J | **0.30** | 0.45 | 0.028 | mg/L | 1 | B9D0428 | ETH | 04/04/19 17:13 | 04/05/19 9:15 | EPA 300.0 |
| Nitrite as N | | ND | 0.30 | 0.097 | mg/L | 1 | B9D0428 | ETH | 04/04/19 17:13 | 04/05/19 9:15 | EPA 300.0 |
| pH | | **7.6** | 0.10 | 0.10 | pH Units | 1 | B9D0509 | DLW | 04/05/19 18:58 | 04/05/19 18:58 | SM 4500-H B |
| Sulfate as SO4 | | **19** | 2.0 | 0.094 | mg/L | 1 | B9D0428 | ETH | 04/04/19 17:13 | 04/05/19 9:15 | EPA 300.0 |
| Total Dissolved Solids | | **370** | 10 | 8.1 | mg/L | 1 | B9D1006 | ACY | 04/10/19 10:14 | 04/11/19 13:10 | SM 2540 C |
| Total Kjeldahl Nitrogen | J | **0.37** | 0.50 | 0.18 | mg/L | 1 | B9D0513 | JAG | 04/06/19 6:30 | 04/10/19 17:02 | EPA 351.2 |
| Total Nitrogen | | **0.67** | 0.50 | | mg/L | 1 | [CALC] | JAG | 04/10/19 17:02 | 04/10/19 17:02 | [CALC] |
| **Metals (Dissolved)** | | | | | | | | | | | |
| Calcium | | **49** | 0.10 | 0.048 | mg/L | 1 | B9D0318 | VAC | 04/11/19 7:35 | 04/12/19 16:31 | EPA 200.7 |
| Hardness (Dissolved) | | **150** | 0.66 | | mg equiv. CaCO3/L | 1 | [CALC] | VAC | 04/12/19 16:31 | 04/12/19 16:31 | SM 2340 B |
| Magnesium | | **5.7** | 0.10 | 0.025 | mg/L | 1 | B9D0318 | VAC | 04/11/19 7:35 | 04/12/19 16:31 | EPA 200.7 |
| Potassium | J | **0.42** | 1.0 | 0.34 | mg/L | 1 | B9D0318 | VAC | 04/11/19 7:35 | 04/12/19 16:31 | EPA 200.7 |
| Sodium | | **62** | 1.0 | 0.26 | mg/L | 1 | B9D0318 | VAC | 04/11/19 7:35 | 04/12/19 16:31 | EPA 200.7 |

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| | | |
|---|---|---|
| MTA Environmental Division<br>2527 Fresno Street<br>Fresno CA, 93721 | **Project:** City of Visalia Water Conservation Plant<br>**Project Number:** A76404.03<br>**Project Manager:** Kirk Jacobsen | **Reported:**<br>04/17/2019 |

## Quality Control Sample Results - Inorganics

| Analyte | Flag | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch - B9D0428** | | | | | | | | | | |
| **Blank (B9D0428-BLK1)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | | | | | |
| **EPA 300.0** | | | | | | | | | | |
| Chloride | | ND | 2.0 | mg/L | | | | | | |
| Nitrate as N | | ND | 0.45 | mg/L | | | | | | |
| Nitrite as N | | ND | 0.30 | mg/L | | | | | | |
| Sulfate as SO4 | | ND | 2.0 | mg/L | | | | | | |
| **LCS (B9D0428-BS1)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | | | | | |
| **EPA 300.0** | | | | | | | | | | |
| Chloride | | 49.7 | 2.0 | mg/L | 50.0 | | 99.4 | 90-110 | | |
| Nitrate as N | | 11.2 | 0.45 | mg/L | 11.3 | | 99.2 | 90-110 | | |
| Nitrite as N | | 4.98 | 0.30 | mg/L | 5.00 | | 99.5 | 90-110 | | |
| Sulfate as SO4 | | 49.8 | 2.0 | mg/L | 50.0 | | 99.6 | 90-110 | | |
| **LCS Dup (B9D0428-BSD1)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | | | | | |
| **EPA 300.0** | | | | | | | | | | |
| Chloride | | 49.9 | 2.0 | mg/L | 50.0 | | 99.7 | 90-110 | 0.316 | 20 |
| Nitrate as N | | 11.3 | 0.45 | mg/L | 11.3 | | 99.9 | 90-110 | 0.752 | 20 |
| Nitrite as N | | 5.02 | 0.30 | mg/L | 5.00 | | 100 | 90-110 | 0.777 | 20 |
| Sulfate as SO4 | | 50.3 | 2.0 | mg/L | 50.0 | | 101 | 90-110 | 0.956 | 20 |
| **Matrix Spike (B9D0428-MS1)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | **Source: FD04012-01** | | | | |
| **EPA 300.0** | | | | | | | | | | |
| Chloride | | 290 | 8.0 | mg/L | 200 | 99.9 | 95.1 | 80-120 | | |
| Nitrate as N | | 63.3 | 1.8 | mg/L | 45.2 | 19.8 | 96.2 | 80-120 | | |
| Nitrite as N | | 17.9 | 1.2 | mg/L | 20.0 | ND | 89.5 | 80-120 | | |
| Sulfate as SO4 | | 209 | 8.0 | mg/L | 200 | 15.7 | 96.7 | 80-120 | | |
| **Matrix Spike Dup (B9D0428-MSD1)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | **Source: FD04012-01** | | | | |
| **EPA 300.0** | | | | | | | | | | |
| Chloride | | 296 | 8.0 | mg/L | 200 | 99.9 | 98.0 | 80-120 | 1.98 | 20 |
| Nitrate as N | | 64.7 | 1.8 | mg/L | 45.2 | 19.8 | 99.2 | 80-120 | 2.15 | 20 |
| Nitrite as N | | 18.3 | 1.2 | mg/L | 20.0 | ND | 91.4 | 80-120 | 2.03 | 20 |
| Sulfate as SO4 | | 213 | 8.0 | mg/L | 200 | 15.7 | 98.8 | 80-120 | 2.00 | 20 |
| **Matrix Spike (B9D0428-MS2)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | **Source: FD04037-01** | | | | |
| **EPA 300.0** | | | | | | | | | | |
| Chloride | | 100 | 4.0 | mg/L | 100 | 1.01 | 99.0 | 80-120 | | |
| Nitrate as N | | 22.9 | 0.90 | mg/L | 22.6 | 0.508 | 98.9 | 80-120 | | |
| Nitrite as N | | 9.92 | 0.60 | mg/L | 10.0 | ND | 99.2 | 80-120 | | |
| Sulfate as SO4 | | 101 | 4.0 | mg/L | 100 | 1.43 | 99.3 | 80-120 | | |
| **Matrix Spike Dup (B9D0428-MSD2)** | | Prepared: 04/04/19 Analyzed: 04/05/19 | | | | **Source: FD04037-01** | | | | |
| **EPA 300.0** | | | | | | | | | | |
| Chloride | | 99.2 | 4.0 | mg/L | 100 | 1.01 | 98.2 | 80-120 | 0.827 | 20 |
| Nitrate as N | | 22.8 | 0.90 | mg/L | 22.6 | 0.508 | 98.5 | 80-120 | 0.396 | 20 |
| Nitrite as N | | 9.91 | 0.60 | mg/L | 10.0 | ND | 99.1 | 80-120 | 0.149 | 20 |
| Sulfate as SO4 | | 100 | 4.0 | mg/L | 100 | 1.43 | 98.9 | 80-120 | 0.382 | 20 |

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| | | |
|---|---|---|
| MTA Environmental Division<br>2527 Fresno Street<br>Fresno CA, 93721 | **Project:** City of Visalia Water Conservation Plant<br>**Project Number:** A76404.03<br>**Project Manager:** Kirk Jacobsen | **Reported:**<br>04/17/2019 |

## Quality Control Sample Results - Inorganics

| Analyte | Flag | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch - B9D0509** | | | | | | | | | | |
| **Blank (B9D0509-BLK1)** | | Prepared & Analyzed: 04/05/19 | | | | | | | | |
| **SM 2320 B** | | | | | | | | | | |
| Bicarbonate Alkalinity as HCO3 | J | 0.340 | 1.3 | mg/L | | | | | | |
| Carbonate Alkalinity as CO3 | | ND | 1.0 | mg/L | | | | | | |
| Hydroxide Alkalinity as OH | | ND | 1.0 | mg/L | | | | | | |
| Total Alkalinity as CaCO3 | J | 0.280 | 1.0 | mg/L | | | | | | |
| **SM 2510 B** | | | | | | | | | | |
| Specific Conductance (EC) | | ND | 1.0 | µS/cm | | | | | | |
| **LCS (B9D0509-BS1)** | | Prepared & Analyzed: 04/05/19 | | | | | | | | |
| **SM 2510 B** | | | | | | | | | | |
| Specific Conductance (EC) | | 489 | 1.0 | µS/cm | 500 | | 97.8 | 80-120 | | |
| **LCS (B9D0509-BS2)** | | Prepared & Analyzed: 04/05/19 | | | | | | | | |
| **SM 4500-H B** | | | | | | | | | | |
| pH | | 7.08 | 0.10 | pH Units | 7.00 | | 101 | 97-103 | | |
| **LCS (B9D0509-BS3)** | | Prepared & Analyzed: 04/05/19 | | | | | | | | |
| **SM 2320 B** | | | | | | | | | | |
| Total Alkalinity as CaCO3 | | 225 | 1.0 | mg/L | 250 | | 90.1 | 80-120 | | |
| **LCS Dup (B9D0509-BSD1)** | | Prepared & Analyzed: 04/05/19 | | | | | | | | |
| **SM 2510 B** | | | | | | | | | | |
| Specific Conductance (EC) | | 490 | 1.0 | µS/cm | 500 | | 98.0 | 80-120 | 0.208 | 20 |
| **LCS Dup (B9D0509-BSD2)** | | Prepared & Analyzed: 04/05/19 | | | | | | | | |
| **SM 4500-H B** | | | | | | | | | | |
| pH | | 7.10 | 0.10 | pH Units | 7.00 | | 101 | 97-103 | 0.282 | 20 |
| **LCS Dup (B9D0509-BSD3)** | | Prepared & Analyzed: 04/05/19 | | | | | | | | |
| **SM 2320 B** | | | | | | | | | | |
| Total Alkalinity as CaCO3 | | 223 | 1.0 | mg/L | 250 | | 89.0 | 80-120 | 1.17 | 20 |
| **Duplicate (B9D0509-DUP1)** | | Prepared & Analyzed: 04/05/19 | | | | **Source: FD04027-01** | | | | |
| **SM 2320 B** | | | | | | | | | | |
| Bicarbonate Alkalinity as HCO3 | | 215 | 1.3 | mg/L | | 191 | | | 11.9 | 20 |
| Carbonate Alkalinity as CO3 | | ND | 1.0 | mg/L | | ND | | | | |
| Hydroxide Alkalinity as OH | | ND | 1.0 | mg/L | | ND | | | | |
| Total Alkalinity as CaCO3 | | 176 | 1.0 | mg/L | | 156 | | | 11.9 | 20 |
| **SM 2510 B** | | | | | | | | | | |
| Specific Conductance (EC) | | 1000 | 1.0 | µS/cm | | 1010 | | | 0.810 | 20 |
| **SM 4500-H B** | | | | | | | | | | |
| pH | | 5.47 | 0.10 | pH Units | | 5.41 | | | 1.10 | 20 |
| **Duplicate (B9D0509-DUP2)** | | Prepared & Analyzed: 04/05/19 | | | | **Source: FD05016-01** | | | | |
| **SM 2320 B** | | | | | | | | | | |
| Bicarbonate Alkalinity as HCO3 | | 187 | 1.3 | mg/L | | 184 | | | 1.40 | 20 |
| Carbonate Alkalinity as CO3 | | ND | 1.0 | mg/L | | ND | | | | |
| Hydroxide Alkalinity as OH | | ND | 1.0 | mg/L | | ND | | | | |
| Total Alkalinity as CaCO3 | | 153 | 1.0 | mg/L | | 151 | | | 1.40 | 20 |
| **SM 2510 B** | | | | | | | | | | |

MOORE TWINING ASSOCIATES, INC.
California ELAP Certificate #1371

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| MTA Environmental Division | Project: | City of Visalia Water Conservation Plant | Reported: |
|---|---|---|---|
| 2527 Fresno Street | Project Number: | A76404.03 | 04/17/2019 |
| Fresno CA, 93721 | Project Manager: | Kirk Jacobsen | |

## Quality Control Sample Results - Inorganics

| Analyte | Flag | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch - B9D0509** | | | | | | | | | | |
| **Duplicate (B9D0509-DUP2)** | | Prepared & Analyzed: 04/05/19 | | | | **Source: FD05016-01** | | | | |
| **SM 2510 B** | | | | | | | | | | |
| Specific Conductance (EC) | | 666 | 1.0 | µS/cm | | 665 | | | 0.152 | 20 |
| **SM 4500-H B** | | | | | | | | | | |
| pH | | 7.27 | 0.10 | pH Units | | 7.23 | | | 0.552 | 20 |
| **Batch - B9D0513** | | | | | | | | | | |
| **Blank (B9D0513-BLK1)** | | Prepared: 04/06/19 Analyzed: 04/10/19 | | | | | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | ND | 0.50 | mg/L | | | | | | |
| **LCS (B9D0513-BS1)** | | Prepared: 04/06/19 Analyzed: 04/10/19 | | | | | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 10.4 | 0.50 | mg/L | 10.0 | | 104 | 90-110 | | |
| **LCS Dup (B9D0513-BSD1)** | | Prepared: 04/06/19 Analyzed: 04/10/19 | | | | | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 10.3 | 0.50 | mg/L | 10.0 | | 103 | 90-110 | 0.888 | 20 |
| **Matrix Spike (B9D0513-MS1)** | | Prepared: 04/06/19 Analyzed: 04/10/19 | | | | **Source: FD04020-01** | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 24.0 | 5.3 | mg/L | 10.0 | 14.1 | 98.6 | 80-120 | | |
| **Matrix Spike Dup (B9D0513-MSD1)** | | Prepared: 04/06/19 Analyzed: 04/10/19 | | | | **Source: FD04020-01** | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 24.6 | 0.50 | mg/L | 10.0 | 14.1 | 105 | 80-120 | 2.71 | 20 |
| **Matrix Spike (B9D0513-MS2)** | | Prepared: 04/06/19 Analyzed: 04/10/19 | | | | **Source: FD04052-03** | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 27.7 | 5.3 | mg/L | 10.0 | 18.2 | 95.7 | 80-120 | | |
| **Matrix Spike Dup (B9D0513-MSD2)** | | Prepared: 04/06/19 Analyzed: 04/10/19 | | | | **Source: FD04052-03** | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 29.5 | 5.3 | mg/L | 10.0 | 18.2 | 113 | 80-120 | 6.08 | 20 |
| **Batch - B9D0805** | | | | | | | | | | |
| **Blank (B9D0805-BLK1)** | | Prepared & Analyzed: 04/08/19 | | | | | | | | |
| **EPA 350.1** | | | | | | | | | | |
| Ammonia as N | | ND | 1.0 | mg/L | | | | | | |
| **LCS (B9D0805-BS1)** | | Prepared & Analyzed: 04/08/19 | | | | | | | | |
| **EPA 350.1** | | | | | | | | | | |
| Ammonia as N | | 10.1 | 1.0 | mg/L | 10.0 | | 101 | 90-110 | | |
| **LCS Dup (B9D0805-BSD1)** | | Prepared & Analyzed: 04/08/19 | | | | | | | | |
| **EPA 350.1** | | | | | | | | | | |
| Ammonia as N | | 9.80 | 1.0 | mg/L | 10.0 | | 98.0 | 90-110 | 3.51 | 20 |
| **Matrix Spike (B9D0805-MS1)** | | Prepared & Analyzed: 04/08/19 | | | | **Source: FD04012-01** | | | | |
| **EPA 350.1** | | | | | | | | | | |
| Ammonia as N | | 11.0 | 1.0 | mg/L | 10.0 | ND | 110 | 80-120 | | |
| **Matrix Spike Dup (B9D0805-MSD1)** | | Prepared & Analyzed: 04/08/19 | | | | **Source: FD04012-01** | | | | |

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| | | |
|---|---|---|
| MTA Environmental Division<br>2527 Fresno Street<br>Fresno CA, 93721 | **Project:** City of Visalia Water Conservation Plant<br>**Project Number:** A76404.03<br>**Project Manager:** Kirk Jacobsen | **Reported:**<br>04/17/2019 |

## Quality Control Sample Results - Inorganics

| Analyte | Flag | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch - B9D0805** | | | | | | | | | | |
| **Matrix Spike Dup (B9D0805-MSD1)** | | Prepared & Analyzed: 04/08/19 | | | | **Source: FD04012-01** | | | | |
| **EPA 350.1** | | | | | | | | | | |
| Ammonia as N | | 10.7 | 1.0 | mg/L | 10.0 | ND | 107 | 80-120 | 2.28 | 20 |
| **Matrix Spike (B9D0805-MS2)** | | Prepared & Analyzed: 04/08/19 | | | | **Source: FD04042-01** | | | | |
| **EPA 350.1** | | | | | | | | | | |
| Ammonia as N | | 19.2 | 1.0 | mg/L | 10.0 | 8.61 | 105 | 80-120 | | |
| **Matrix Spike Dup (B9D0805-MSD2)** | | Prepared & Analyzed: 04/08/19 | | | | **Source: FD04042-01** | | | | |
| **EPA 350.1** | | | | | | | | | | |
| Ammonia as N | | 19.3 | 5.0 | mg/L | 10.0 | 8.61 | 107 | 80-120 | 0.908 | 20 |
| **Batch - B9D1006** | | | | | | | | | | |
| **Blank (B9D1006-BLK1)** | | Prepared: 04/10/19 Analyzed: 04/11/19 | | | | | | | | |
| **SM 2540 C** | | | | | | | | | | |
| Total Dissolved Solids | | ND | 10 | mg/L | | | | | | |
| **LCS (B9D1006-BS1)** | | Prepared: 04/10/19 Analyzed: 04/11/19 | | | | | | | | |
| **SM 2540 C** | | | | | | | | | | |
| Total Dissolved Solids | | 238 | 10 | mg/L | 240 | | 99.2 | 80-120 | | |
| **LCS Dup (B9D1006-BSD1)** | | Prepared: 04/10/19 Analyzed: 04/11/19 | | | | | | | | |
| **SM 2540 C** | | | | | | | | | | |
| Total Dissolved Solids | | 251 | 10 | mg/L | 240 | | 105 | 80-120 | 5.32 | 20 |
| **Duplicate (B9D1006-DUP1)** | | Prepared: 04/10/19 Analyzed: 04/11/19 | | | | **Source: FD03038-01** | | | | |
| **SM 2540 C** | | | | | | | | | | |
| Total Dissolved Solids | | 1720 | 20 | mg/L | | 1740 | | | 1.15 | 20 |
| **Duplicate (B9D1006-DUP2)** | | Prepared: 04/10/19 Analyzed: 04/11/19 | | | | **Source: FD05009-01** | | | | |
| **SM 2540 C** | | | | | | | | | | |
| Total Dissolved Solids | | 508 | 10 | mg/L | | 521 | | | 2.43 | 20 |

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| | | |
|---|---|---|
| MTA Environmental Division<br>2527 Fresno Street<br>Fresno CA, 93721 | **Project:** City of Visalia Water Conservation Plant<br>**Project Number:** A76404.03<br>**Project Manager:** Kirk Jacobsen | **Reported:**<br>04/17/2019 |

## Quality Control Sample Results - Metals (Dissolved)

| Analyte | Flag | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch - B9D0318** | | | | | | | | | | |
| **Blank (B9D0318-BLK1)** | | Prepared: 04/11/19 Analyzed: 04/12/19 | | | | | | | | |
| **EPA 200.7** | | | | | | | | | | |
| Calcium | | ND | 0.10 | mg/L | | | | | | |
| Magnesium | | ND | 0.10 | mg/L | | | | | | |
| Potassium | | ND | 1.0 | mg/L | | | | | | |
| Sodium | | ND | 1.0 | mg/L | | | | | | |
| **LCS (B9D0318-BS1)** | | Prepared: 04/11/19 Analyzed: 04/12/19 | | | | | | | | |
| **EPA 200.7** | | | | | | | | | | |
| Calcium | | 0.955 | 0.10 | mg/L | 1.00 | | 95.5 | 85-115 | | |
| Magnesium | | 1.97 | 0.10 | mg/L | 2.00 | | 98.4 | 85-115 | | |
| Potassium | | 2.04 | 1.0 | mg/L | 2.00 | | 102 | 85-115 | | |
| Sodium | | 2.05 | 1.0 | mg/L | 2.00 | | 103 | 85-115 | | |
| **LCS Dup (B9D0318-BSD1)** | | Prepared: 04/11/19 Analyzed: 04/12/19 | | | | | | | | |
| **EPA 200.7** | | | | | | | | | | |
| Calcium | | 0.954 | 0.10 | mg/L | 1.00 | | 95.4 | 85-115 | 0.120 | 20 |
| Magnesium | | 1.98 | 0.10 | mg/L | 2.00 | | 99.0 | 85-115 | 0.640 | 20 |
| Potassium | | 2.02 | 1.0 | mg/L | 2.00 | | 101 | 85-115 | 0.906 | 20 |
| Sodium | | 2.08 | 1.0 | mg/L | 2.00 | | 104 | 85-115 | 1.24 | 20 |

## Notes and Definitions

| | |
|---|---|
| J | Detected but below the Reporting Limit; therefore, result is an estimated concentration ( CLP J-Flag). Same as DNQ - Detected, but Not Quantified. |
| µg/L | micrograms per liter (parts per billion concentration units) |
| mg/L | milligrams per liter (parts per million concentration units) |
| mg/kg | milligrams per kilogram (parts per million concentration units) |
| ND | Analyte NOT DETECTED at or above the reporting limit |
| RPD | Relative Percent Difference |

Analysis of pH, filtration, and residual chlorine is to take place immediately after sampling in the field.
If the test was performed in the laboratory, the hold time was exceeded. **(for aqueous matrices only)**

MOORE TWINING ASSOCIATES, INC.

ANALYTICAL CHEMISTRY DIVISION
CALIFORNIA ELAP CERTIFICATION # 1371

# CHAIN OF CUSTODY/ANALYSIS REQUEST

2527 FRESNO STREET • FRESNO, CA 93721 • PHONE (559) 268-7021 • FAX: (559) 268-0740

**WORK ORDER #:** FD04035
**PAGE** 1 **OF** 2

| REPORT TO: | X INVOICE TO: X REPORT COPY TO: | REPORTING: |
|---|---|---|
| ATTENTION: Kirk Jacobsen | ATTENTION: Kirk Jacobsen | X STANDARD FORMAT |
| NAME: Moore Twining Associates | NAME: Moore Twining Associates | ☐ EDT (STATE FORM) |
| ADDRESS: 2527 Fresno Street | ADDRESS: 2527 Fresno Street | ☐ GEOTRACKER/COELT (LUFT) |
| Fresno, CA 93721 | Fresno, California 93721 | ☐ PDF ☐ EXCEL |
| PHONE: (559)268-7021 | PHONE: 559-268-7021 | ☐ County DHS : |
| FAX: (559)268-7126 | FAX: 559-268-7126 | ☐ Environmental Health Agency : |
| | | X OTHER: J Flag Report/Standard Excel |

**SAMPLE INFORMATION**

SAMPLED BY (PRINT): Joe Clark
SIGNATURE: [signature]

☐ PUBLIC SYSTEM ☐ ROUTINE
☐ PRIVATE WELL ☐ REPEAT
☐ OTHER ☐ REPLACEMENT

TURN AROUND TIME: ☐ RUSH, DUE ON:
☐ STANDARD

**SAMPLE TYPES:**

SOLID:
BS – BIOSOLID
CR – CERAMIC
SL – SOIL/SOLID
LIQUID:
DW - DRINKING WATER
GW - GROUND WATER
OL - OIL
SF - SURFACE WATER
ST - STORM WATER
WW – WASTE WATER

**PROJECT INFORMATION**

CONTRACT/P.O. NO.:
PROJECT: City of Visalia Water Conservation Plant
PROJECT NUMBER: A76404.03
CRWA MEMBER? YES ☐ NO☐

LAB USE — NOTES ON RECEIVED CONDITION:
☐ CUSTODY SEAL(S) BROKEN ☐ SAMPLE(S) DAMAGED
X ON ICE ☐ AMBIENT TEMP. ☐ INCORRECT PRESERVATION
5.9

ANALYSIS REQUESTED

| LAB USE | CLIENT SAMPLE ID | DATE | TIME | TYPE | pH, EC, TDS, TN | Ammonia | General Minerals (dissolved)* | | | | | | | | System Number / Station Code |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MW-H2 | 4/4/19 | 1200 | GW | X | X | X | | | | | | | | |
| 2 | MW-\H3 | 4/4/19 | 1421 | GW | X | X | X | | | | | | | | |
| 3 | MW-Q | 4/4/19 | 1018 | GW | X | X | X | | | | | | | | |

COMMENTS/ADDITIONAL INSTRUCTIONS: **Laboratory filter and preserve for metals upon receipt.**

* General Minerals – Total Alkalinity, Calcium, Chloride, Hardness, Potassium, Sodium, Sulfate, TDS, Nitrate, Cation/Anion Balance.

| RELINQUISHED BY | COMPANY | DATE | TIME | RECEIVED BY | COMPANY |
|---|---|---|---|---|---|
| [signature] | MTA | 4.4.19 | 1600 | [signature] | MTA |

Moore Twining Associates

Sample Integrity    Page 2 of 2    WO# FD04035    MTA Bottles: Yes (circled) or No

| COC Info | | | | |
|---|---|---|---|---|
| Was temperature within range? Chemistry ≤6°C Micro <10°C Temp ____ °C | Yes No N/A (circled N/A) | Did all bottle labels agree with COC? | Yes (circled) No N/A | Were there bubbles in VOA vials? **(Volatiles Only)** | Yes No N/A (circled N/A) |
| If samples were taken today, is there evidence that chilling has begun? Recvd 5.9 C° | Yes (circled) No N/A | Was a sufficient amount of sample received? | Yes (circled) No N/A | Was PM notified of discrepancies? PM: By/Time: | Yes No N/A (circled N/A) |
| Did all bottles arrive unbroken and intact? | Yes (circled) No N/A | Were correct containers and preservatives received for the tests requested? | Yes (circled) No N/A | | |
| Do samples have a hold time <72 hours? | Yes (circled) No N/A | | | | |

**Bottles Received**

| 125ml (A) 250ml (B) 1Liter (C) 40ml VOA (V) | 1-3 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bacti $Na_2S_2O_3$ | | | | | | | | | | | | | | | |
| None (P) | 1C 1B | | | | | | | | | | | | | | |
| Cr6 Buffer (P) Borate Carbonate Buffer | | | | | | | | | | | | | | | |
| $HNO_3$ (P) | 1-A | | | | | | | | | | | | | | |
| $H_2SO_4$ (P) | 1-A | | | | | | | | | | | | | | |
| NaOH (P) | | | | | | | | | | | | | | | |
| NaOH+ZnAc (P) | | | | | | | | | | | | | | | |
| Dissolved Oxygen 300ml (P) | | | | | | | | | | | | | | | |
| None (AG) | | | | | | | | | | | | | | | |
| None (CG) 500ml | | | | | | | | | | | | | | | |
| $Na_2S_2O_3$ 250ml (Brown P) 549 | | | | | | | | | | | | | | | |
| $Na_2S_2O_3$ (AG) | | | | | | | | | | | | | | | |
| $Na_2S_2O_3$ (AG) | | | | | | | | | | | | | | | |
| Thio/K Citrate | | | | | | | | | | | | | | | |
| $NH_4Cl$ (AG) 552 | | | | | | | | | | | | | | | |
| HCl (AG) | | | | | | | | | | | | | | | |
| None (CG) 500ml | | | | | | | | | | | | | | | |
| $H_3PO_4$ (AG) | | | | | | | | | | | | | | | |
| Other: | | | | | | | | | | | | | | | |
| Plastic Bag | | | | | | | | | | | | | | | |
| Low Level Hg/Metals Double Bag | | | | | | | | | | | | | | | |
| Client Own | | | | | | | | | | | | | | | |
| Glass Jar: 125/ 250/ 500 | | | | | | | | | | | | | | | |
| Soil Tube: Brass/ Steel/ Plastic | | | | | | | | | | | | | | | |
| 5 g Encore | | | | | | | | | | | | | | | |

**Filter or Split**

| | Container | Preservative | Date/Time/Initials |
|---|---|---|---|
| S P F (F circled) | 125 mL | HNO3 | 4-4-19 1605 [initials] |
| S P F | | | |
| S P F | | | |
| S P F | | | |
| S P F | | | |

Labeled by: M @ 1616    Labels checked by: [signature] @ 1611

FL-SC-0003-06

MOORE TWINING ASSOCIATES, INC.
California ELAP Certificate #1371

**2527 Fresno Street**
**Fresno, CA 93721**
**(559) 268-7021 Phone**
**(559) 268-0740 Fax**

April 24, 2019

Work Order #: **FD10003**

Kirk Jacobsen
MTA Environmental Division
2527 Fresno Street
Fresno, CA 93721

**RE: City of Visalia Water Conservation Plant**

Enclosed are the analytical results for samples received by our laboratory on **04/10/19** . For your reference, these analyses have been assigned laboratory work order number **FD10003**.

All analyses have been performed according to our laboratory's quality assurance program. All results are intended to be considered in their entirety, Moore Twining Associates, Inc. (MTA) is not responsible for use of less than complete reports. Results apply only to samples analyzed.

If you have any questions, please feel free to contact us at the number listed above.

Sincerely,

**Moore Twining Associates, Inc.**

Susan Federico
Client Services Representative

MOORE TWINING ASSOCIATES, INC.
California ELAP Certificate #1371

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| | | |
|---|---|---|
| MTA Environmental Division<br>2527 Fresno Street<br>Fresno CA, 93721 | **Project:** City of Visalia Water Conservation Plant<br>**Project Number:** A76404.03<br>**Project Manager:** Kirk Jacobsen | **Reported:**<br>04/24/2019 |

## Analytical Report for the Following Samples

| Sample ID | Notes | Laboratory ID | Matrix | Date Sampled | Date Received |
|---|---|---|---|---|---|
| MW-J2 | | FD10003-01 | Ground Water | 04/09/19 10:53 | 04/10/19 10:05 |
| MW-J3 | | FD10003-02 | Ground Water | 04/09/19 12:01 | 04/10/19 10:05 |
| MW-K2 | | FD10003-03 | Ground Water | 04/09/19 13:22 | 04/10/19 10:05 |
| MW-K3 | | FD10003-04 | Ground Water | 04/09/19 14:29 | 04/10/19 10:05 |
| MW-S | | FD10003-05 | Ground Water | 04/09/19 15:19 | 04/10/19 10:05 |

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| | | |
|---|---|---|
| MTA Environmental Division<br>2527 Fresno Street<br>Fresno CA, 93721 | **Project:** City of Visalia Water Conservation Plant<br>**Project Number:** A76404.03<br>**Project Manager:** Kirk Jacobsen | **Reported:**<br>04/24/2019 |

## MW-J2

FD10003-01 (Ground Water) Sampled: 04/09/19 10:53

| Analyte | Flag | Result | Reporting Limit | MDL | Units | Dilution | Batch | Analyst | Prepared | Analyzed | Method |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Inorganics** | | | | | | | | | | | |
| Bicarbonate Alkalinity as HCO3 | | **200** | 1.3 | 0.23 | mg/L | 1 | B9D1011 | GMC | 04/10/19 19:53 | 04/10/19 19:53 | SM 2320 B |
| Carbonate Alkalinity as CO3 | | ND | 1.0 | 0.23 | mg/L | 1 | B9D1011 | GMC | 04/10/19 19:53 | 04/10/19 19:53 | SM 2320 B |
| Hydroxide Alkalinity as OH | | ND | 1.0 | 0.23 | mg/L | 1 | B9D1011 | GMC | 04/10/19 19:53 | 04/10/19 19:53 | SM 2320 B |
| Total Alkalinity as CaCO3 | | **160** | 1.0 | 0.23 | mg/L | 1 | B9D1011 | GMC | 04/10/19 19:53 | 04/10/19 19:53 | SM 2320 B |
| Ammonia as N | J | **0.45** | 1.0 | 0.18 | mg/L | 1 | B9D1504 | HME | 04/15/19 9:40 | 04/17/19 19:08 | EPA 350.1 |
| Cation/Anion Balance (% Difference) | | **2.8** | | | % | 1 | B9D2313 | MCM | 04/23/19 14:32 | 04/23/19 14:33 | SM 1030 F |
| Chloride | | **79** | 4.0 | 0.36 | mg/L | 2 | B9D1018 | CMF | 04/10/19 15:31 | 04/10/19 21:25 | EPA 300.0 |
| Specific Conductance (EC) | | **670** | 1.0 | 0.26 | µS/cm | 1 | B9D1011 | GMC | 04/10/19 19:53 | 04/10/19 19:53 | SM 2510 B |
| Nitrate as N | | **8.0** | 0.90 | 0.056 | mg/L | 2 | B9D1018 | CMF | 04/10/19 15:31 | 04/10/19 21:25 | EPA 300.0 |
| Nitrite as N | | ND | 0.60 | 0.19 | mg/L | 2 | B9D1018 | CMF | 04/10/19 15:31 | 04/10/19 21:25 | EPA 300.0 |
| pH | | **7.7** | 0.10 | 0.10 | pH Units | 1 | B9D1011 | GMC | 04/10/19 19:53 | 04/10/19 19:53 | SM 4500-H B |
| Sulfate as SO4 | | **35** | 4.0 | 0.19 | mg/L | 2 | B9D1018 | CMF | 04/10/19 15:31 | 04/10/19 21:25 | EPA 300.0 |
| Total Dissolved Solids | | **410** | 10 | 8.1 | mg/L | 1 | B9D1111 | ACY | 04/11/19 10:45 | 04/12/19 13:10 | SM 2540 C |
| Total Kjeldahl Nitrogen | | **1.0** | 0.50 | 0.18 | mg/L | 1 | B9D1024 | JAG | 04/11/19 7:30 | 04/12/19 13:32 | EPA 351.2 |
| Total Nitrogen | | **9** | 0.90 | | mg/L | 2 | [CALC] | JAG | 04/12/19 13:32 | 04/12/19 13:32 | [CALC] |
| **Metals (Dissolved)** | | | | | | | | | | | |
| Calcium | | **53** | 0.10 | 0.048 | mg/L | 1 | B9D1020 | VAC | 04/17/19 8:54 | 04/19/19 15:56 | EPA 200.7 |
| Hardness (Dissolved) | | **140** | 0.66 | | mg equiv. CaCO3/L | 1 | [CALC] | VAC | 04/19/19 15:56 | 04/19/19 15:56 | SM 2340 B |
| Magnesium | | **1.2** | 0.10 | 0.025 | mg/L | 1 | B9D1020 | VAC | 04/17/19 8:54 | 04/19/19 15:56 | EPA 200.7 |
| Potassium | | **1.4** | 1.0 | 0.34 | mg/L | 1 | B9D1020 | VAC | 04/17/19 8:54 | 04/19/19 15:56 | EPA 200.7 |
| Sodium | | **84** | 1.0 | 0.26 | mg/L | 1 | B9D1020 | VAC | 04/17/19 8:54 | 04/19/19 15:56 | EPA 200.7 |

## MW-J3

FD10003-02 (Ground Water) Sampled: 04/09/19 12:01

| Analyte | Flag | Result | Reporting Limit | MDL | Units | Dilution | Batch | Analyst | Prepared | Analyzed | Method |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Inorganics** | | | | | | | | | | | |
| Bicarbonate Alkalinity as HCO3 | | **46** | 1.3 | 0.23 | mg/L | 1 | B9D1011 | GMC | 04/10/19 20:01 | 04/10/19 20:01 | SM 2320 B |
| Carbonate Alkalinity as CO3 | | **3.3** | 1.0 | 0.23 | mg/L | 1 | B9D1011 | GMC | 04/10/19 20:01 | 04/10/19 20:01 | SM 2320 B |
| Hydroxide Alkalinity as OH | | ND | 1.0 | 0.23 | mg/L | 1 | B9D1011 | GMC | 04/10/19 20:01 | 04/10/19 20:01 | SM 2320 B |
| Total Alkalinity as CaCO3 | | **44** | 1.0 | 0.23 | mg/L | 1 | B9D1011 | GMC | 04/10/19 20:01 | 04/10/19 20:01 | SM 2320 B |
| Ammonia as N | | ND | 1.0 | 0.18 | mg/L | 1 | B9D1504 | HME | 04/15/19 9:40 | 04/17/19 19:08 | EPA 350.1 |
| Cation/Anion Balance (% Difference) | | **0.28** | | | % | 1 | B9D2313 | MCM | 04/23/19 14:32 | 04/23/19 14:33 | SM 1030 F |
| Chloride | | **8.7** | 2.0 | 0.18 | mg/L | 1 | B9D1018 | CMF | 04/10/19 15:31 | 04/10/19 21:39 | EPA 300.0 |
| Specific Conductance (EC) | | **120** | 1.0 | 0.26 | µS/cm | 1 | B9D1011 | GMC | 04/10/19 20:01 | 04/10/19 20:01 | SM 2510 B |
| Nitrate as N | | ND | 0.45 | 0.028 | mg/L | 1 | B9D1018 | CMF | 04/10/19 15:31 | 04/10/19 21:39 | EPA 300.0 |
| Nitrite as N | J | **0.26** | 0.30 | 0.097 | mg/L | 1 | B9D1018 | CMF | 04/10/19 15:31 | 04/10/19 21:39 | EPA 300.0 |
| pH | | **8.6** | 0.10 | 0.10 | pH Units | 1 | B9D1011 | GMC | 04/10/19 20:01 | 04/10/19 20:01 | SM 4500-H B |
| Sulfate as SO4 | | **5.1** | 2.0 | 0.094 | mg/L | 1 | B9D1018 | CMF | 04/10/19 15:31 | 04/10/19 21:39 | EPA 300.0 |
| Total Dissolved Solids | | **96** | 10 | 8.1 | mg/L | 1 | B9D1111 | ACY | 04/11/19 10:45 | 04/12/19 13:10 | SM 2540 C |
| Total Kjeldahl Nitrogen | | ND | 0.50 | 0.18 | mg/L | 1 | B9D1024 | JAG | 04/11/19 7:30 | 04/12/19 13:34 | EPA 351.2 |
| Total Nitrogen | | ND | 0.50 | | mg/L | 1 | [CALC] | JAG | 04/12/19 13:34 | 04/12/19 13:34 | [CALC] |
| **Metals (Dissolved)** | | | | | | | | | | | |

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| | | |
|---|---|---|
| MTA Environmental Division<br>2527 Fresno Street<br>Fresno CA, 93721 | **Project:** City of Visalia Water Conservation Plant<br>**Project Number:** A76404.03<br>**Project Manager:** Kirk Jacobsen | **Reported:**<br>04/24/2019 |

## MW-J3

FD10003-02 (Ground Water) Sampled: 04/09/19 12:01

| Analyte | Flag | Result | Reporting Limit | MDL | Units | Dilution | Batch | Analyst | Prepared | Analyzed | Method |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Metals (Dissolved)** | | | | | | | | | | | |
| Calcium | | **2.8** | 0.10 | 0.048 | mg/L | 1 | B9D1020 | VAC | 04/17/19 8:54 | 04/19/19 16:13 | EPA 200.7 |
| Hardness (Dissolved) | | **7.1** | 0.66 | | mg equiv. CaCO3/L | 1 | [CALC] | VAC | 04/19/19 16:13 | 04/19/19 16:13 | SM 2340 B |
| Magnesium | | ND | 0.10 | 0.025 | mg/L | 1 | B9D1020 | VAC | 04/17/19 8:54 | 04/19/19 16:13 | EPA 200.7 |
| Potassium | | ND | 1.0 | 0.34 | mg/L | 1 | B9D1020 | VAC | 04/17/19 8:54 | 04/19/19 16:13 | EPA 200.7 |
| Sodium | | **25** | 1.0 | 0.26 | mg/L | 1 | B9D1020 | VAC | 04/17/19 8:54 | 04/19/19 16:13 | EPA 200.7 |

## MW-K2

FD10003-03 (Ground Water) Sampled: 04/09/19 13:22

| Analyte | Flag | Result | Reporting Limit | MDL | Units | Dilution | Batch | Analyst | Prepared | Analyzed | Method |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Inorganics** | | | | | | | | | | | |
| Bicarbonate Alkalinity as HCO3 | | **68** | 1.3 | 0.23 | mg/L | 1 | B9D1011 | GMC | 04/10/19 20:08 | 04/10/19 20:08 | SM 2320 B |
| Carbonate Alkalinity as CO3 | | ND | 1.0 | 0.23 | mg/L | 1 | B9D1011 | GMC | 04/10/19 20:08 | 04/10/19 20:08 | SM 2320 B |
| Hydroxide Alkalinity as OH | | ND | 1.0 | 0.23 | mg/L | 1 | B9D1011 | GMC | 04/10/19 20:08 | 04/10/19 20:08 | SM 2320 B |
| Total Alkalinity as CaCO3 | | **55** | 1.0 | 0.23 | mg/L | 1 | B9D1011 | GMC | 04/10/19 20:08 | 04/10/19 20:08 | SM 2320 B |
| Ammonia as N | | ND | 1.0 | 0.18 | mg/L | 1 | B9D1504 | HME | 04/15/19 9:40 | 04/17/19 19:09 | EPA 350.1 |
| Cation/Anion Balance (% Difference) | | **4.3** | | | % | 1 | B9D2313 | MCM | 04/23/19 14:32 | 04/23/19 14:33 | SM 1030 F |
| Chloride | | **82** | 2.0 | 0.18 | mg/L | 1 | B9D1018 | CMF | 04/10/19 15:31 | 04/10/19 21:53 | EPA 300.0 |
| Specific Conductance (EC) | | **490** | 1.0 | 0.26 | µS/cm | 1 | B9D1011 | GMC | 04/10/19 20:08 | 04/10/19 20:08 | SM 2510 B |
| Nitrate as N | | **7.0** | 0.45 | 0.028 | mg/L | 1 | B9D1018 | CMF | 04/10/19 15:31 | 04/10/19 21:53 | EPA 300.0 |
| Nitrite as N | | ND | 0.30 | 0.097 | mg/L | 1 | B9D1018 | CMF | 04/10/19 15:31 | 04/10/19 21:53 | EPA 300.0 |
| pH | | **7.6** | 0.10 | 0.10 | pH Units | 1 | B9D1011 | GMC | 04/10/19 20:08 | 04/10/19 20:08 | SM 4500-H B |
| Sulfate as SO4 | | **40** | 2.0 | 0.094 | mg/L | 1 | B9D1018 | CMF | 04/10/19 15:31 | 04/10/19 21:53 | EPA 300.0 |
| Total Dissolved Solids | | **300** | 10 | 8.1 | mg/L | 1 | B9D1111 | ACY | 04/11/19 10:45 | 04/12/19 13:10 | SM 2540 C |
| Total Kjeldahl Nitrogen | | **1.7** | 0.50 | 0.18 | mg/L | 1 | B9D1024 | JAG | 04/11/19 7:30 | 04/12/19 13:35 | EPA 351.2 |
| Total Nitrogen | | **8.7** | 0.50 | | mg/L | 1 | [CALC] | JAG | 04/12/19 13:35 | 04/12/19 13:35 | [CALC] |
| **Metals (Dissolved)** | | | | | | | | | | | |
| Calcium | | **29** | 0.10 | 0.048 | mg/L | 1 | B9D1020 | VAC | 04/17/19 8:54 | 04/19/19 16:17 | EPA 200.7 |
| Hardness (Dissolved) | | **75** | 0.66 | | mg equiv. CaCO3/L | 1 | [CALC] | VAC | 04/19/19 16:17 | 04/19/19 16:17 | SM 2340 B |
| Magnesium | | **0.38** | 0.10 | 0.025 | mg/L | 1 | B9D1020 | VAC | 04/17/19 8:54 | 04/19/19 16:17 | EPA 200.7 |
| Potassium | J | **0.82** | 1.0 | 0.34 | mg/L | 1 | B9D1020 | VAC | 04/17/19 8:54 | 04/19/19 16:17 | EPA 200.7 |
| Sodium | | **66** | 1.0 | 0.26 | mg/L | 1 | B9D1020 | VAC | 04/17/19 8:54 | 04/19/19 16:17 | EPA 200.7 |

## MW-K3

FD10003-04 (Ground Water) Sampled: 04/09/19 14:29

| Analyte | Flag | Result | Reporting Limit | MDL | Units | Dilution | Batch | Analyst | Prepared | Analyzed | Method |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Inorganics** | | | | | | | | | | | |
| Bicarbonate Alkalinity as HCO3 | | **45** | 1.3 | 0.23 | mg/L | 1 | B9D1011 | GMC | 04/10/19 20:16 | 04/10/19 20:16 | SM 2320 B |
| Carbonate Alkalinity as CO3 | | **6.7** | 1.0 | 0.23 | mg/L | 1 | B9D1011 | GMC | 04/10/19 20:16 | 04/10/19 20:16 | SM 2320 B |
| Hydroxide Alkalinity as OH | | ND | 1.0 | 0.23 | mg/L | 1 | B9D1011 | GMC | 04/10/19 20:16 | 04/10/19 20:16 | SM 2320 B |
| Total Alkalinity as CaCO3 | | **48** | 1.0 | 0.23 | mg/L | 1 | B9D1011 | GMC | 04/10/19 20:16 | 04/10/19 20:16 | SM 2320 B |

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|---|---|---|---|
| MTA Environmental Division | **Project:** | City of Visalia Water Conservation Plant | **Reported:** |
| 2527 Fresno Street | **Project Number:** | A76404.03 | 04/24/2019 |
| Fresno CA, 93721 | **Project Manager:** | Kirk Jacobsen | |

## MW-K3

FD10003-04 (Ground Water) Sampled: 04/09/19 14:29

| Analyte | Flag | Result | Reporting Limit | MDL | Units | Dilution | Batch | Analyst | Prepared | Analyzed | Method |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Inorganics** | | | | | | | | | | | |
| Ammonia as N | | ND | 1.0 | 0.18 | mg/L | 1 | B9D1504 | HME | 04/15/19 9:40 | 04/17/19 19:10 | EPA 350.1 |
| Cation/Anion Balance (% Difference) | | **1.9** | | | % | 1 | B9D2313 | MCM | 04/23/19 14:32 | 04/23/19 14:33 | SM 1030 F |
| Chloride | | **4.0** | 2.0 | 0.18 | mg/L | 1 | B9D1018 | CMF | 04/10/19 15:31 | 04/10/19 22:07 | EPA 300.0 |
| Specific Conductance (EC) | | **110** | 1.0 | 0.26 | µS/cm | 1 | B9D1011 | GMC | 04/10/19 20:16 | 04/10/19 20:16 | SM 2510 B |
| Nitrate as N | J | **0.036** | 0.45 | 0.028 | mg/L | 1 | B9D1018 | CMF | 04/10/19 15:31 | 04/10/19 22:07 | EPA 300.0 |
| Nitrite as N | J | **0.25** | 0.30 | 0.097 | mg/L | 1 | B9D1018 | CMF | 04/10/19 15:31 | 04/10/19 22:07 | EPA 300.0 |
| pH | | **8.8** | 0.10 | 0.10 | pH Units | 1 | B9D1011 | GMC | 04/10/19 20:16 | 04/10/19 20:16 | SM 4500-H B |
| Sulfate as SO4 | | **3.0** | 2.0 | 0.094 | mg/L | 1 | B9D1018 | CMF | 04/10/19 15:31 | 04/10/19 22:07 | EPA 300.0 |
| Total Dissolved Solids | | **92** | 10 | 8.1 | mg/L | 1 | B9D1610 | ACY | 04/16/19 10:46 | 04/17/19 14:10 | SM 2540 C |
| Total Kjeldahl Nitrogen | | ND | 0.50 | 0.18 | mg/L | 1 | B9D1024 | JAG | 04/11/19 7:30 | 04/12/19 13:36 | EPA 351.2 |
| Total Nitrogen | | ND | 0.50 | | mg/L | 1 | [CALC] | JAG | 04/12/19 13:36 | 04/12/19 13:36 | [CALC] |
| **Metals (Dissolved)** | | | | | | | | | | | |
| Calcium | | **2.3** | 0.10 | 0.048 | mg/L | 1 | B9D1020 | VAC | 04/17/19 8:54 | 04/19/19 16:26 | EPA 200.7 |
| Hardness (Dissolved) | | **5.8** | 0.66 | | mg equiv. CaCO3/L | 1 | [CALC] | VAC | 04/19/19 16:26 | 04/19/19 16:26 | SM 2340 B |
| Magnesium | | ND | 0.10 | 0.025 | mg/L | 1 | B9D1020 | VAC | 04/17/19 8:54 | 04/19/19 16:26 | EPA 200.7 |
| Potassium | | ND | 1.0 | 0.34 | mg/L | 1 | B9D1020 | VAC | 04/17/19 8:54 | 04/19/19 16:26 | EPA 200.7 |
| Sodium | | **25** | 1.0 | 0.26 | mg/L | 1 | B9D1020 | VAC | 04/17/19 8:54 | 04/19/19 16:26 | EPA 200.7 |

## MW-S

FD10003-05 (Ground Water) Sampled: 04/09/19 15:19

| Analyte | Flag | Result | Reporting Limit | MDL | Units | Dilution | Batch | Analyst | Prepared | Analyzed | Method |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Inorganics** | | | | | | | | | | | |
| Bicarbonate Alkalinity as HCO3 | | **260** | 1.3 | 0.23 | mg/L | 1 | B9D1011 | GMC | 04/10/19 20:32 | 04/10/19 20:32 | SM 2320 B |
| Carbonate Alkalinity as CO3 | | ND | 1.0 | 0.23 | mg/L | 1 | B9D1011 | GMC | 04/10/19 20:32 | 04/10/19 20:32 | SM 2320 B |
| Hydroxide Alkalinity as OH | | ND | 1.0 | 0.23 | mg/L | 1 | B9D1011 | GMC | 04/10/19 20:32 | 04/10/19 20:32 | SM 2320 B |
| Total Alkalinity as CaCO3 | | **210** | 1.0 | 0.23 | mg/L | 1 | B9D1011 | GMC | 04/10/19 20:32 | 04/10/19 20:32 | SM 2320 B |
| Ammonia as N | J | **0.21** | 1.0 | 0.18 | mg/L | 1 | B9D1504 | HME | 04/15/19 9:40 | 04/17/19 19:11 | EPA 350.1 |
| Cation/Anion Balance (% Difference) | | **1.1** | | | % | 1 | B9D2313 | MCM | 04/23/19 14:32 | 04/23/19 14:33 | SM 1030 F |
| Chloride | | **100** | 6.0 | 0.55 | mg/L | 3 | B9D1018 | CMF | 04/10/19 15:31 | 04/10/19 22:21 | EPA 300.0 |
| Specific Conductance (EC) | | **1300** | 1.0 | 0.26 | µS/cm | 1 | B9D1011 | GMC | 04/10/19 20:32 | 04/10/19 20:32 | SM 2510 B |
| Nitrate as N | | **58** | 1.4 | 0.084 | mg/L | 3 | B9D1018 | CMF | 04/10/19 15:31 | 04/10/19 22:21 | EPA 300.0 |
| Nitrite as N | | ND | 0.90 | 0.29 | mg/L | 3 | B9D1018 | CMF | 04/10/19 15:31 | 04/10/19 22:21 | EPA 300.0 |
| pH | | **7.4** | 0.10 | 0.10 | pH Units | 1 | B9D1011 | GMC | 04/10/19 20:32 | 04/10/19 20:32 | SM 4500-H B |
| Sulfate as SO4 | | **78** | 6.0 | 0.28 | mg/L | 3 | B9D1018 | CMF | 04/10/19 15:31 | 04/10/19 22:21 | EPA 300.0 |
| Total Dissolved Solids | | **960** | 10 | 8.1 | mg/L | 1 | B9D1610 | ACY | 04/16/19 10:46 | 04/17/19 14:10 | SM 2540 C |
| Total Kjeldahl Nitrogen | | **0.84** | 0.50 | 0.18 | mg/L | 1 | B9D1024 | JAG | 04/11/19 7:30 | 04/12/19 13:38 | EPA 351.2 |
| Total Nitrogen | | **59** | 1.4 | | mg/L | 3 | [CALC] | JAG | 04/12/19 13:38 | 04/12/19 13:38 | [CALC] |
| **Metals (Dissolved)** | | | | | | | | | | | |
| Calcium | | **150** | 0.10 | 0.048 | mg/L | 1 | B9D1020 | VAC | 04/17/19 8:54 | 04/19/19 16:30 | EPA 200.7 |
| Hardness (Dissolved) | | **450** | 0.66 | | mg equiv. CaCO3/L | 1 | [CALC] | VAC | 04/19/19 16:30 | 04/19/19 16:30 | SM 2340 B |
| Magnesium | | **17** | 0.10 | 0.025 | mg/L | 1 | B9D1020 | VAC | 04/17/19 8:54 | 04/19/19 16:30 | EPA 200.7 |
| Potassium | J | **0.98** | 1.0 | 0.34 | mg/L | 1 | B9D1020 | VAC | 04/17/19 8:54 | 04/19/19 16:30 | EPA 200.7 |

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| | | |
|---|---|---|
| MTA Environmental Division<br>2527 Fresno Street<br>Fresno CA, 93721 | **Project:** City of Visalia Water Conservation Plant<br>**Project Number:** A76404.03<br>**Project Manager:** Kirk Jacobsen | **Reported:**<br>04/24/2019 |

## MW-S

FD10003-05 (Ground Water) Sampled: 04/09/19 15:19

| Analyte | Flag | Result | Reporting Limit | MDL | Units | Dilution | Batch | Analyst | Prepared | Analyzed | Method |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Metals (Dissolved)** | | | | | | | | | | | |
| Sodium | | **84** | 1.0 | 0.26 | mg/L | 1 | B9D1020 | VAC | 04/17/19 8:54 | 04/19/19 16:30 | EPA 200.7 |

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| | | |
|---|---|---|
| MTA Environmental Division<br>2527 Fresno Street<br>Fresno CA, 93721 | **Project:** City of Visalia Water Conservation Plant<br>**Project Number:** A76404.03<br>**Project Manager:** Kirk Jacobsen | **Reported:**<br>04/24/2019 |

## Quality Control Sample Results - Inorganics

| Analyte | Flag | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch - B9D1011** | | | | | | | | | | |
| **Blank (B9D1011-BLK1)** | | Prepared & Analyzed: 04/10/19 | | | | | | | | |
| **SM 2320 B** | | | | | | | | | | |
| Bicarbonate Alkalinity as HCO3 | J | 0.340 | 1.3 | mg/L | | | | | | |
| Carbonate Alkalinity as CO3 | | ND | 1.0 | mg/L | | | | | | |
| Hydroxide Alkalinity as OH | | ND | 1.0 | mg/L | | | | | | |
| Total Alkalinity as CaCO3 | J | 0.280 | 1.0 | mg/L | | | | | | |
| **SM 2510 B** | | | | | | | | | | |
| Specific Conductance (EC) | | ND | 1.0 | µS/cm | | | | | | |
| **LCS (B9D1011-BS1)** | | Prepared & Analyzed: 04/10/19 | | | | | | | | |
| **SM 2510 B** | | | | | | | | | | |
| Specific Conductance (EC) | | 490 | 1.0 | µS/cm | 500 | | 98.0 | 80-120 | | |
| **LCS (B9D1011-BS2)** | | Prepared & Analyzed: 04/10/19 | | | | | | | | |
| **SM 4500-H B** | | | | | | | | | | |
| pH | | 7.05 | 0.10 | pH Units | 7.00 | | 101 | 97-103 | | |
| **LCS (B9D1011-BS3)** | | Prepared & Analyzed: 04/10/19 | | | | | | | | |
| **SM 2320 B** | | | | | | | | | | |
| Total Alkalinity as CaCO3 | | 225 | 1.0 | mg/L | 250 | | 90.0 | 80-120 | | |
| **LCS Dup (B9D1011-BSD1)** | | Prepared & Analyzed: 04/10/19 | | | | | | | | |
| **SM 2510 B** | | | | | | | | | | |
| Specific Conductance (EC) | | 493 | 1.0 | µS/cm | 500 | | 98.6 | 80-120 | 0.618 | 20 |
| **LCS Dup (B9D1011-BSD2)** | | Prepared & Analyzed: 04/10/19 | | | | | | | | |
| **SM 4500-H B** | | | | | | | | | | |
| pH | | 7.04 | 0.10 | pH Units | 7.00 | | 101 | 97-103 | 0.142 | 20 |
| **LCS Dup (B9D1011-BSD3)** | | Prepared & Analyzed: 04/10/19 | | | | | | | | |
| **SM 2320 B** | | | | | | | | | | |
| Total Alkalinity as CaCO3 | | 223 | 1.0 | mg/L | 250 | | 89.1 | 80-120 | 0.973 | 20 |
| **Duplicate (B9D1011-DUP1)** | | Prepared & Analyzed: 04/10/19 | | | | **Source: FD09041-02** | | | | |
| **SM 2320 B** | | | | | | | | | | |
| Bicarbonate Alkalinity as HCO3 | | 199 | 1.3 | mg/L | | 202 | | | 1.28 | 20 |
| Carbonate Alkalinity as CO3 | | ND | 1.0 | mg/L | | ND | | | | |
| Hydroxide Alkalinity as OH | | ND | 1.0 | mg/L | | ND | | | | |
| Total Alkalinity as CaCO3 | | 163 | 1.0 | mg/L | | 165 | | | 1.28 | 20 |
| **SM 2510 B** | | | | | | | | | | |
| Specific Conductance (EC) | | 818 | 1.0 | µS/cm | | 821 | | | 0.372 | 20 |
| **SM 4500-H B** | | | | | | | | | | |
| pH | | 6.88 | 0.10 | pH Units | | 6.87 | | | 0.145 | 20 |
| **Duplicate (B9D1011-DUP2)** | | Prepared & Analyzed: 04/10/19 | | | | **Source: FD10009-03** | | | | |
| **SM 2320 B** | | | | | | | | | | |
| Bicarbonate Alkalinity as HCO3 | | 110 | 1.3 | mg/L | | 109 | | | 0.756 | 20 |
| Carbonate Alkalinity as CO3 | | ND | 1.0 | mg/L | | ND | | | | |
| Hydroxide Alkalinity as OH | | ND | 1.0 | mg/L | | ND | | | | |
| Total Alkalinity as CaCO3 | | 90.4 | 1.0 | mg/L | | 89.7 | | | 0.755 | 20 |

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| | | |
|---|---|---|
| MTA Environmental Division<br>2527 Fresno Street<br>Fresno CA, 93721 | **Project:** City of Visalia Water Conservation Plant<br>**Project Number:** A76404.03<br>**Project Manager:** Kirk Jacobsen | **Reported:**<br>04/24/2019 |

## Quality Control Sample Results - Inorganics

| Analyte | Flag | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch - B9D1011** | | | | | | | | | | |
| **Duplicate (B9D1011-DUP2)** | | Prepared & Analyzed: 04/10/19 | | | | **Source: FD10009-03** | | | | |
| **SM 2510 B** | | | | | | | | | | |
| Specific Conductance (EC) | | 393 | 1.0 | µS/cm | | 387 | | | 1.30 | 20 |
| **SM 4500-H B** | | | | | | | | | | |
| pH | | 7.53 | 0.10 | pH Units | | 7.53 | | | 0.00 | 20 |
| **Batch - B9D1018** | | | | | | | | | | |
| **Blank (B9D1018-BLK1)** | | Prepared & Analyzed: 04/10/19 | | | | | | | | |
| **EPA 300.0** | | | | | | | | | | |
| Chloride | | ND | 2.0 | mg/L | | | | | | |
| Nitrate as N | J | 0.108 | 0.45 | mg/L | | | | | | |
| Nitrite as N | | ND | 0.30 | mg/L | | | | | | |
| Sulfate as SO4 | | ND | 2.0 | mg/L | | | | | | |
| **LCS (B9D1018-BS1)** | | Prepared & Analyzed: 04/10/19 | | | | | | | | |
| **EPA 300.0** | | | | | | | | | | |
| Chloride | | 53.7 | 2.0 | mg/L | 50.0 | | 107 | 90-110 | | |
| Nitrate as N | | 12.0 | 0.45 | mg/L | 11.3 | | 106 | 90-110 | | |
| Nitrite as N | | 5.39 | 0.30 | mg/L | 5.00 | | 108 | 90-110 | | |
| Sulfate as SO4 | | 53.0 | 2.0 | mg/L | 50.0 | | 106 | 90-110 | | |
| **LCS Dup (B9D1018-BSD1)** | | Prepared & Analyzed: 04/10/19 | | | | | | | | |
| **EPA 300.0** | | | | | | | | | | |
| Chloride | | 53.1 | 2.0 | mg/L | 50.0 | | 106 | 90-110 | 1.06 | 20 |
| Nitrate as N | | 11.9 | 0.45 | mg/L | 11.3 | | 105 | 90-110 | 1.25 | 20 |
| Nitrite as N | | 5.31 | 0.30 | mg/L | 5.00 | | 106 | 90-110 | 1.44 | 20 |
| Sulfate as SO4 | | 52.3 | 2.0 | mg/L | 50.0 | | 105 | 90-110 | 1.33 | 20 |
| **Matrix Spike (B9D1018-MS1)** | | Prepared & Analyzed: 04/10/19 | | | | **Source: FD10002-01** | | | | |
| **EPA 300.0** | | | | | | | | | | |
| Chloride | | 111 | 4.0 | mg/L | 100 | 12.2 | 98.8 | 80-120 | | |
| Nitrate as N | | 25.3 | 0.90 | mg/L | 22.6 | 3.97 | 94.5 | 80-120 | | |
| Nitrite as N | | 9.65 | 0.60 | mg/L | 10.0 | ND | 96.5 | 80-120 | | |
| Sulfate as SO4 | | 111 | 4.0 | mg/L | 100 | 16.1 | 94.7 | 80-120 | | |
| **Matrix Spike Dup (B9D1018-MSD1)** | | Prepared & Analyzed: 04/10/19 | | | | **Source: FD10002-01** | | | | |
| **EPA 300.0** | | | | | | | | | | |
| Chloride | | 115 | 4.0 | mg/L | 100 | 12.2 | 103 | 80-120 | 3.33 | 20 |
| Nitrate as N | | 26.2 | 0.90 | mg/L | 22.6 | 3.97 | 98.5 | 80-120 | 3.50 | 20 |
| Nitrite as N | | 9.97 | 0.60 | mg/L | 10.0 | ND | 99.7 | 80-120 | 3.24 | 20 |
| Sulfate as SO4 | | 114 | 4.0 | mg/L | 100 | 16.1 | 98.3 | 80-120 | 3.17 | 20 |
| **Matrix Spike (B9D1018-MS2)** | | Prepared: 04/10/19 Analyzed: 04/11/19 | | | | **Source: FD10039-01** | | | | |
| **EPA 300.0** | | | | | | | | | | |
| Chloride | | 108 | 4.0 | mg/L | 100 | 2.54 | 105 | 80-120 | | |
| Nitrate as N | | 26.4 | 0.90 | mg/L | 22.6 | 3.57 | 101 | 80-120 | | |
| Nitrite as N | | 10.3 | 0.60 | mg/L | 10.0 | ND | 103 | 80-120 | | |
| Sulfate as SO4 | | 105 | 4.0 | mg/L | 100 | 2.14 | 103 | 80-120 | | |

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|---|---|---|---|
| MTA Environmental Division | **Project:** | City of Visalia Water Conservation Plant | **Reported:** |
| 2527 Fresno Street | **Project Number:** | A76404.03 | 04/24/2019 |
| Fresno CA, 93721 | **Project Manager:** | Kirk Jacobsen | |

## Quality Control Sample Results - Inorganics

| Analyte | Flag | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch - B9D1018** | | | | | | | | | | |
| **Matrix Spike Dup (B9D1018-MSD2)** | | Prepared: 04/10/19 Analyzed: 04/11/19 | | | | **Source: FD10039-01** | | | | |
| **EPA 300.0** | | | | | | | | | | |
| Chloride | | 103 | 4.0 | mg/L | 100 | 2.54 | 101 | 80-120 | 4.22 | 20 |
| Nitrate as N | | 25.1 | 0.90 | mg/L | 22.6 | 3.57 | 95.4 | 80-120 | 4.75 | 20 |
| Nitrite as N | | 9.84 | 0.60 | mg/L | 10.0 | ND | 98.4 | 80-120 | 4.28 | 20 |
| Sulfate as SO4 | | 99.3 | 4.0 | mg/L | 100 | 2.14 | 97.2 | 80-120 | 5.25 | 20 |
| **Batch - B9D1024** | | | | | | | | | | |
| **Blank (B9D1024-BLK1)** | | Prepared: 04/11/19 Analyzed: 04/12/19 | | | | | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | ND | 0.50 | mg/L | | | | | | |
| **LCS (B9D1024-BS1)** | | Prepared: 04/11/19 Analyzed: 04/12/19 | | | | | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 10.2 | 0.50 | mg/L | 10.0 | | 102 | 90-110 | | |
| **LCS Dup (B9D1024-BSD1)** | | Prepared: 04/11/19 Analyzed: 04/12/19 | | | | | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 10.1 | 0.50 | mg/L | 10.0 | | 101 | 90-110 | 0.305 | 20 |
| **Matrix Spike (B9D1024-MS1)** | | Prepared: 04/11/19 Analyzed: 04/12/19 | | | | **Source: FD09073-01** | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 10.8 | 0.50 | mg/L | 10.0 | 0.810 | 99.8 | 80-120 | | |
| **Matrix Spike Dup (B9D1024-MSD1)** | | Prepared: 04/11/19 Analyzed: 04/12/19 | | | | **Source: FD09073-01** | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 11.6 | 0.50 | mg/L | 10.0 | 0.810 | 108 | 80-120 | 7.53 | 20 |
| **Matrix Spike (B9D1024-MS2)** | | Prepared: 04/11/19 Analyzed: 04/12/19 | | | | **Source: FD10035-01** | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 11.1 | 0.50 | mg/L | 10.0 | 1.96 | 91.0 | 80-120 | | |
| **Matrix Spike Dup (B9D1024-MSD2)** | | Prepared: 04/11/19 Analyzed: 04/12/19 | | | | **Source: FD10035-01** | | | | |
| **EPA 351.2** | | | | | | | | | | |
| Total Kjeldahl Nitrogen | | 11.3 | 0.50 | mg/L | 10.0 | 1.96 | 93.7 | 80-120 | 2.45 | 20 |
| **Batch - B9D1111** | | | | | | | | | | |
| **Blank (B9D1111-BLK1)** | | Prepared: 04/11/19 Analyzed: 04/12/19 | | | | | | | | |
| **SM 2540 C** | | | | | | | | | | |
| Total Dissolved Solids | | ND | 10 | mg/L | | | | | | |
| **LCS (B9D1111-BS1)** | | Prepared: 04/11/19 Analyzed: 04/12/19 | | | | | | | | |
| **SM 2540 C** | | | | | | | | | | |
| Total Dissolved Solids | | 238 | 10 | mg/L | 240 | | 99.2 | 80-120 | | |
| **LCS Dup (B9D1111-BSD1)** | | Prepared: 04/11/19 Analyzed: 04/12/19 | | | | | | | | |
| **SM 2540 C** | | | | | | | | | | |
| Total Dissolved Solids | | 235 | 10 | mg/L | 240 | | 97.9 | 80-120 | 1.27 | 20 |
| **Duplicate (B9D1111-DUP1)** | | Prepared: 04/11/19 Analyzed: 04/12/19 | | | | **Source: FD09001-07** | | | | |
| **SM 2540 C** | | | | | | | | | | |
| Total Dissolved Solids | | 388 | 10 | mg/L | | 400 | | | 3.04 | 20 |

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Fresno, CA 93721
(559) 268-7021 Phone
(559) 268-0740 Fax

| | | |
|---|---|---|
| MTA Environmental Division<br>2527 Fresno Street<br>Fresno CA, 93721 | **Project:** City of Visalia Water Conservation Plant<br>**Project Number:** A76404.03<br>**Project Manager:** Kirk Jacobsen | **Reported:**<br>04/24/2019 |

## Quality Control Sample Results - Inorganics

| Analyte | Flag | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch - B9D1111** | | | | | | | | | | |
| **Duplicate (B9D1111-DUP2)** | | Prepared: 04/11/19 Analyzed: 04/12/19 | | | | **Source: FD09038-05** | | | | |
| **SM 2540 C** | | | | | | | | | | |
| Total Dissolved Solids | | 490 | 10 | mg/L | | 503 | | | 2.62 | 20 |
| **Batch - B9D1504** | | | | | | | | | | |
| **Blank (B9D1504-BLK1)** | | Prepared: 04/15/19 Analyzed: 04/17/19 | | | | | | | | |
| **EPA 350.1** | | | | | | | | | | |
| Ammonia as N | | ND | 1.0 | mg/L | | | | | | |
| **LCS (B9D1504-BS1)** | | Prepared: 04/15/19 Analyzed: 04/17/19 | | | | | | | | |
| **EPA 350.1** | | | | | | | | | | |
| Ammonia as N | | 9.69 | 5.0 | mg/L | 10.0 | | 96.9 | 90-110 | | |
| **LCS Dup (B9D1504-BSD1)** | | Prepared: 04/15/19 Analyzed: 04/17/19 | | | | | | | | |
| **EPA 350.1** | | | | | | | | | | |
| Ammonia as N | | 11.0 | 1.0 | mg/L | 10.0 | | 110 | 90-110 | 12.7 | 20 |
| **Matrix Spike (B9D1504-MS1)** | | Prepared: 04/15/19 Analyzed: 04/17/19 | | | | **Source: FD09001-07** | | | | |
| **EPA 350.1** | | | | | | | | | | |
| Ammonia as N | | 11.3 | 1.0 | mg/L | 10.0 | ND | 113 | 80-120 | | |
| **Matrix Spike Dup (B9D1504-MSD1)** | | Prepared: 04/15/19 Analyzed: 04/17/19 | | | | **Source: FD09001-07** | | | | |
| **EPA 350.1** | | | | | | | | | | |
| Ammonia as N | | 10.5 | 1.0 | mg/L | 10.0 | ND | 105 | 80-120 | 7.51 | 20 |
| **Matrix Spike (B9D1504-MS2)** | | Prepared: 04/15/19 Analyzed: 04/17/19 | | | | **Source: FD10003-05** | | | | |
| **EPA 350.1** | | | | | | | | | | |
| Ammonia as N | | 10.1 | 1.0 | mg/L | 10.0 | 0.206 | 99.4 | 80-120 | | |
| **Matrix Spike Dup (B9D1504-MSD2)** | | Prepared: 04/15/19 Analyzed: 04/17/19 | | | | **Source: FD10003-05** | | | | |
| **EPA 350.1** | | | | | | | | | | |
| Ammonia as N | | 11.1 | 1.0 | mg/L | 10.0 | 0.206 | 109 | 80-120 | 8.68 | 20 |
| **Batch - B9D1610** | | | | | | | | | | |
| **Blank (B9D1610-BLK1)** | | Prepared: 04/16/19 Analyzed: 04/17/19 | | | | | | | | |
| **SM 2540 C** | | | | | | | | | | |
| Total Dissolved Solids | | ND | 10 | mg/L | | | | | | |
| **LCS (B9D1610-BS1)** | | Prepared: 04/16/19 Analyzed: 04/17/19 | | | | | | | | |
| **SM 2540 C** | | | | | | | | | | |
| Total Dissolved Solids | | 234 | 10 | mg/L | 240 | | 97.7 | 80-120 | | |
| **LCS Dup (B9D1610-BSD1)** | | Prepared: 04/16/19 Analyzed: 04/17/19 | | | | | | | | |
| **SM 2540 C** | | | | | | | | | | |
| Total Dissolved Solids | | 252 | 10 | mg/L | 240 | | 105 | 80-120 | 7.19 | 20 |
| **Duplicate (B9D1610-DUP1)** | | Prepared: 04/16/19 Analyzed: 04/17/19 | | | | **Source: FD10003-05** | | | | |
| **SM 2540 C** | | | | | | | | | | |
| Total Dissolved Solids | | 992 | 10 | mg/L | | 958 | | | 3.49 | 20 |
| **Duplicate (B9D1610-DUP2)** | | Prepared: 04/16/19 Analyzed: 04/17/19 | | | | **Source: FD11019-02** | | | | |
| **SM 2540 C** | | | | | | | | | | |
| Total Dissolved Solids | | 564 | 10 | mg/L | | 586 | | | 3.65 | 20 |

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California ELAP Certificate #1371

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| | | |
|---|---|---|
| MTA Environmental Division<br>2527 Fresno Street<br>Fresno CA, 93721 | **Project:** City of Visalia Water Conservation Plant<br>**Project Number:** A76404.03<br>**Project Manager:** Kirk Jacobsen | **Reported:**<br>04/24/2019 |

## Quality Control Sample Results - Metals (Dissolved)

| Analyte | Flag | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| **Batch - B9D1020** | | | | | | | | | | |
| **Blank (B9D1020-BLK1)** | | Prepared: 04/17/19 Analyzed: 04/19/19 | | | | | | | | |
| **EPA 200.7** | | | | | | | | | | |
| Calcium | | ND | 0.10 | mg/L | | | | | | |
| Magnesium | | ND | 0.10 | mg/L | | | | | | |
| Potassium | | ND | 1.0 | mg/L | | | | | | |
| Sodium | | ND | 1.0 | mg/L | | | | | | |
| **LCS (B9D1020-BS1)** | | Prepared: 04/17/19 Analyzed: 04/19/19 | | | | | | | | |
| **EPA 200.7** | | | | | | | | | | |
| Calcium | | 0.957 | 0.10 | mg/L | 1.00 | | 95.7 | 85-115 | | |
| Magnesium | | 1.94 | 0.10 | mg/L | 2.00 | | 97.0 | 85-115 | | |
| Potassium | | 1.97 | 1.0 | mg/L | 2.00 | | 98.5 | 85-115 | | |
| Sodium | | 2.01 | 1.0 | mg/L | 2.00 | | 101 | 85-115 | | |
| **LCS Dup (B9D1020-BSD1)** | | Prepared: 04/17/19 Analyzed: 04/19/19 | | | | | | | | |
| **EPA 200.7** | | | | | | | | | | |
| Calcium | | 0.955 | 0.10 | mg/L | 1.00 | | 95.5 | 85-115 | 0.240 | 20 |
| Magnesium | | 1.95 | 0.10 | mg/L | 2.00 | | 97.7 | 85-115 | 0.749 | 20 |
| Potassium | | 2.02 | 1.0 | mg/L | 2.00 | | 101 | 85-115 | 2.34 | 20 |
| Sodium | | 2.03 | 1.0 | mg/L | 2.00 | | 102 | 85-115 | 0.971 | 20 |

## Notes and Definitions

| | |
|---|---|
| J | Detected but below the Reporting Limit; therefore, result is an estimated concentration ( CLP J-Flag). Same as DNQ - Detected, but Not Quantified. |
| µg/L | micrograms per liter (parts per billion concentration units) |
| mg/L | milligrams per liter (parts per million concentration units) |
| mg/kg | milligrams per kilogram (parts per million concentration units) |
| ND | Analyte NOT DETECTED at or above the reporting limit |
| RPD | Relative Percent Difference |
| | Analysis of pH, filtration, and residual chlorine is to take place immediately after sampling in the field. If the test was performed in the laboratory, the hold time was exceeded. **(for aqueous matrices only)** |

MOORE TWINING ASSOCIATES, INC.

ANALYTICAL CHEMISTRY DIVISION
CALIFORNIA ELAP CERTIFICATION # 1371

# CHAIN OF CUSTODY/ANALYSIS REQUEST

2527 FRESNO STREET • FRESNO, CA 93721 • PHONE (559) 268-7021 • FAX: (559) 268-0740

**WORK ORDER #:** ED10003
**PAGE** 1 **OF** 2

| REPORT TO: | X INVOICE TO: X REPORT COPY TO: | REPORTING: |
|---|---|---|
| ATTENTION: Kirk Jacobsen | ATTENTION: Kirk Jacobsen | X STANDARD FORMAT |
| NAME: Moore Twining Associates | NAME: Moore Twining Associates | ☐ EDT (STATE FORM) |
| ADDRESS: 2527 Fresno Street | ADDRESS: 2527 Fresno Street | ☐ GEOTRACKER/COELT (LUFT) |
| Fresno, CA 93721 | Fresno, California 93721 | ☐ PDF ☐ EXCEL |
| PHONE: (559)268-7021 | PHONE: 559-268-7021 | ☐ County DHS : |
| FAX: (559)268-7126 | FAX: 559-268-7126 | ☐ Environmental Health Agency : |
| | | X OTHER: J Flag Report/Standard Excel |

**SAMPLE INFORMATION**

SAMPLED BY (PRINT): Joe Clark

SIGNATURE: [signature]

☐ PUBLIC SYSTEM ☐ ROUTINE
☐ PRIVATE WELL ☐ REPEAT
☐ OTHER ☐ REPLACEMENT

TURN AROUND TIME: ☐ RUSH, DUE ON:
☐ STANDARD

**SAMPLE TYPES:**

SOLID:
BS – BIOSOLID
CR – CERAMIC
SL – SOIL/SOLID

LIQUID:
DW - DRINKING WATER
GW - GROUND WATER
OL - OIL
SF - SURFACE WATER
ST - STORM WATER
WW – WASTE WATER

**PROJECT INFORMATION**

CONTRACT/P.O. NO.:

PROJECT: City of Visalia Water Conservation Plant

PROJECT NUMBER: A76404.03

CRWA MEMBER? YES ☐ NO☐

NOTES ON RECEIVED CONDITION:

☐ CUSTODY SEAL(S) BROKEN ☐ SAMPLE(S) DAMAGED

☐ ON ICE ☐ AMBIENT TEMP. ☐ INCORRECT PRESERVATION

**ANALYSIS REQUESTED**

| LAB USE | CLIENT SAMPLE ID | DATE | TIME | TYPE | pH, EC, TDS, TN | Ammonia | General Minerals (dissolved)* | | | | | | | | System Number / Station Code |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MW-J2 | 4/9/19 | 1053 | GW | X | X | X | | | | | | | | |
| 2 | MW-J3 | 4/9/19 | 1201 | GW | X | X | X | | | | | | | | |
| 3 | MW-K2 | 4/9/19 | 1322 | GW | X | X | X | | | | | | | | |
| 4 | MW-K3 | 4/9/19 | 1429 | GW | X | X | X | | | | | | | | |
| 5 | MW-S | 4/9/19 | 1519 | GW | X | X | X | | | | | | | | |

COMMENTS/ADDITIONAL INSTRUCTIONS: **Laboratory filter and preserve for metals upon receipt. SAMPLES HELD IN LAB FRIDGE OVERNIGHT**

* General Minerals – Total Alkalinity, Calcium, Chloride, Hardness, Potassium, Sodium, Sulfate, TDS, Nitrate, Cation/Anion Balance.

| RELINQUISHED BY | COMPANY | DATE | TIME | RECEIVED BY | COMPANY |
|---|---|---|---|---|---|
| [signature] | MTA | 4/10/19 | 1000 | [signature] | MTA |
| [signature] | MTA | 4/10/19 | 1005 | [signature] | MTA |

FL-SC-0005-02

Moore Twining Associates
WO# ED10003

MTA Bottles: (Yes) or No

Sample Integrity — Page 2 of 2

| COC Info | | |
|---|---|---|
| Was temperature within range? Chemistry ≤6°C Micro <10°C Temp 4.5 °C | (Yes) No N/A | |
| If samples were taken today, is there evidence that chilling has begun? Recvd ____ C° | (Yes) No N/A | |
| Did all bottles arrive unbroken and intact? | (Yes) No N/A | |
| Do samples have a hold time <72 hours? | (Yes) No N/A | |
| Did all bottle labels agree with COC? | (Yes) No N/A | |
| Was a sufficient amount of sample received? | (Yes) No N/A | |
| Were correct containers and preservatives received for the tests requested? | (Yes) No N/A | |
| Were there bubbles in VOA vials? **(Volatiles Only)** | Yes No (N/A) | |
| Was PM notified of discrepancies? PM: By/Time: | Yes No (N/A) | |

| Bottles Received | 1 | |
|---|---|---|
| 125ml (A) 250ml (B) 1Liter (C) 40ml VOA (V) | | |
| Bacti $Na_2S_2O_3$ | 1-C1-B | |
| None (P) | | |
| Cr6 Buffer (P) Borate Carbonate Buffer | | |
| $HNO_3$ (P) | 1-A | |
| $H_2SO_4$ (P) | 1-A | |
| NaOH (P) | | |
| NaOH+ZnAc (P) | | |
| Dissolved Oxygen 300ml (P) | | |
| None (AG) | | |
| None (CG) 500ml | | |
| $Na_2S_2O_3$ 250ml (Brown P) 549 | | |
| $Na_2S_2O_3$ (AG) | | |
| $Na_2S_2O_3$ (AG) | | |
| Thio/K Citrate | | |
| $NH_4Cl$ (AG) 552 | | |
| HCl (AG) | | |
| None (CG) 500ml | | |
| $H_3PO_4$ (AG) | | |
| Other: | | |
| Plastic Bag | | |
| Low Level Hg/Metals Double Bag | | |
| Client Own | | |
| Glass Jar: 125/ 250/ 500 | | |
| Soil Tube: Brass/ Steel/ Plastic | | |
| 5 g Encore | | |

| Filter or Split | Container | Preservative | Date/Time/Initials |
|---|---|---|---|
| S P (F) | 125mL | HNO3 | 4-10-19 1105 [initials] |
| S P F | | | |
| S P F | | | |
| S P F | | | |
| S P F | | | |

Labeled by: [signature] @ ______

Labels checked by: [signature] @ 1100

FL-SC-0003-06

# APPENDIX C

FIELD RECORDS OF WATER SAMPLING

# FIELD RECORD OF WATER SAMPLING

Visalia Water Conservation Plant
Moore Twining Project No. A76404.02
Visalia, CA

---

Groundwater Sampling Event: 4/4/2019
Sampler's Name: Joe Clark

---

| | | | |
|---|---|---|---|
| Well Identification No. | MW- H2 | Depth to Water (ft. to TOC) | 119.46 |
| Casing Type/ Diameter: | 2" | Casing Water Column (ft) | 140.54 |
| Depth of Well (ft. bgs) | 260 | One Casing Volume (gal) | 23.05 |
| | | Three Casing Volumes (gal) | 69.15 |

| Date | Time | Temp (°C) | EC (µS/cm) | pH | Color | Odor | Purge Volume (Gallons) | Comments |
|---|---|---|---|---|---|---|---|---|
| 4/4/2019 | 1102 | | | | | | 0 | Begin Purge |
| | 1114 | 22.8 | 531 | 7.33 | Clear | no | 20 | Clear no odor |
| | 1126 | 23.1 | 529 | 8.28 | \| | \| | 40 | \| |
| | 1148 | 22.8 | 531 | 8.55 | \| | \| | 60 | \| |
| | 1200 | 22.5 | 529 | 8.59 | \| | \| | 80 | \| |
| | | | | | | | | |
| | | | | | | | | |

Total Purge Volume (Gallons): 80
Total Purge Time (min.): 58

Purge Volume Measurement: 5 - Gallon Bucket
Purge Rate (Gal./Min.): 1.38
Conversion Factors: 2" 0.164 gal/ft
4" 0.654 gal/ft

## RECORD OF SAMPLING

Sampling Method: Discharge Hose
Date of Sample: 4/4/2019
Sample Time: 1200
Sample Identification: MW- H2

Temp: 22.4
EC: 530
pH: 8.60

| Number of Samples | Container Types |
|---|---|
| 1 | 1 L non preserve |
| 1 | 125 ml HNO3 (field filtered) or |
| | 250ml non-preserve (not filtered) |
| 1 | 125 ml H2SO4 |
| | |
| | |

| Measured Parameter | Instrument Used | Instrument Serial No. | Source | Calibration Date |
|---|---|---|---|---|
| Water Level | Solinst Sounder | NA | MTA | |
| Temperature | YSI | NA | MTA | |
| EC | YSI | NA | MTA | |
| pH | YSI | NA | MTA | |

Notes: 1126 pump paused to cool, 1136 pump restarted

# FIELD RECORD OF WATER SAMPLING

Visalia Water Conservation Plant
Moore Twining Project No. A76404.02
Visalia, CA

Groundwater Sampling Event: 4/4/2019
Sampler's Name: Joe Clark

| | | | |
|---|---|---|---|
| Well Identification No. | MW- #3 | Depth to Water (ft. to TOC) | 165.29 |
| Casing Type/ Diameter: | 2" | Casing Water Column (ft) | 149.71 |
| Depth of Well (ft. bgs) | 315 | One Casing Volume (gal) | 24.55 |
| | | Three Casing Volumes (gal) | 73.65 |

| Date | Time | Temp (°C) | EC (µS/cm) | pH | Color | Odor | Purge Volume (Gallons) | Comments |
|---|---|---|---|---|---|---|---|---|
| 4/4/2019 | 1251 | | | | | | 0 | Begin Purge |
| | 1311 | 23.5 | 151 | 9.62 | Clear | no | 20 | Clear no odor |
| | 1331 | 23.5 | 143 | 9.64 | \| | \| | 40 | \| |
| | 1401 | 24.2 | 144 | 9.72 | \| | \| | 60 | \| |
| | 1421 | 24.0 | 144 | 9.68 | \| | \| | 80 | \| |
| | | | | | | | | |
| | | | | | | | | |

Total Purge Volume (Gallons): 80
Total Purge Time (min.): 90
Purge Volume Measurement: 5 - Gallon Bucket
Purge Rate (Gal./Min.): 0.89
Conversion Factors: 2" 0.164 gal/ft; 4" 0.654 gal/ft

## RECORD OF SAMPLING

Sampling Method: Discharge Hose
Date of Sample: 4/4/2019
Sample Time: 1421
Sample Identification: MW-

Temp: 24.2
EC: 143
pH: 9.67

| Number of Samples | Container Types |
|---|---|
| 1 | 1 L non preserve |
| 1 | 125 ml HNO3 (field filtered) or |
| | 250ml non-preserve (not filtered) |
| 1 | 125 ml H2SO4 |

| Measured Parameter | Instrument Used | Instrument Serial No. | Source | Calibration Date |
|---|---|---|---|---|
| Water Level | Solinst Sounder | NA | MTA | |
| Temperature | YSI | NA | MTA | |
| EC | YSI | NA | MTA | |
| pH | YSI | NA | MTA | |

Notes: 1331 pump paused to cool, 1341 pump restarted

# FIELD RECORD OF WATER SAMPLING

Visalia Water Conservation Plant
Moore Twining Project No. A76404.02
Visalia, CA

Groundwater Sampling Event: 4/9/2019
Sampler's Name: Joe Clark

| | | | |
|---|---|---|---|
| Well Identification No. | MW-J2 | Depth to Water (ft. to TOC) | 124.19 |
| Casing Type/ Diameter: | 2" | Casing Water Column (ft) | 120.81 |
| Depth of Well (ft. bgs) | 245 | One Casing Volume (gal) | 19.81 |
| | | Three Casing Volumes (gal) | 59.44 |

| Date | Time | Temp (°C) | EC (µS/cm) | pH | Color | Odor | Purge Volume (Gallons) | Comments |
|---|---|---|---|---|---|---|---|---|
| 4/9/2019 | 1001 | | | | | | 0 | Begin Purge |
| | 1014 | 23.8 | 713 | 6.55 | partly cloudy | no | 20 | partly cloudy, no odor |
| | 1027 | 23.1 | 730 | 7.50 | Clear | no | 40 | Clear no odor |
| | 1040 | 23.0 | 730 | 7.54 | \| | \| | 60 | \| |
| | 1053 | 23.0 | 727 | 7.58 | \| | \| | 80 | \| |
| | | | | | | | | |
| | | | | | | | | |

Total Purge Volume (Gallons): 80
Total Purge Time (min.): 52
Purge Volume Measurement: 5 - Gallon Bucket
Purge Rate (Gal./Min.): 1.54
Conversion Factors: 2" 0.164 gal/ft; 4" 0.654 gal/ft

## RECORD OF SAMPLING

Sampling Method: Discharge Hose
Date of Sample: 4/9/2019
Sample Time: 1053
Sample Identification: MW-J2

Temp: 23.1
EC: 723
pH: 7.58

| Number of Samples | Container Types |
|---|---|
| 1 | 1 L non preserve |
| 1 | 125 ml HNO3 (field filtered) or |
| | 250ml non-preserve (not filtered) |
| 1 | 125 ml H2SO4 |

| Measured Parameter | Instrument Used | Instrument Serial No. | Source | Calibration Date |
|---|---|---|---|---|
| Water Level | Solinst Sounder | NA | MTA | |
| Temperature | YSI | NA | MTA | |
| EC | YSI | NA | MTA | |
| pH | YSI | NA | MTA | |

Notes:

$\frac{1}{40} = \frac{x}{60}$

# FIELD RECORD OF WATER SAMPLING

Visalia Water Conservation Plant
Moore Twining Project No. A76404.02
Visalia, CA

Groundwater Sampling Event: 4/9/2019
Sampler's Name: Joe Clark

| | | | |
|---|---|---|---|
| Well Identification No. | MW-J3 | Depth to Water (ft. to TOC) | 149.96 |
| Casing Type/ Diameter: | 2" | Casing Water Column (ft) | 138.04 |
| Depth of Well (ft. bgs) | 288 | One Casing Volume (gal) | 22.64 |
| | | Three Casing Volumes (gal) | 67.92 |

| Date | Time | Temp ( °C) | EC (µS/cm) | pH | Color | Odor | Purge Volume (Gallons) | Comments |
|---|---|---|---|---|---|---|---|---|
| 4/9/2019 | 1105 | | | | | | 0 | Begin Purge |
| | 1119 | 23.6 | 161 | 9.14 | Clear | no | 20 | clear no odor |
| | 1133 | 23.7 | 140 | 9.40 | \| | \| | 40 | \| |
| | 1147 | 23.4 | 141 | 9.39 | \| | \| | 60 | \| |
| | 1201 | 23.6 | 141 | 9.39 | \| | \| | 80 | \| |
| | | | | | | | | |
| | | | | | | | | |

Total Purge Volume (Gallons): 80
Total Purge Time (min.): 56

Purge Volume Measurement: 5 - Gallon Bucket
Purge Rate (Gal./Min.): 1.43
Conversion Factors: 2" 0.164 gal/ft; 4" 0.654 gal/ft

## RECORD OF SAMPLING

Sampling Method : Discharge Hose
Date of Sample: 4/9/2019
Sample Time: 1201
Sample Identification: MW-

Temp: 23.5
EC: 142
pH: 9.40

| Number of Samples | Container Types |
|---|---|
| 1 | 1 L non preserve |
| 1 | 125 ml HNO3 (field filtered) or 250ml non-preserve (not filtered) |
| 1 | 125 ml H2SO4 |

| Measured Parameter | Instrument Used | Instrument Serial No. | Source | Calibration Date |
|---|---|---|---|---|
| Water Level | Solinst Sounder | NA | MTA | |
| Temperature | YSI | NA | MTA | |
| EC | YSI | NA | MTA | |
| pH | YSI | NA | MTA | |

Notes:

# FIELD RECORD OF WATER SAMPLING

Visalia Water Conservation Plant
Moore Twining Project No. A76404.02
Visalia, CA

Groundwater Sampling Event: 4/9/2019
Sampler's Name: Joe Clark

Well Identification No.: MW- K2
Casing Type/ Diameter: 2"
Depth of Well (ft. bgs): 252

Depth to Water (ft. to TOC): 123.38
Casing Water Column (ft): 128.62
One Casing Volume (gal): 21.09
Three Casing Volumes (gal): 63.28

| Date | Time | Temp (°C) | EC (µS/cm) | pH | Color | Odor | Purge Volume (Gallons) | Comments |
|---|---|---|---|---|---|---|---|---|
| 4/9/2019 | 1230 | | | | | | 0 | Begin Purge |
| | 1243 | 22.6 | 534 | 6.88 | Clear | no | 20 | Clear no odor |
| | 1256 | 22.2 | 533 | 7.54 | \| | \| | 40 | \| |
| | 1309 | 22.1 | 529 | 7.84 | \| | \| | 60 | \| |
| | 1322 | 22.3 | 529 | 7.92 | \| | \| | 80 | \| |
| | | | | | | | | |
| | | | | | | | | |

Total Purge Volume (Gallons): 80
Total Purge Time (min.): 52

Purge Volume Measurement: 5 - Gallon Bucket
Purge Rate (Gal./Min.): 1.54
Conversion Factors: 2" 0.164 gal/ft; 4" 0.654 gal/ft

## RECORD OF SAMPLING

Sampling Method: Discharge Hose
Date of Sample: 4/9/2019
Sample Time: 1322
Sample Identification: MW- K2

Temp: 22.1
EC: 525
pH: 7.96

| Number of Samples | Container Types |
|---|---|
| 1 | 1 L non preserve |
| 1 | 125 ml HNO3 (field filtered) or |
| | 250ml non-preserve (not filtered) |
| 1 | 125 ml H2SO4 |

| Measured Parameter | Instrument Used | Instrument Serial No. | Source | Calibration Date |
|---|---|---|---|---|
| Water Level | Solinst Sounder | NA | MTA | |
| Temperature | YSI | NA | MTA | |
| EC | YSI | NA | MTA | |
| pH | YSI | NA | MTA | |

Notes:

# FIELD RECORD OF WATER SAMPLING

Visalia Water Conservation Plant
Moore Twining Project No. A76404.02
Visalia, CA

Groundwater Sampling Event: 4/9/2019
Sampler's Name: Joe Clark

| | | | |
|---|---|---|---|
| Well Identification No. | MW- K3 | Depth to Water (ft. to TOC) | 153.92 |
| Casing Type/ Diameter: | 2" | Casing Water Column (ft) | 120.08 |
| Depth of Well (ft. bgs) | 274 | One Casing Volume (gal) | 19.69 |
| | | Three Casing Volumes (gal) | 59.08 |

| Date | Time | Temp ( °C) | EC (µS/cm) | pH | Color | Odor | Purge Volume (Gallons) | Comments |
|---|---|---|---|---|---|---|---|---|
| 4/9/2019 | 1333 | | | | | | 0 | Begin Purge |
| | 1347 | 22.8 | 140 | 9.39 | Clear | no | 20 | Clear no odor |
| | 1401 | 23.0 | 130 | 9.51 | \| | \| | 40 | \| |
| | 1415 | 23.1 | 131 | 9.51 | \| | \| | 60 | \| |
| | 1429 | 23.1 | 131 | 9.52 | | | 80 | |
| | | | | | | | | |
| | | | | | | | | |

Total Purge Volume (Gallons): 80
Total Purge Time (min.): 56
Purge Volume Measurement: 5 - Gallon Bucket
Purge Rate (Gal./Min.): 1.43
Conversion Factors: 2" 0.164 gal/ft; 4" 0.654 gal/ft

## RECORD OF SAMPLING

Sampling Method : Discharge Hose
Date of Sample: 4/9/2019
Sample Time: 1429
Sample Identification: MW-

Temp: 23.0
EC: 132
pH: 9.51

| Number of Samples | Container Types |
|---|---|
| 1 | 1 L non preserve |
| 1 | 125 ml HNO3 (field filtered) or |
| | 250ml non-preserve (not filtered) |
| 1 | 125 ml H2SO4 |

| Measured Parameter | Instrument Used | Instrument Serial No. | Source | Calibration Date |
|---|---|---|---|---|
| Water Level | Solinst Sounder | NA | MTA | |
| Temperature | YSI | NA | MTA | |
| EC | YSI | NA | MTA | |
| pH | YSI | NA | MTA | |

Notes:

## FIELD RECORD OF WATER SAMPLING

Visalia Water Conservation Plant
Moore Twining Project No. A76404.02
Visalia, CA

Groundwater Sampling Event: 4/2/2019
Sampler's Name: Joe Clark

Well Identification No.: MW-N
Casing Type/ Diameter: 2"
Depth of Well (ft. bgs): 158

Depth to Water (ft. to TOC): 138.84
Casing Water Column (ft): 22.16
One Casing Volume (gal): 3.63
Three Casing Volumes (gal): 10.90

| Date | Time | Temp (°C) | EC (µS/cm) | pH | Color | Odor | Purge Volume (Gallons) | Comments |
|---|---|---|---|---|---|---|---|---|
| 4/2/2019 | 1458 | | | | | | 0 | Begin Purge |
| | 1501 | 22.0 | 1014 | 7.50 | Cloudy | no | 3 | Cloudy no odor |
| | 1504 | 22.2 | 1028 | 7.37 | Partly Cloudy | no | 6 | partly Cloudy no odor |
| | 1507 | 22.0 | 1031 | 7.34 | mostly Clear | no | 9 | mostly Clear no odor |
| | 1510 | 21.8 | 1033 | 7.36 | Clear | no | 12 | Clear no odor |
| | | | | | | | | |
| | | | | | | | | |

Total Purge Volume (Gallons): 12
Total Purge Time (min.): 12

Purge Volume Measurement: 5 - Gallon Bucket
Purge Rate (Gal./Min.): 1
Conversion Factors: 2" 0.164 gal/ft
4" 0.654 gal/ft

### RECORD OF SAMPLING

Sampling Method : Discharge Hose
Date of Sample: 4/2/2019
Sample Time: 1510
Sample Identification: MW-

Temp: 21.9
EC: 1031
pH: 7.35

Number of Samples / Container Types:

| Number of Samples | Container Types |
|---|---|
| 1 | 1 L non preserve |
| 1 | 125 ml HNO3 (field filtered) or |
| | 250ml non-preserve (not filtered) |
| 1 | 125 ml H2SO4 |
| | |
| | |

| Measured Parameter | Instrument Used | Instrument Serial No. | Source | Calibration Date |
|---|---|---|---|---|
| Water Level | Solinst Sounder | NA | MTA | |
| Temperature | YSI | NA | MTA | |
| EC | YSI | NA | MTA | |
| pH | YSI | NA | MTA | |

Notes:

# FIELD RECORD OF WATER SAMPLING

Visalia Water Conservation Plant
Moore Twining Project No. A76404.02
Visalia, CA

Groundwater Sampling Event: 4/2/2019
Sampler's Name: Joe Clark

Well Identification No.: MW- 0
Casing Type/ Diameter: 2"
Depth of Well (ft. bgs): 143.00

Depth to Water (ft. to TOC): 124.59
Casing Water Column (ft): 18.41
One Casing Volume (gal): 3.02
Three Casing Volumes (gal): 9.06

| Date | Time | Temp (°C) | EC (µS/cm) | pH | Color | Odor | Purge Volume (Gallons) | Comments |
|---|---|---|---|---|---|---|---|---|
| 4/2/2019 | 1004 | | | | | | 0 | Begin Purge |
| | 1006 | 23.2 | 861 | 6.67 | Cloudy | no | 2 | Cloudy, no odor |
| | 1008 | 23.1 | 869 | 6.87 | | | 4 | |
| | 1010 | 23.2 | 867 | 7.01 | | | 6 | |
| | 1012 | 23.2 | 870 | 7.06 | | | 8 | |
| | 1014 | 23.2 | 871 | 7.12 | | | 10 | |
| | | | | | | | | |

Total Purge Volume (Gallons): 10
Total Purge Time (min.): 10

Purge Volume Measurement: 5 - Gallon Bucket
Purge Rate (Gal./Min.): 1
Conversion Factors: 2" 0.164 gal/ft
4" 0.654 gal/ft

## RECORD OF SAMPLING

Sampling Method: Discharge Hose
Date of Sample: 4/2/2019
Sample Time: 1014
Sample Identification: MW- 0

Temp: 22.9
EC: 873
pH: 7.15

| Number of Samples | Container Types |
|---|---|
| 1 | 1 L non preserve |
| 1 | 125 ml HNO3 (field filtered) or |
| | 250ml non-preserve (not filtered) |
| 1 | 125 ml H2SO4 |
| | |
| | |

| Measured Parameter | Instrument Used | Instrument Serial No. | Source | Calibration Date |
|---|---|---|---|---|
| Water Level | Solinst Sounder | NA | MTA | |
| Temperature | YSI | NA | MTA | |
| EC | YSI | NA | MTA | |
| pH | YSI | NA | MTA | |

Notes:

# FIELD RECORD OF WATER SAMPLING

Visalia Water Conservation Plant
Moore Twining Project No. A76404.02
Visalia, CA

Groundwater Sampling Event: 4/3/2019
Sampler's Name: Joe Clark

| | | | |
|---|---|---|---|
| Well Identification No. | MW- P | Depth to Water (ft. to TOC) | 92.98 |
| Casing Type/ Diameter: | 2 | Casing Water Column (ft) | 67.02 |
| Depth of Well (ft. bgs) | 160 | One Casing Volume (gal) | 10.99 |
| | | Three Casing Volumes (gal) | 32.97 |

| Date | Time | Temp (°C) | EC (µS/cm) | pH | Color | Odor | Purge Volume (Gallons) | Comments |
|---|---|---|---|---|---|---|---|---|
| 4/3/2019 | 0933 | | | | | | 0 | Begin Purge |
| | 0938 | 20.1 | 799 | 6.91 | partly cloudy | no | 10 | partly cloudy no odor |
| | 0943 | 20.3 | 804 | 7.12 | mostly clear | no | 20 | mostly clear no odor |
| | 0948 | 20.3 | 806 | 7.19 | clear | no | 30 | clear no odor |
| | 0953 | 20.5 | 806 | 7.22 | \| | \| | 40 | \| |
| | | | | | | | | |
| | | | | | | | | |

Total Purge Volume (Gallons): 40
Total Purge Time (min.): 20
Purge Volume Measurement: 5 - Gallon Bucket
Purge Rate (Gal./Min.): 2
Conversion Factors: 2" 0.164 gal/ft; 4" 0.654 gal/ft

## RECORD OF SAMPLING

Sampling Method: Discharge Hose
Date of Sample: 4/3/2019
Sample Time: 0953
Sample Identification: MW- P

Temp: 20.5
EC: 807
pH: 7.27

| Number of Samples | Container Types |
|---|---|
| 1 | 1 L non preserve |
| 1 | 125 ml HNO3 (field filtered) or |
| | 250ml non-preserve (not filtered) |
| 1 | 125 ml H2SO4 |
| | |
| | |

| Measured Parameter | Instrument Used | Instrument Serial No. | Source | Calibration Date |
|---|---|---|---|---|
| Water Level | Solinst Sounder | NA | MTA | |
| Temperature | YSI | NA | MTA | |
| EC | YSI | NA | MTA | |
| pH | YSI | NA | MTA | |

Notes:

# FIELD RECORD OF WATER SAMPLING

Visalia Water Conservation Plant
Moore Twining Project No. A76404.02
Visalia, CA

Groundwater Sampling Event: 4/4/2019
Sampler's Name: Joe Clark

Well Identification No. MW- Q
Casing Type/ Diameter: 2"
Depth of Well (ft. bgs) 160

Depth to Water (ft. to TOC) 87.78
Casing Water Column (ft) 72.22
One Casing Volume (gal) 11.84
Three Casing Volumes (gal) 35.53

| Date | Time | Temp (°C) | EC (µS/cm) | pH | Color | Odor | Purge Volume (Gallons) | Comments |
|---|---|---|---|---|---|---|---|---|
| 4/4/2019 | 0954 | | | | | | 0 | Begin Purge |
| | 1000 | 23.1 | 603 | 6.91 | Clear | no | 10 | Clear no odor |
| | 1006 | 23.2 | 607 | 7.12 | \| | \| | 20 | \| |
| | 1012 | 23.2 | 609 | 7.24 | \| | \| | 30 | \| |
| | 1018 | 23.2 | 610 | 7.26 | \| | \| | 40 | |
| | | | | | | | | |
| | | | | | | | | |

Total Purge Volume (Gallons) 40
Total Purge Time (min.) 24

Purge Volume Measurement: 5 - Gallon Bucket
Purge Rate (Gal./Min.) 1.42
Conversion Factors: 2" 0.164 gal/ft
4" 0.654 gal/ft

## RECORD OF SAMPLING

Sampling Method : Discharge Hose
Date of Sample 4/4/2019
Sample Time 1018
Sample Identification MW- Q

Temp 23.2
EC 610
pH 7.28

| Number of Samples | Container Types |
|---|---|
| 1 | 1 L non preserve |
| 1 | 125 ml HNO3 (field filtered) or |
| | 250ml non-preserve (not filtered) |
| 1 | 125 ml H2SO4 |
| | |
| | |

| Measured Parameter | Instrument Used | Instrument Serial No. | Source | Calibration Date |
|---|---|---|---|---|
| Water Level | Solinst Sounder | NA | MTA | |
| Temperature | YSI | NA | MTA | |
| EC | YSI | NA | MTA | |
| pH | YSI | NA | MTA | |

Notes:

## FIELD RECORD OF WATER SAMPLING

Visalia Water Conservation Plant
Moore Twining Project No. A76404.02
Visalia, CA

Groundwater Sampling Event 4/2/2019
Sampler's Name Joe Clark

Well Identification No. MW- R
Casing Type/ Diameter: 2"
Depth of Well (ft. bgs) 143

Depth to Water (ft. to TOC) 125.68
Casing Water Column (ft) 17.32
One Casing Volume (gal) 2.84
Three Casing Volumes (gal) 8.52

| Date | Time | Temp (°C) | EC (µS/cm) | pH | Color | Odor | Purge Volume (Gallons) | Comments |
|---|---|---|---|---|---|---|---|---|
| 4/2/2019 | 1109 | | | | | | 0 | Begin Purge |
| | 1112 | 23.8 | 793 | 7.41 | Cloudy | no | 3 | Cloudy no odor |
| 1125 | ~~1115~~ | 24.7 | 799 | 7.41 | | | 6 | |
| 1138 | ~~1114~~ | 25.1 | 810 | 7.51 | | | 9 | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

Total Purge Volume (Gallons) 9
Total Purge Time (min.) 29
Purge Volume Measurement: 5 - Gallon Bucket
Purge Rate (Gal./Min.) 0.31
Conversion Factors: 2" 0.164 gal/ft
4" 0.654 gal/ft

## RECORD OF SAMPLING

Sampling Method : ~~Discharge Hose~~ disposable bailer
Date of Sample 4/2/2019
Sample Time ~~1118~~ 1151
Sample Identification MW- R

Temp 22.3
EC 804
pH 7.54

Number of Samples: 1, 1, 1

Container Types:
- 1 L non preserve
- 125 ml HNO3 (field filtered) or 250ml non-preserve (not filtered)
- 125 ml H2SO4

| Measured Parameter | Instrument Used | Instrument Serial No. | Source | Calibration Date |
|---|---|---|---|---|
| Water Level | Solinst Sounder | NA | MTA | |
| Temperature | YSI | NA | MTA | |
| EC | YSI | NA | MTA | |
| pH | YSI | NA | MTA | |

Notes: 1114 ~~well dry~~ pump stopped
1119 well sounded @ 125.71
1122 pump restarted
1125 pump stopped again, sounded @ 125.68
1133 pump restarted @ slower speed
1138. pump stopped before sample obtained
well sampled w/ bailer

# FIELD RECORD OF WATER SAMPLING

Visalia Water Conservation Plant
Moore Twining Project No. A76404.02
Visalia, CA

Groundwater Sampling Event 4/9/2019
Sampler's Name Joe Clark

Well Identification No. MW- 5
Casing Type/ Diameter: 2
Depth of Well (ft. bgs) 146

Depth to Water (ft. to TOC) 104.52
Casing Water Column (ft) 41.48
One Casing Volume (gal) 6.80
Three Casing Volumes (gal) 20.41

| Date | Time | Temp (°C) | EC (µS/cm) | pH | Color | Odor | Purge Volume (Gallons) | Comments |
|---|---|---|---|---|---|---|---|---|
| 4/9/2019 | 1503 | | | | | | 0 | Begin Purge |
| | 1507 | 22.1 | 1428 | 7.08 | Cloudy | no | 8 | Cloudy no odor |
| | 1511 | 22.1 | 1437 | 7.15 | partly cloudy | no | 16 | partly cloudy no odor |
| | 1515 | 22.0 | 1434 | 7.15 | Clear | no | 24 | Clear no odor |
| | 1519 | 22.1 | 1428 | 7.12 | \ | \ | 32 | \ |
| | | | | | | | | |
| | | | | | | | | |

Total Purge Volume (Gallons) 33
Total Purge Time (min.) 16

Purge Volume Measurement: 5 - Gallon Bucket
Purge Rate (Gal./Min.) 2
Conversion Factors: 2" 0.164 gal/ft
4" 0.654 gal/ft

## RECORD OF SAMPLING

Sampling Method : Discharge Hose
Date of Sample 4/9/2019
Sample Time 1519
Sample Identification MW- 5

Temp 22.2
EC 1430
pH 7.15

Number of Samples / Container Types

| Number of Samples | Container Types |
|---|---|
| 1 | 1 L non preserve |
| 1 | 125 ml HNO3 (field filtered) or |
| | 250ml non-preserve (not filtered) |
| 1 | 125 ml H2SO4 |
| | |
| | |

| Measured Parameter | Instrument Used | Instrument Serial No. | Source | Calibration Date |
|---|---|---|---|---|
| Water Level | Solinst Sounder | NA | MTA | |
| Temperature | YSI | NA | MTA | |
| EC | YSI | NA | MTA | |
| pH | YSI | NA | MTA | |

Notes:

**APPENDIX D**

STANDARD OPERATING PROCEDURES

## STANDARD OPERATING PROCEDURES

**Standard Operating Procedures for Groundwater Monitoring Well Sampling:** Standard operating procedures (SOPs) used by Moore Twining Associates, Inc. (Moore Twining) when sampling groundwater monitoring wells are presented below. Moore Twining observes these procedures in order to obtain consistent, reliable data.

Groundwater sampling will be performed a minimum of 24 hours following development, or when the post-development water level in the well has returned to the static level. Before purging and sampling is performed, the depth to water and the total well depth will be measured. If floating hydrocarbons are suspected, a bottom-filling clear bailer, or hydrocarbon-detecting paste bailer, or interface probe may be used to record floating hydrocarbon thickness. Depth to water will be measured with an electric sounder, according to Moore Twining's "Standard Operating Procedures for Measuring Depths to Water and Calculating Groundwater Elevations".

Prior to sampling a monitoring well, a minimum of 3 well casing volumes will be purged using a clean, stainless steel submersible pump or a disposable bailer equipped with a length of new rope. Disposable bailers and rope lengths will be used once, and discarded. After 3 casing volumes of water have been removed from the well, purging will continue until measured field parameters (pH, specific electrical conductivity, and temperature) have stabilized. Purging data will be recorded on the Well Sampling log.

Some monitoring wells are expected to be evacuated to dryness after removing fewer than three casing volumes. These low-yield monitoring wells will be allowed to recharge for as long as 24 hours. Samples will be collected as soon as the monitoring wells have recharged sufficiently to allow sample collection. If insufficient water has recharged after 24 hours, the monitoring well will be recorded as "dry" for the sampling event.

Purged water will be containerized in Department of Transportation-approved drums, and stored on site in an area inaccessible to the general public. The purged water is typically characterized either by sampling, or on the basis of the groundwater sample analytical results. Moore Twining can recommend an appropriate method for disposition of the purged water. Disposal will be the responsibility of the client.

Water samples will be transferred into sample containers supplied by the analytical laboratory. Sample containers will be labeled and placed in an ice-cooled chest, equipped with a thermometer, for transport to the laboratory. The temperature inside the ice-cooled chest will be recorded on chain of custody documents when samples are placed in the chest, and when they are received by the laboratory. Samples will be maintained at a temperature of approximately 4 degrees Centigrade.

**Standard Operating Procedures for Equipment Decontamination:** Proper decontamination procedures reduce the potential for: cross-contamination among sample locations; and introduction of contamination from outside sources. Sampling equipment and any tools, measuring devices, or other equipment which will contact soil, groundwater, or any media being assessed will be washed in a low-phosphate soap and water solution, and rinsed in clean water before each use. The type of soap used will depend upon project requirements.

Standard Operating Procedures for Sample Handling and Chain-of-Custody: Records are developed for samples which include: sampling date, sample type, location, job number, name of sampling personnel, and method of preservation. Each sample container is labeled immediately following collection. Chain-of-custody protocol, as described in United States Environmental Protection Agency, 1986, Test Methods for Evaluating Solid Waste, SW-846, Third Edition, is followed. Samples will be maintained at approximately 4°C. Upon arrival at the laboratory, the samples will be preserved for analysis as appropriate.

Samples may be delivered to Moore Twining's chemistry laboratory in Fresno, California. The Moore Twining representative in charge of the field work transport or direct the transportation of the samples and custody forms to the laboratory, where the samples are transferred to the sample control department. A receiving clerk, or an authorized analyst, signs the custody forms, present a duplicate copy to the Moore Twining representative, and transfers the samples to a laboratory analyst. The laboratory manager retains possession of the custody forms during analyses of the samples.

The laboratory manager's responsibilities include monitoring the sample integrity within the laboratory. This involves assigning each sample a laboratory number and maintaining cross-reference between the sample's field and laboratory identifications. The analysts' responsibilities include maintaining accurate records of the samples analyzed along with the analytical data produced. This involves labeling chromatograms and maintaining the laboratory numbers on sub-samples taken from the submitted samples, labeling glassware used in the analyses and properly labeling sample extract containers with each sample's laboratory number.

Following analyses, the samples are transferred to a limited-access storage room. Chain-of-custody forms, chromatograms, and other pertinent information are filed for future reference. Splits of samples analyzed are kept for 30 days. Samples containing hazardous concentrations will be returned to the client for disposal.

**Standard Operating Procedures for Laboratory Quality Assurance/Quality Control:** These laboratory QA/QC procedures were developed to reduce outside interferences during analyses of samples. The laboratory director is responsible for creating and maintaining the program. General QA/QC procedures follow:

- Analytical instruments are serviced on a regular basis to assure an accurate calibration;

- Organic-free water is monitored daily for quality;

- Gas chromatographs are calibrated daily;

- Method blanks are run to check whether the glassware and reagents are free of interference from chemicals that would invalidate the analyses;

- Standards are prepared using the applicable reference materials;

- Matrix spikes are analyzed in duplicate to validate the accuracy and precision of the method.

# Appendix 4B Tulare Irrigation District Groundwater Elevation Monitoring Plan

Tulare Irrigation District

# Groundwater Elevation Monitoring Plan

December 2011

# Table of Contents

# DISTRICT BACKGROUND

## History

The Tulare Irrigation District (District) is a political subdivision of the State of California, which operates as an independent agency under the California Water Code. The District was formed in 1889 as one of the first irrigation districts in the state of California to manage the supply of irrigation water to farmers within the District. The use of surface water within the basin is on a conjunctive use basis where water supplies from the Kaweah River and the Friant Unit of the Central Valley Project help offset groundwater pumping. The District received its Federal contract from the United States Bureau of Reclamation in 1950 for an imported water supply to bolster conjunctive user operations within the District. Over the last 50 plus years the District has been monitoring depth to groundwater levels and providing conjunctive use operations for farmers and residents within the District.

## Location

The District is located in western Tulare County on the eastern part of the San Joaquin Valley, about 20 miles west of the Sierra Nevada foothills, approximately 50 miles southeast of the City of Fresno and approximately 65 miles northwest of the City of Bakersfield. The District covers approximately 77,000 acres (120 square miles) and is completely within Tulare County. The total service area within the District is approximately 65,000 acres, with 62,000 being irrigable. Recently as the City of Tulare has grown, some areas that were crops have been converted to urban development and have detached from the District. Also, a significant number of dairies have been developed in the District. Both of these developments have reduced the cropped acreage within the District.

## Water Supplies

The District's average annual surface water supply from 1988 to 2008 was approximately 163,400 acre-feet of water, which is comprised of entitlements on the Kaweah River and contract water from the Friant division of the Central Valley Project (CVP). The average yield of Kaweah River rights is approximately 75,000 acre-feet. The District has a Class 1 contract with the Bureau of Reclamation for 30,000 acre-feet and a Class 2 contract for 141,000 acre feet of water annually. The District's surface water supplies can vary widely from year to year. In the recent past, supplies have ranged from a low of about 40,000 acre-feet in 2007 to a high of 340,000 acre-feet in 2011. It is in such wetter years that the District is heavily engaged in groundwater efforts, devoting more than half of its water supplies to such direct recharge program through utilization of groundwater recharge facilities

The agricultural demands within the District were estimated to be approximately 221,500 acre-feet per year in 2002. However, in recent years, the District has experienced a significant shift in cropped acreage away from cotton and towards crops that support the dairy industry. These crops typically require more water therefore the average annual water demand within the District may be increasing. Agricultural demand that is beyond the surface water supplied by the District is met by groundwater pumping. The District does not operate any groundwater wells as a source of irrigation supply to landowners. Each individual landowner must provide his/her own groundwater well(s) to sustain irrigation practices when surface water supplies are not available.

In addition to landowner extraction wells, the City of Tulare own and operates a municipal well field to serve its inhabitants. This well field is situated within the confines of the District's service area and the City extracts approximately 18,000 acre-feet annually for residential, commercial and industrial uses.

## District Facilities

The District operates a vast system of unlined earthen channels with reinforced concrete control structures and road crossings. Collectively the District owns and operates over 300 miles of earthen canals and ditches. The District also owns and operates approximately 30 miles of pipeline. The diversions points from the Kaweah River System and the Friant-Kern Canal that the District utilizes are located approximately 15 miles northeast of the District. Water from the Kaweah system and the Friant system are generally diverted into the District Main Intake Canal. The water is brought into the District at the northeast corner of the District. A system of canals and pipelines has been established within the District that serve water to a vast majority of the landowners within the District. The District utilizes approximately 535 farm gate turnouts to deliver water to landowners.  This District also operates approximately 12 recharge basins (approximately 1,200 acres).

## District Geology

The District is located entirely within the confines of the San Joaquin Valley. The San Joaquin Valley is a large asymmetric structural trough that has been receiving sediments from the Sierra-Nevada Mountains to the east and from the Coast Ranges to the west. In the area of TID, these sediments and corresponding structures control the direction of groundwater flow and the quality of groundwater available to wells. In general, TID is underlain by (oldest to youngest) basement rocks, unconsolidated deposits, and topsoil.

### Groundwater Basin

TID is located in the Tulare Lake Hydrologic Region, which covers 10.9 million acres (17,000 square miles) and includes all of Kings and Tulare Counties and most of Fresno and Kern Counties. The Tulare Lake Hydrologic Region has 12 distinct groundwater basins and 7 sub-basins. TID is located in the Kaweah sub-basin of the San Joaquin Valley Groundwater Basin. The San Joaquin Valley Groundwater Basin is surrounded on the west by the Coast Range, on the south by the San Emigdio and Tehachapi Mountains, on the east by the Sierra Nevada Mountains and on the north by the Sacramento-San Joaquin Delta and Sacramento Valley. General information on the San Joaquin Valley Basin and Kaweah sub-basin can be found in the California Department of Water Resources Groundwater Bulletin (2003 update).

The Kaweah sub-basin lies between the Kings Groundwater sub-basin on the north, the Tule Groundwater sub-basin on the south, the crystalline bedrock of the Sierra Nevada foothills on the east and the Tulare Lake sub-basin on the west. The Kaweah sub-basin boundaries are similar to those for the Kaweah Delta Water Conservation District (KDWCD). Major rivers and streams in the sub-basin include the Lower Kaweah and St. Johns Rivers. The Kaweah River is considered a primary surface water source for groundwater recharge to the area. In the 1980 California Groundwater Bulletin 118 (DWR, 1980), the California Department of Water Resources (DWR) classified the Kaweah sub-basin as being critically overdrafted. This designation was not reevaluated by DWR when Bulletin 118 was updated in 2003. (However, recent analysis by Fugro (2007) still shows the basin to be in a state of overdraft). DWR has assigned the sub basin a 'Type B' groundwater budget, which means that enough data is available to estimate the groundwater extraction to meet the local water needs, but not enough data is available to characterize the groundwater budget.

According to DWR (2003), well yields in the Kaweah sub-basin are 1,000 to 2,000 gpm, with a maximum of 2,500 gpm. The total dissolved solids in the groundwater ranges from 35-580 mg/L with an average of 189 mg/L.

## Physiography of the District

The San Joaquin Valley, which is the southerly part of the great Central Valley of California, extends from the Sacramento-San Joaquin Delta area on the north about 250 miles to the Tehachapi Mountains on the south. In the vicinity of the District, it is approximately 65 miles wide. The Valley is bordered on the east by the Sierra Nevada Mountains, which range in elevation from about 1,000 feet or less to more than 14,000 feet above sea level. The Coast Range Mountains, which borders the Valley on the west, rises to about 6,000 feet above sea level. The southern end of the San Joaquin Valley, also known as the Tulare Basin, is a closed feature, with water flowing out of the basin only in extreme wet periods. Tributary streams drain to depressions, the largest of which is Tulare Lake bed located to the west of the District's boundary. The Kings River, Kaweah River, Tule River, White River, Deer Creek, Lewis Creek and Poso Creek, and, on occasion, the Kern River, discharge into Tulare Lake at times when flows exceed the capacity of foothill reservoirs and of the irrigation and recharge diversion systems.

Water level fluctuations in the Tulare Lake waters have been common, and it is reasonable to assume that the process has been taking place for many centuries. During years of heavy precipitation and run-off, before levees were constructed, large volumes of water accumulated in Tulare Lake, and as the relief is very low, the area of the lake fluctuated widely with slight changes in depth of water. Through the years, very little water has escaped from the lake by overflow; most has evaporated or been absorbed by the sands and silts of the lake bottom. Dissolved salts brought in by tributary streams have, in this way, been concentrated. Currently, much less water accumulates in the Lake from runoff due to the construction of several dams and numerous irrigation diversions, and much of the land in the Lakebed is now cropped.

**Stratigraphy**

The following discussion focuses on significant hydrogeologic units that could have an impact on the groundwater resources within the District. Stratigraphy in the District is documented in several reports. The description below is based primarily on the information provided in Technical Studies in Support of the Factual Report – Tulare Irrigation District (USBR, February 1949). The generalized stratigraphic sequence of the District includes topsoil, a water bearing series and a non-water bearing series. Attached in Appendix E is a Hyrdogeologic Section through Kings and Tulare County which shows the general layers of material below the District.

**Topsoil**

Soils in the District are generally favorable for irrigated agriculture with regards to depth, texture and freedom from gravel, stones, or hardpan. According to the Natural Resources Conservation Service Soil Survey for Western Tulare County (2007), most of the District is comprised of loam or sandy loam. The primary soil types include Colpien loam, Nord fine sandy loam, and Gambogy loam. According to the TID Factual Report (March 1949), about 80 percent of the District’s land is affected by varying concentrations of alkali, which has resulted from former high water table conditions.

**Water Bearing Series**

The water-bearing series consists of alluvial fans and lake beds of late Tertiary and Quaternary geologic age which form the groundwater reservoir of the District and adjacent areas. They consist generally of the Delano beds, the Kern River formation, and Young Alluvium. For the purpose of this study, the Kern River Series has been divided into the lower "Kern River formation", and an upper portion, the "Delano beds". Clay beds apparently formed in relatively still lakes are included within the latter. The water-bearing sediments form a huge wedge, thickest near the western edge of the San Joaquin Valley and thinnest along the mountain front to the east.

**Kern River Series.** The Kern River formation, in this discussion, includes all known or suspected local sediments older than the Delano beds. Sediments of the Kern River Formation crop out south of Tule River where they disappear northerly beneath the Delano beds. Aquifers in this formation presumably contribute water to the deeper wells. The lithology is similar to the Delano Beds described below. The Delano Beds consist of fluvial sands, silts, sandy clays, and clays, in part lacustrine, with a few thin lenses of gravel. They crop out east of the District in the area of Lindsay. The sands are generally arkosic, angular to subangular, friable to loose, poorly sorted, and of various shades of reddish-brown, tan and gray.

**Young Alluvium.** This material forms the fans, floodplains, and channels of the present streams. It resembles the Delano beds, but being younger is not so deeply weathered.

Soils developed in Young Alluvium are generally open and porous, but on the outer fringes of the fans of Tule and Kaweah Rivers and in interfan areas between distributaries of the Kaweah Branch, dense subsoils correspond to areas formerly having a high water table and restricted surface drainage.

Younger alluvium consists of gravelly sand, silty sand, silt, and clay deposited along stream channels and laterally away from the channels in the westerly portion of the District. Younger alluvium is relatively thin locally, reaching a maximum depth below ground surface of perhaps 100 feet. The Young Alluvium is generally above the water table and does not constitute a major water-bearing unit.

Soils developed on the Young Alluvium do not show multiple soil horizons (layers) and are generally free of underlying clay subsoil or hardpan. Because percolation rates through the Young Alluvium are moderate to high, this deposit serves as a permeable conveyance system for recharge to underlying water-bearing materials.

**Clay Layers.** The westerly two-thirds of the District is largely underlain by the socalled Corcoran Clay or E-Clay, which separates a generally unconfined aquifer system above and a confined aquifer system below.  Irrigation wells in the District's area are generally perforated in both systems.

Although as many as six laterally continuous clay zones have locally been defined in the southern San Joaquin Valley, only the most prominent of thesE-Clay zones known as the E-Clay (or Corcoran Clay member) is found within the District. The E-Clay is one of the largest confining bodies in the area and underlies about 1,000 square miles of the San Joaquin Valley. The beds were deposited in a lake that occupied the San Joaquin Valley trough and which varied from 10 to 40 miles in width and was more than 200 miles in length (Davis et al., 1957).

The E-Clay extends from Tulare Lake Bed to U.S. Highway 99 and is vertically bifurcated near Goshen. It is about 140 feet thick near Corcoran and the average thickness is about 75 feet. The deposits near the City of Corcoran are probably the thickest section in the San Joaquin Valley. The Corcoran Clay is generally used to differentiate between a lower confined aquifer and an upper unconfined aquifer west of its eastern extent.

As mapped by Page (1986), the E-Clay (or Corcoran Clay) underlies the majority of the District. Pages' mapping extends the eastern limit of the Corcoran Clay in the vicinity of the plan area from earlier studies by Davis et. al. (1957), and Croft (1968). Later mapping of the Corcoran Clay by R. S. Brown (1981) of the California Department of Water Resources, is in large part similar to Pages (1986) mapping, and as such his description is used here. All of the sources consulted for this study agree that the Corcoran Clay dips and thickens southwest beneath the District. The depth to the top is questionable in the northeast portion of the plan area, but appears to be between 200 to 300 feet deep there, dipping to depths of 400 feet beneath the southwest part of the District. While information on thickness is incomplete in the District, it does show that the Corcoran Clay thickens from about 20 feet thick in the northeast to about 40 feet thick in the southwest portion of the District, and locally maybe as much as 60 feet thick.

A Hydrogeologic Section through Kings and Tulare County is included in Appendix E. The location of the E-Clay is depicted in the section.

**Alluvial Fans.** TID is located on the recent and still growing alluvial fan of the Kaweah and St. Johns Rivers. The Tule River alluvial fan approaches to about two miles southeast of the District. The alluvial fan slopes generally southwesterly at 7 to 8 feet per mile in the northeastern half of the district. Land classification studies show the soils in this area to be generally light-textured. The southwestern half of the District slopes southwesterly about 5 feet per mile, with prevailingly medium-textured soils. Change in slope and in soil texture reflects the change from the active portion of the fan to the outer, largely inactive, portion.

The Kaweah alluvial fan was built by deposition from Kaweah River and its distributaries. Original slopes of the fan were gentle, and deposition was sufficiently slow to allow deep weathering and break down of coarser materials. The aquifers are lenticular (composed of lenses) in character and are separated from each other by less permeable deposits, permitting a slow, steady migration of ground water from sand lens to sand lens.

**Basement Complex (Non-water bearing series)**

The non-water bearing series is the Basement Complex, which crops out throughout the mountains and foothills, 10 miles or so east of the District. The Basement Complex consists of ancient sedimentary and volcanic rocks, now greatly metamorphosed, and of the granitic rocks which intrude them. These were involved in the late Jurassic deformation and form a unit that underlies the valley fill at varying depths—probably not less than 5,300 feet below TID. The Basement Complex is relatively impervious and inhibits groundwater recharge. Streams flowing through the Basement Complex lose little or none of their original flow by influent seepage. In the District the basement is assumed to be deep enough to have no significant effect on ground-water supply and conditions.

## Aquifer Characteristics

The aquifers within the District occur in unconfined, semi-confined and confined states. The upper unconfined aquifer is characterized by a hydrostatic pressure that is equal to the atmospheric pressure and subject to seasonal water level variations. The lower confined aquifer is overlain by a clay and fine silt layer which creates hydrostatic pressure and the pressure is reflected by the height above the confining stratus to which water will rise in a well drilled into the aquifer.

*Specific Yield* – In February 1949 the United States Bureau of Reclamation studied 477 water wells and the material within those wells. It was estimated that the specific yield of the sediments in the upper 20 to 70 feet of soil was 10 percent.

*Transmissivity* – Studies conducted within the District have yielded an estimated transmissivity range of 63,000 to 90,000 gpd/ft.

*Well Yields and Depths* – The average well yield within the District is approximately 700 gallons per minute and the specific capacity is approximately 55 gallons per minute per foot of drawdown.

*Safe Yield* – A report produce for the Kaweah Delta Water Conservation District by Fugro found that the practical rate of withdrawal for the District was between 126,000 to 141,000 AF/year.

*Groundwater Storage* – The District estimates that the approximate groundwater storage capacity within the District is 8.9 million AF.

*Groundwater Flow* – Groundwater within the District generally flows in a northwest to southwest pattern.

*Recharge* – The District has soils that a highly permeable in the northeast quadrant of the District and less permeable as the soils change to the southwest.

# DISTRICT GROUNDWATER MONITORING HISTORY

## Groundwater Management Plan

The Tulare Irrigation District (District) was one of the first public districts to adopt a Groundwater Management Plan (GWMP) in 1992. The original GWMP was prepared in accordance with the requirements prescribed in Assembly Bill No. 255 (California Water Code Section 10750 et seq.). In September 2010 the District adopted an updated GWMP that satisfies the requirements of Senate Bill No. 1938 which was passed in 2002 and amended Sections 10753 and 10795 of the California Water Code. This GWMP outlines the framework under which the District conducts its groundwater efforts. Within this document the District describes the geology, hydrology, basin management objectives and activities that are carried out to sustain groundwater within the District.

The objectives of the GWMP are as follows:

1. Address potential changes in local hydrology brought about by surface water losses (i.e. San Joaquin River Restoration), urban development and drought.
2. Preclude surface water groundwater exports that would reduce the long-term reliability of groundwater.
3. Coordinate groundwater management efforts between regional water users.
4. Maintain local management of the groundwater resources.
5. Implement a groundwater-monitoring program to provide an "early warning" system to future problems.
6. Stabilize groundwater levels in order to minimize pumping costs and energy use, and provide groundwater reserves for use in droughts.
7. Develop groundwater storage facilities to reduce stress on local groundwater reserves during droughts.
8. Maximize the use of all surface water sources, including available flood water, for beneficial use and groundwater recharge, and thus reduce stress on groundwater resources.

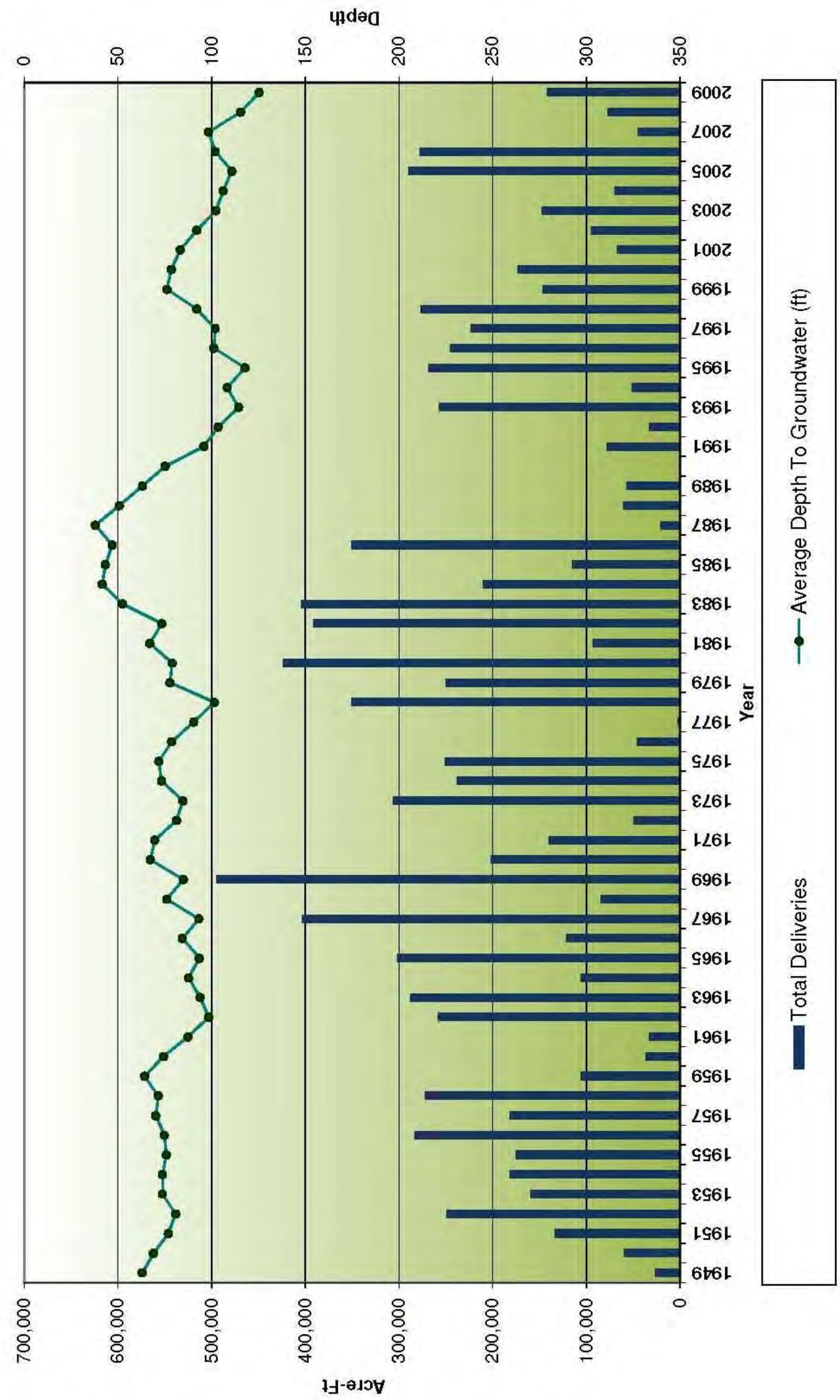
9. Increase knowledge of the local geology and hydrogeology to better understand threats to groundwater quality and quantity.
10. Minimize future land subsidence caused by groundwater pumping through in-lieu groundwater recharge, and wise and conservative use of pumped groundwater.
11. Prevent groundwater degradation by protecting groundwater quality, importing clean surface water, and preventing intrusion of poor quality groundwater from neighboring areas.

## Historic Groundwater Levels

Groundwater levels throughout the District have fluctuated seasonally and according to climatic conditions. According to historical records, when the District began recording average depth to groundwater levels in 1949, the average depth to groundwater was 63.0 feet. Prior to 1977, the District had seen the average groundwater levels fluctuate from 63.0 feet to 98.5 feet, with an average of 78.4 feet. Beginning in 1977, the driest recorded year on record, the District saw a two-year decline of 22.9 feet; which brought groundwater levels to an average all-time low of 101.6 feet below ground surface.

In 1979, the District recorded a one-year rise of 23.8 feet, bringing groundwater levels close to their pre-1977 level of 77.8 feet. Between 1979 and 1987 groundwater levels rose approximately 40 feet to a District average of 38.0 feet. Historic hydrographs show that from 1987 to 1995, the region experienced a 7-year drought that saw groundwater levels decline approximately 80 feet, with most wells seeing an average depth to water decline from 40 feet to around 120 feet. Between 1995 and 1999, the District saw a five-year rise in water levels of 41.6 feet. However, from 1999 to 2009, the average depth to groundwater declined 49.2 feet to an all-time low of 125.4 feet. From 1995 to 2009, the District saw five years that can be classified from their percent of water year, as considerably-above average; two years that can be considered average; three years below average; and five years of considerably below average. Figure 1 depicts the historical depth to groundwater levels in the District along with the surface water deliveries within the District.

Figure 1. Depth to Groundwater Plotted with Surface Water Deliveries to the District



# MONITORING PLAN

## WELL NETWORK

The District has had a long history of monitoring groundwater levels within the District. The measurement of groundwater dates back to the late 1940's within the District. The District currently does not own or operate any dedicated monitoring wells, and utilizes existing groundwater deepwells to obtain depth to groundwater readings. The District currently reads over 100 deepwells within the District, however for the purposes of reporting under CASGEM the District has established a network of wells as depicted in 2012 California Statewide Groundwater Elevation Monitoring (CASGEM) Well Location Map included in Appendix A. This reporting network represents a system that utilizes one deepwell reading for every 4 square miles. Where possible the District will take a reading in the center of the 4 square miles, however in certain circumstances it is not feasible to obtain a reading in the center and an alternate well has been selected. At this time the District does not have full access to CASGEM wells to cover a network that covers a reading for every 4 square miles, however the District intends to provide its coverage through supplying a combination of voluntary well information and CASGEM certified wells (wells with depth and screening information) within the CASGEM reporting system. These voluntary wells will not have well depth or screening information, however will provide a depth to groundwater reading. Over time, the District will convert the Well Network into readings that are CASGEM certified. Included in Appendix B is a Well Database, which is a list of the wells that are part of the monitoring network and certain characteristics of each well.

The current well locations were selected based upon the following criteria:

- Location of the well in relations to a 4 square mile grid pattern;
- Adequate access to the well to accomplish a consistent yearly depth to groundwater reading;
- A long-term history of well readings and the continued availability of the well for readings;
- Ability to make a representative determination of local groundwater conditions; and

- Coordination with neighboring agencies also conducting groundwater level monitoring.

Currently, the District measures depth in private irrigation wells, which are volunteered as monitoring sites for the District. In time these irrigation wells become abandoned or destroyed, therefore causing the District to lose monitoring sites. As groundwater wells are destroyed or abandoned and/or new monitoring wells are constructed, the District will adjust the Well Network to meet the criteria set forth above and amend this Groundwater Elevation Monitoring Plan as needed.

## DATA GAPS

Only three of the 53 wells selected for CASGEM by Tulare Irrigation District were found with both screening information and depth after the DWR searched for the well logs and records (Appendix A & B). The three wells are located in the south-central portion of the District service area. The depths of eight other wells selected for the monitoring program were found, but the screening information was not. Seven of the eight wells are shallow (200 feet deep or less) and appear to be completed above the Corcoran Clay (E-Clay) which is estimated to be between 200 to 300 feet beneath the TID service area. So water elevations reported for these wells should represent the shallow, semi-confined conditions in the basin.

However, the depths of two wells in the northern portion of the district (Local ID: 192418R1 and 192425D1) are at or near the current depth to water and may either be dry or the depth information for these wells is out of date. Attempts will be made to assess the current well depths during subsequent semi-annual events and if the well depth information currently reported on CASGEM is found to be out of date, the new well depths will be entered into the database. Otherwise, if the wells are dry and continue to be reported as dry they will be removed from CASGEM monitoring after three years (six monitoring) events.

Of the three wells in the TID CASGEM monitoring program that have screening information, it appears that two are screened below the E-Clay and a third may be screened through the E-Clay. The two wells with screen information below the E-Clay will remain in the monitoring program where the third (Local ID: 202313E2) which appears to be screened through the E-Clay, will eventually be replaced with a discretely screened well.

When the three wells with construction details and five of the wells with shallow depth information are plotted, they represent a range of wells extending along the northern portion and from northwest to southeast across the District service area (Appendix A). Therefore, horizontal data gaps are present in the west and southwest portions of the basin and within the limits of the City of Tulare, since public wells are not allowed to be used for CASGEM purposes, per the California Department of Public Health.

Vertical data gaps exist in the southwest, northwest, and northeast portions of the basin where discretely screened wells below the Corcoran Clay are not currently part of the monitoring program and shallow well coverage is also insufficient in the southwest portion of the basin due to a lack of well coverage.

In addition, the current CASGEM well density is insufficient since the Tule Subbasin has been designated as a high priority basin and should have approximately eight to ten CASGEM wells per 100 square miles, representing another data gap. It is TID's goal to eventually exceed the minimum required coverage and have at least one CASGEM well for every four square miles, which will be accomplished over time through public outreach to well owners with known construction information and installing depth discrete monitoring well clusters as grant and other funding becomes available.

The District intends to establish a revised CASGEM Well Network that will include well readings that are sourced from wells that include overall depth and screening information. To accomplish this, the District has identified the following strategies:

- Development of dedicated monitoring wells.
- Identification and participation of landowners with existing well depth and screening information.
- Identification and participation of landowners willing to allow the District to obtain well depth and screening information via well video logs.

## Dedicated Monitoring Wells

At this time the District does not own or operate any dedicated monitoring wells. The District recognizes that the monitoring network as presented in Appendix A has a combination of wells where the District has depth information and wells where we do not have depth information. The District is currently working on identifying locations and designs on dedicated monitoring wells for future installations. Future monitoring wells will be constructed such that the exact depth and screening information is obtained and provided in the CASGEM monitoring system. Future grant funding will be pursued to identify, design and install future dedicated groundwater monitoring wells. The District will utilize the network established for CASGEM when locating new monitoring wells such that the District can maintain a monitoring well centrally located within each 4 square mile zone inside the District service area.

Data gaps that exist in and around the City of Tulare will be addressed by data collected from dedicated monitoring wells that will be cited and installed in coordination with the City of Tulare. These dedicated monitoring wells are contingent upon City of Tulare approval and grant funding availability. The network of monitoring wells within the City will maintain the consistency of approximately 1 monitoring well for every 4 square mile zone.

The District also recognizes that the availability of monitoring wells exclusively above or below the E-Clay is lacking. Current wells within the District are typically above the E-Clay or are terminated at the E-Clay. A limited number of wells within the District have depths at approximately 400’ to 450’ which penetrate the E-Clay layer, however the screening intervals on these wells is unknown. New wells being drilled wells in the western half of the District have the potential to penetrate the E-Clay and reach into the confined aquifer, however the District has not coordinated any communications or information sharing with landowners who have recently drilled such wells. With the design of dedicated monitoring wells the District intends provide “nested” monitoring wells that will provide readings above and below the E-Clay layers. The availability of this information is dependent upon the availability of grant funding to provide dedicated monitoring wells.

### Landowner Well Participation

The District will initiate an outreach program to solicit participation by landowners who are willing to allow the District to utilize their wells for the CASGEM program. Only those wells that have total depth and screening information will be considered. The wells will also need to be strategically located to maintain the proper coverage within the Well Monitoring Network and provide an appropriate unconfined/semi-confined and confined aquifer space readings.

### Landowner Well Video Program

The District will initiate and outreach program to solicit the participation by landowners who are willing to allow the District to video existing wells to determine total depth and screening intervals. Landowners often have a video log done of wells to determine any issues or conditions within the wells, and the District may obtain this information. The District may also offer to cost-share with landowners to have video logs done under the agreement that the data is available to the District and therefore suitable for the CASGEM program.

## MEASUREMENT FREQUENCY

The District currently measures depth to groundwater twice a year, to provide such measurements to the U.S. Department of the Interior Bureau of Reclamation (USBR). A reading is taken each year in early spring (January to February) to reflect groundwater conditions prior to the summer irrigation season and to reflect the amount of recharge that had occurred in the previous winter. A late fall reading (September to October) is taken, which coincides with the end of the irrigation season for District landowners and will reflect the amount of groundwater extracted during the summer months. The readings are taken at these times at the request of USBR. The readings that are taken are carefully planned to allow for sufficient time to elapse between usage of a deepwell and a reading taken in that well to prevent skewed data due to operating wells that may reflect drawdown conditions and not static levels. Wells are typically allowed to recover for 24 to 28 hours before any readings are taken. The well readings are also typically taken within a two-week window. This measurement schedule is designed to reflect the seasonal groundwater elevation highs and lows.

| | Spring Reading | Fall Reading |
|---|---|---|
| Measurement Frequency | January - February | September - October |

## ESTABLISHING THE REFERENCE POINT

A critical component to the consistent measurement of groundwater levels is the identification and usage of a Reference Point (RP) for each monitoring well. The District does not currently utilize any dedicated monitoring wells, however in the future will include a mark on each monitoring well that is used to indicate the Reference Point (mark with a "RP"). Production wells that are utilized are typically accessed via the top of the access tube or a hole in the well casing. The District will identify the reference point on each DWR Form 429, which will be carried into the field to ensure a consistent use of reference points (see Appendix C for a DWR Form 429). A picture of each RP will be kept with each DWR Form 429 and an attempt to permanently mark the reference point on each monitoring location will be made. The District will survey each reference point to establish an elevation using the North American Datum of 1988 (NAD88).

The land-surface datum (LSD) is established in the field at the time of the reading. The LSD represents the average elevation of the ground around the well. Because the LSD around the well may change over time, the distance between the RP and the LSD should be verified every 3 to 5 years. If available, the District will utilize a fixed structure nearby such as the well pad to establish a more permanent surface of measure.

The District will provide a clearly displayed Reference Mark (RM) near each monitoring location where appropriate. The RM must be a fixed structure that can be used in the future to check the RP or re-establish the RP if it is destroyed or moved. The RP and the RM will be documented with a photograph and diagram to be kept in each Well Monitoring Folder (WMF).

A WMF will be created for each site and include the site specific information and historical depth to groundwater readings for that site.  This information will be used to maintain consistency and reliability between readings.

## WELL MEASURMENT GUIDELINES

Depth to groundwater readings are typically conducted by District's Engineering Technician or another employee who has been trained in groundwater measurement techniques.  Since the inception of collecting groundwater measurement data the District has utilized a standard depth to water measurement consistent with most current measuring practices.  Based on location, the District utilizes a combination of steel tape measurements and electric sounding tape measurements.  The following discussion describes the techniques and procedures followed during the collection of depth to groundwater measurements.

### Equipment

The District utilizes the two following measurement devices for depth to groundwater readings:

- Steel Tape – The District utilizes a standard surveyor steel tape which is 300 feet in length mounted on a manually retractable spool.
- Well Sounder – The District utilizes a Powers Well Sounder which is 200 feet in length.
- An Equipment Maintenance Log (EML) will be kept with each measuring device to record any maintenance or issues with the equipment.

### Guidelines - Steel Tape Method

The District typically utilizes this method on wells that have restricted access where a thin steel tape is the only form of access available.  The District typically monitors depth to groundwater from 75' to 150', which makes this type of measurement appropriate.  The District utilizes the following equipment:

- 300-foot steel tape
- Chalk or dust

- Towels

During the measurement the District will note any of the following issues in the WMF:

- Water dripping into the well or condensing on the well casing, which may cause a erroneous reading.
- If the well casing is angled the reading may need to be corrected. A correction will be noted in the WMF.
- If the tape becomes obstructed or stuck it will be noted.

The District will conduct the following pre-measurement steps to ensure a reliable reading:

- Maintain the steel measuring tape in good working condition. Check the tape for any rust, breaks, kinks, or any possible signs of stretch. Verify the calibration and maintenance data for the tape to ensure that the tape is in proper calibration.
- If a new steel tape is purchased, ensure that the black coating on the tape has been dulled with steel wool to ensure that the tape will hold chalk or dust.
- Prepare all field forms, including DWR Form 1213 (Sample provided in Appendix D). Ensure that all previous material that has been recorded for the monitoring site is included in the WMF.
- Verify that the RP is clearly marked or identifiable on the monitoring site and verify that it is the proper RP as identified in the WMF.

Field measurements will be carried out in the following manner:

1. Clean the lower 5 feet of the steel tape with a disinfectant wipe and rinse the tape with de-ionized water or tap water. Immediately dry the tape with a cloth towel.
2. Where required, attach a weight to the end of the tape. The weight should be made of a material that will not cause a contamination issue in the well. The weight should be cleaned with a disinfectant wipe and rinsed with de-ionized water or tap water. When measuring production wells **<u>DO NOT ATTACH WEIGHTS.</u>**

3. Utilize information in the MWF to determine what depth was last read at the measurement well. Utilizing the previous reading determine the estimated length that should be lowered into the well. The reading used should be the last measurement taken in that same season or year.
4. Chalk the lower few feet (operator is to make a field determination on length to be chalked) by pulling the tape across a piece of blue carpenter's chalk or sidewalk chalk.
5. Slowly lower the measuring tape into the well to avoid splashing and potential erroneous readings. The operator should be cautious to feel resistance on the tape, which would indicate an obstruction or the tape is sticking to the well casing. Once the depth of water is reached by estimation or resistance in tape, lower the end of the tape an extra foot into the water until and even increment can be marked on the RP. Once this number is determined record the footage on DWR Form 1213 next to the "Tape at RP" column.
6. Retract the steel tape back to the surface being cautious to avoid any obstruction or snags. Record the number on the tape where the chalk mark is to the nearest 0.01 foot in the column labeled "Tape at WS" in DWR Form 1213.
7. If there is an oil layer present, read the tape at the top of the oil mark to the nearest 0.01 foot and use this value for the "Tape at WS" instead of the wetter chalk mark. This will require the recording of an "8" in the QM column of DWR Form 1213, which indicates that there is a questionable measurement due to the presence of oil in the well.
8. Subtract the "Tape at WS" from the "Tape at RP" number and record the difference (to the nearest 0.01foot) as "RP to WS". This reading represents the depth to water below the RP.
9. Wipe the water and excess chalk form the steel tape and re-chalk the tape based on the first reading.
10. Repeat the above steps 5 to 8 and record the time of the second measurement on the line below the first measurement on DWR Form 1213. The second measurement should be made using a different "Tape at RP" than what was used for the first reading. If the first and second reading do not agree within 0.02 feet (0.20 for production wells), make a third measurement. The third measurement should be recorded below the second reading. If more than two readings are taken, average all reasonable readings.

11. After all measurements are complete wipe any excess chalk from the steel tape, wipe with a disinfectant wipe and rinse with de-ionized water or tap water. DO NOT STORE STEEL TAPE WILE DIRTY OR WET. Review all paperwork in the WMF to ensure that all pertinent information has been recorded.

## Guideline - Electronic Sounder Method

The District typically utilizes this method on wells that have access for a cable, which typically is an access port. The District typically monitors depth to groundwater from 75' to 150', which makes this type of measurement appropriate. The District utilizes the following equipment:

- Well Sounder
- Towels

During the measurement the District will note any of the following issues in the well monitoring folder:

- If the well casing is angled the reading may need to be corrected. A correction will be noted in the WMF.
- If the tape becomes obstructed or stuck it will be noted.
- If oil is noted in the well, the Steel Tape Method shall be used to minimize damage to the electronic sounder.

The District will conduct the following pre-measurement steps to ensure a reliable reading:

- Maintain the well sounding equipment in good working condition. Check the sounding tape and electrode for any wear in the tape, kinks, frayed electrical connections and any possible stretching of the tape. Ensure that all batteries are charged and that a replacement set is available.
- Check the distance from the electrode probe's sensor to the nearest foot marker on the tape, to ensure that this distance puts the sensor at the zero foot mark for the tape. If it does not, a correction must be applied to all depth to water measurements. The correction should be noted in WMF and also included in the equipment logs stored with the electronic sounder.

- Prepare all field forms, including DWR Form 1213. Ensure that all previous material that has been recorded for the monitoring site is included in the WMF.
- Verify that the RP is clearly marked or identifiable on the monitoring site and verify that it is the proper RP as identified in the well monitoring folder.
- Check the circuitry of the electric sounder prior to lowering the electrode probe into the well. Dip the electrode probe into tap water to ensure that the indicator needle is reading and the beeper is working.

Field measurements will be carried out in the following manner:

Clean the lower 5 feet of the well sounding tape with a disinfectant wipe and rinse the tape with de-ionized water or tap water. Immediately dry the tape with a cloth towel.

1. Utilize information in the MWF to determine what depth was last reading at the measurement well. Utilizing the previous reading determine the estimate length that should be lowered into the well. The reading used should be the last measurement taken in that same season or year.
2. Slowly lower the sounding tape into the well to avoid splashing and potential erroneous readings. The operator should be cautious to feel resistance on the tape, which would indicate an obstruction or the tape is sticking to the well casing. Once the depth of water is reached by an indication that the circuit is closed, the operator shall place the tip or nail of the index finger on the insulated wire at the RP and read the depth to water to the nearest 0.01 feet. Once this number is determined record the footage on DWR Form 1213 next to the "Tape at RP" column.
3. Retract the sounding tape back a few feet and make a second measurement by repeating step 2 and recording the second measurement with the time in the row below the first measurement. Make all reading using the same deflection point on the indicator scale, light intensity, or sound so that water levels will be consistent between measurements. If the second reading does not agree with the first measurement within 0.02 of a foot (0.2 in production wells), make a third measurement. If more than two readings are taken, record the average of all reasonable readings.
4. After all measurements are complete wipe any excess water from the sounding tape, wipe with a disinfectant wipe and rinse with de-ionized water or tap water. DO NOT STORE

SOUNDING TAPE WILE DIRTY OR WET. Review all paperwork in the WMF to ensure that all pertinent information has been recorded.

## Quality Assurance Measures

Monitoring Equipment

In order to maintain consistent and reliable depth to groundwater readings the District shall maintain and operate equipment as detailed in instructions provided by the manufacturer of all equipment. All equipment shall be kept and stored in a dry state and calibrated as required. Any indication of rust and wear shall be documented in an Equipment Maintenance Log (EML), which shall be kept with each piece of equipment.

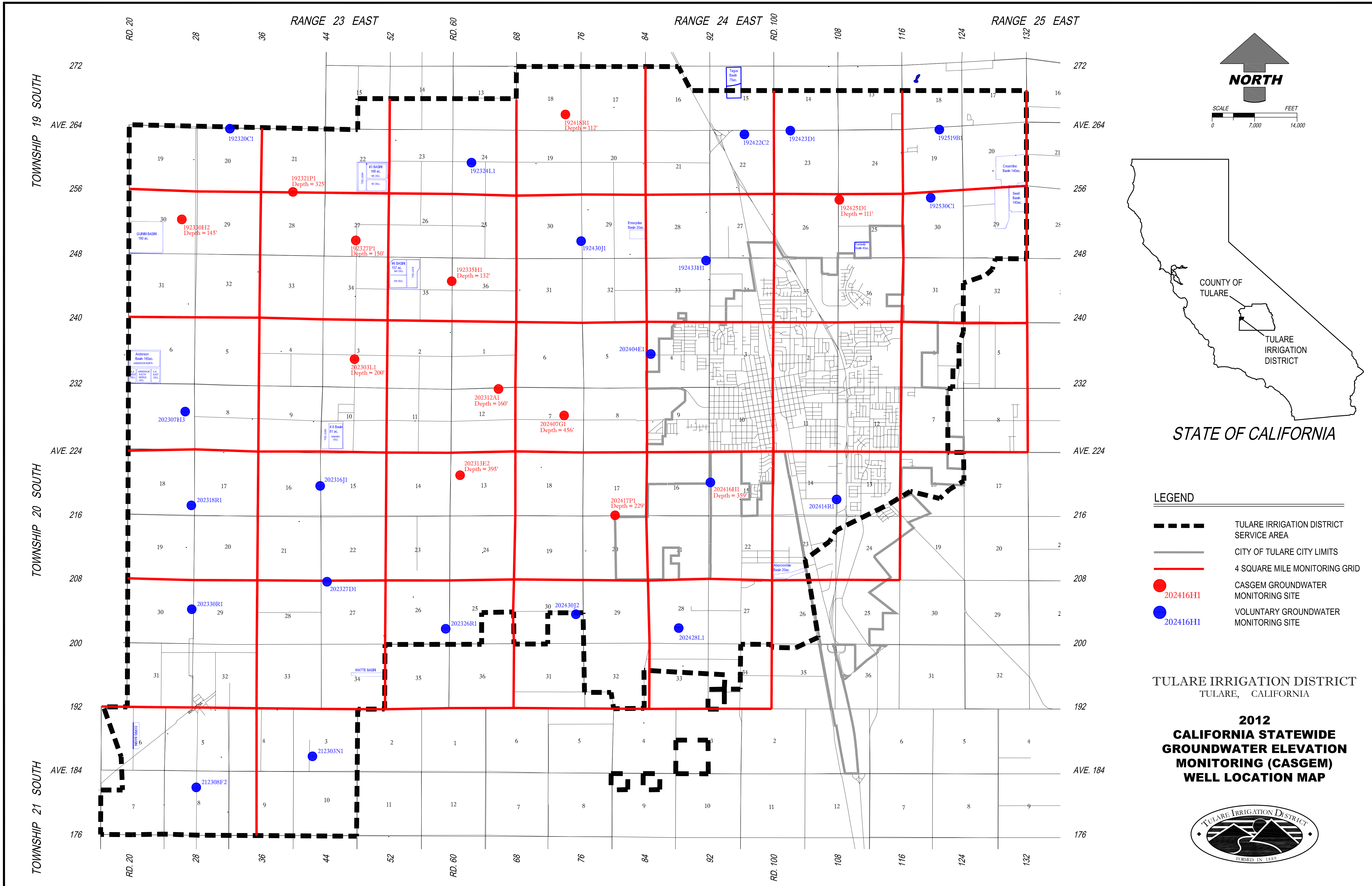
Well Readings

In order to maintain consistent and reliable depth to groundwater readings the District shall follow all guidelines for measurement as set forth in the section titled Well Measurement Guidelines. Each well will be measured at least two times at each reading interval in order to provide a comparison of results. If the results do not agree within the tolerances allowed in the Well Measurement Guidelines, a third measurement will be taken and the results of the closest values shall be averaged. If the results are not consistent a note shall be added to the DWR Form 1213. The District will also compare readings with historical depths in the field to provide an indication of any discrepancies.

Data Entry

Once all field data is collected, the District will enter all depth to groundwater readings into an electronic spreadsheet or database. The readings shall be proofed by a second person to ensure accuracy of entry. Once the data is entered, should a suspicious reading be determined, another field reading shall be taken to ensure consistency and reliability.

# APPENDIX A


RANGE 23 EAST
RANGE 24 EAST
RANGE 25 EAST
TOWNSHIP 19 SOUTH
TOWNSHIP 20 SOUTH
TOWNSHIP 21 SOUTH
RD. 20
RD. 60
RD. 100
AVE. 264
AVE. 224
AVE. 184
NORTH
SCALE
FEET
0
7,000
14,000
COUNTY OF TULARE
TULARE IRRIGATION DISTRICT
STATE OF CALIFORNIA
LEGEND
TULARE IRRIGATION DISTRICT SERVICE AREA
CITY OF TULARE CITY LIMITS
4 SQUARE MILE MONITORING GRID
202416H1 CASGEM GROUNDWATER MONITORING SITE
202416H1 VOLUNTARY GROUNDWATER MONITORING SITE
192320C1
192418R1 Depth = 112'
192422C2
192423D1
192519B1
192324L1
192321P1 Depth = 325'
192425D1 Depth = 111'
192530C1
192330H2 Depth = 145'
192327P1 Depth = 150'
192430J1
192433H1
192335H1 Depth = 132'
202404E1
202303L1 Depth = 200'
202312A1 Depth = 160'
202407G1 Depth = 456'
202307H3
202313E2 Depth = 395'
202316J1
202318R1
202416H1 Depth = 359'
202417P1 Depth = 229'
202414R1
202327D1
202330R1
202430J2
202326R1
202428L1
212303N1
212308F2
TULARE IRRIGATION DISTRICT
TULARE, CALIFORNIA
2012
CALIFORNIA STATEWIDE
GROUNDWATER ELEVATION
MONITORING (CASGEM)
WELL LOCATION MAP
TULARE IRRIGATION DISTRICT
FORMED IN 1889

# APPENDIX B

## Tulare Irrigation District

CASGEM Well Monitoring Network

| Local Well Designation | Well Classification | Refence Point Elevation | Reference Point Description | Ground Surface Elevation | Latitude | Longitude | Well Depth | Well Screening |
|---|---|---|---|---|---|---|---|---|
| 192320C1 | Voluntary | 247.16 | Well Casing | 246.82 | 36.2690 | 119.5013 | Unknown | Unknown |
| 192321P1 | CASGEM | 250.63 | Sounding Tube | 250.00 | 36.2547 | 119.4836 | 325 | Unknown |
| 192324L1 | Voluntary | 269.48 | Well Casing | 268.71 | 36.2616 | 119.4337 | Unknown | Unknown |
| 192418R1 | CASGEM | 281.89 | Sounding Tube | 281.36 | 36.2726 | 119.4075 | 112 | Unknown |
| 192422C2 | Voluntary | 297.13 | Well Casing | 297.49 | 36.2682 | 119.3575 | Unknown | Unknown |
| 192423D1 | Voluntary | 304.86 | Sounding Tube | 303.77 | 36.2691 | 119.3446 | Unknown | Unknown |
| 192330H2 | CASGEM | 241.51 | Sounding Tube | 239.21 | 36.2484 | 119.5146 | 145 | Unknown |
| 192327P1 | CASGEM | 255.13 | Pump Base | 254.42 | 36.2438 | 119.4660 | 150 | Unknown |
| 192335H1 | CASGEM | 261.09 | Well Casing | 261.12 | 36.2347 | 119.4391 | 132 | Unknown |
| 192430J1 | Voluntary | 276.18 | Pump Base | 274.95 | 36.2439 | 119.4030 | Unknown | Unknown |
| 192433H1 | Voluntary | 286.47 | Pump Base | 279.38 | 36.2396 | 119.3680 | Unknown | Unknown |
| 192425D1 | CASGEM | 309.32 | Pump Base | 302.59 | 36.2535 | 119.3030 | 111 | Unknown |
| 192519B1 | Voluntary | 315.15 | Pump Base | 314.34 | 36.2540 | 119.3053 | Unknown | Unknown |
| 192530C1 | Voluntary | 310.17 | Pump Base | 309.58 | 36.2540 | 119.3053 | Unknown | Unknown |
| 202404E1 | Voluntary | 276.07 | Pump Base | 275.63 | 36.2184 | 119.3834 | Unknown | Unknown |
| 202407G1 | CASGEM | 260.11 | Pump Base | 259.74 | 36.2044 | 119.4075 | 456 | 216-456 |
| 202312A1 | CASGEM | 254.78 | Pump Base | 254.28 | 36.2102 | 119.4259 | 160 | Unknown |
| 202303L1 | CASGEM | 248.04 | Pump Base | 246.29 | 36.2169 | 119.4662 | 200 | Unknown |
| 202307H3 | Voluntary | 230.30 | Pump Base | 229.58 | 36.2049 | 119.5134 | Unknown | Unknown |
| 202318R1 | Voluntary | 220.06 | Pump Base | 218.76 | 36.1741 | 119.5129 | Unknown | Unknown |
| 202316J1 | Voluntary | 236.67 | Pump Base | 236.48 | 36.1882 | 119.4756 | Unknown | Unknown |
| 202313E2 | CASGEM | 246.40 | Sounding Tube | 244.94 | 36.1907 | 119.4365 | 395 | 157-357 |
| 202417P1 | CASGEM | 249.51 | Pump Base | 249.36 | 36.1818 | 119.3932 | 229 | 170-210 |
| 202416H1 | Voluntary | 264.42 | Pump Base | 263.48 | 36.1894 | 119.3666 | Unknown | Unknown |
| 202414R1 | Voluntary | 272.86 | Pump Base | 271.52 | 36.1856 | 119.3313 | Unknown | Unknown |
| 202428L1 | Voluntary | 245.87 | Pump Base | 245.13 | 36.1594 | 119.4040 | Unknown | Unknown |
| 202430J2 | Voluntary | 243.82 | Pump Base | 242.82 | 36.1594 | 119.4040 | Unknown | Unknown |
| 202326R1 | Voluntary | 237.34 | Pump Base | 236.48 | 36.1559 | 119.4403 | Unknown | Unknown |
| 202327D1 | Voluntary | 230.98 | Pump Base | 229.76 | 36.1665 | 119.4735 | Unknown | Unknown |
| 202330R1 | Voluntary | 218.36 | Pump Base | 218.59 | 36.1601 | 119.5113 | Unknown | Unknown |
| 212308F2 | Voluntary | 209.95 | Pump Base | 208.81 | 36.1197 | 119.5098 | Unknown | Unknown |
| 212303N1 | Voluntary | 218.65 | Pump Base | 217.69 | 36.1269 | 119.4774 | Unknown | Unknown |

# APPENDIX C

State of California DEPARTMENT OF WATER RESOURCES California Natural Resources Agency

# WELL DATA

State Well No. ____________________

Region ____________________

| | |
|---|---|
| OWNER | SITE ID |
| ADDRESS | WELL NAME |
| TENANT | OTHER NO. |
| ADDRESS | |

TYPE OF WELL ☐ SPECIAL STUDIES ☐ MONTHLY ☐ SEMI ANNUAL ☐ WATER QUALITY

LOCATION COUNTY BASIN NO.

| | |
|---|---|
| U.S.G.S. QUAD. | QUAD NO. |

1/4 1/4 SECTION TWP. RGE. ☐MD ☐SB ☐H BASE & MERIDIAN

| | |
|---|---|
| COORDINATES (NAD83) LONGITUDE LATITUDE | SOURCE |

DESCRIPTION

REFERENCE POINT DESCRIPTION

WHICH IS FT. ABOVE ☐ BELOW ☐ LAND SURFACE DATUM GROUND ELEVATION FT.

| | |
|---|---|
| REFERENCE POINT ELEVATION FT. | DETERMINED FROM |

| | | |
|---|---|---|
| WELL USE | CONDITION | DEPTH FT. |

| | |
|---|---|
| CASING, SIZE IN., | PERFORATIONS |

MEASUREMENTS BY ☐ DWR ☐ USGS ☐ USBR ☐ COUNTY ☐ IRR. DIST. ☐ WATER DIST. ☐ CONS. DIST. ☐ OTHER

| | | |
|---|---|---|
| GRAVEL PACK? ☐ YES ☐ NO | DEPTH TO TOP GR. | DEPTH TO BOT GR. |
| TYPE OF MATERIAL | PERM. RATING | THICKNESS |
| CHIEF AQUIFER | DEPTH TO TOP AQ. | DEPTH TO BOT. AQ. |
| SUPP. AQUIFER | DEPTH TO TOP AQ. | DEPTH TO BOT. AQ. |

| | | |
|---|---|---|
| DRILLER | DATE DRILLED | LOG NUMBER (DWR 188) |

| | | | |
|---|---|---|---|
| WELL PUMP TYPE | MAKE | MODEL | SERIAL NO. |

| | | |
|---|---|---|
| WATER ANALYSIS MIN. | SAN. | H.M. |

| | |
|---|---|
| POWER SOURCE | WATER LEVELS AVAILABLE? ☐ YES ☐ NO |

| | | | |
|---|---|---|---|
| H.P. | MOTOR SERIAL NO | PERIOD OF RECORD BEGIN | END |
| ELEC. METER NO. | TRANSFORMER NO. | COLLECTING AGENCY | |

SIZE OF DISCHARGE PIPE IN.

| | | | | |
|---|---|---|---|---|
| YIELD G.P.M. | PUMPING LEVEL FT. | PROD. REC. | PUMP TEST | YIELD |

| | |
|---|---|
| SKETCH | REMARKS |
| N | |
| | RECORDED BY |
| | DATE |

# APPENDIX D

# GROUNDWATER LEVEL DATA FORM
## MANUAL MEASUREMENTS

| WELL ID NUMBER | WELL NAME | STATE WELL NUMBER | COUNTY | B-118 BASIN OR SUBBASIN | MEASURING AGENCY | LAND SURFACE DATUM (LSD) ELEV. | RP TO LAND SURFACE DATUM (LSD), IN FT | REFERENCE POINT (RP) ELEV. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

**NO MEASUREMENT (NM)**

0. Measurement discontinued
1. Pumping
2. Pump house locked
3. Tape hung up
4. Can't get tape in casing
5. Unable to locate well
6. Well has been destroyed
7. Special
8. Casing leaky or wet
9. Temporarily inaccessible

**QUESTIONABLE MEASUREMENT (QM)**

0. Caved or deepened
1. Pumping
2. Nearby pump operating
3. Casing leaky or wet
4. Pumped recently
5. Air or pressure gauge measurement
6. Other
7. Recharge operation at or nearby well
8. Oil in casing

**MEASUREMENT METHOD (MM)**

0. Steel tape
1. Electric sounding tape
2. Other

| DATE | TIME | N M | Q M | MM | TAPE at RP | TAPE at WS | RP to WS | LSD to WS | OBS | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
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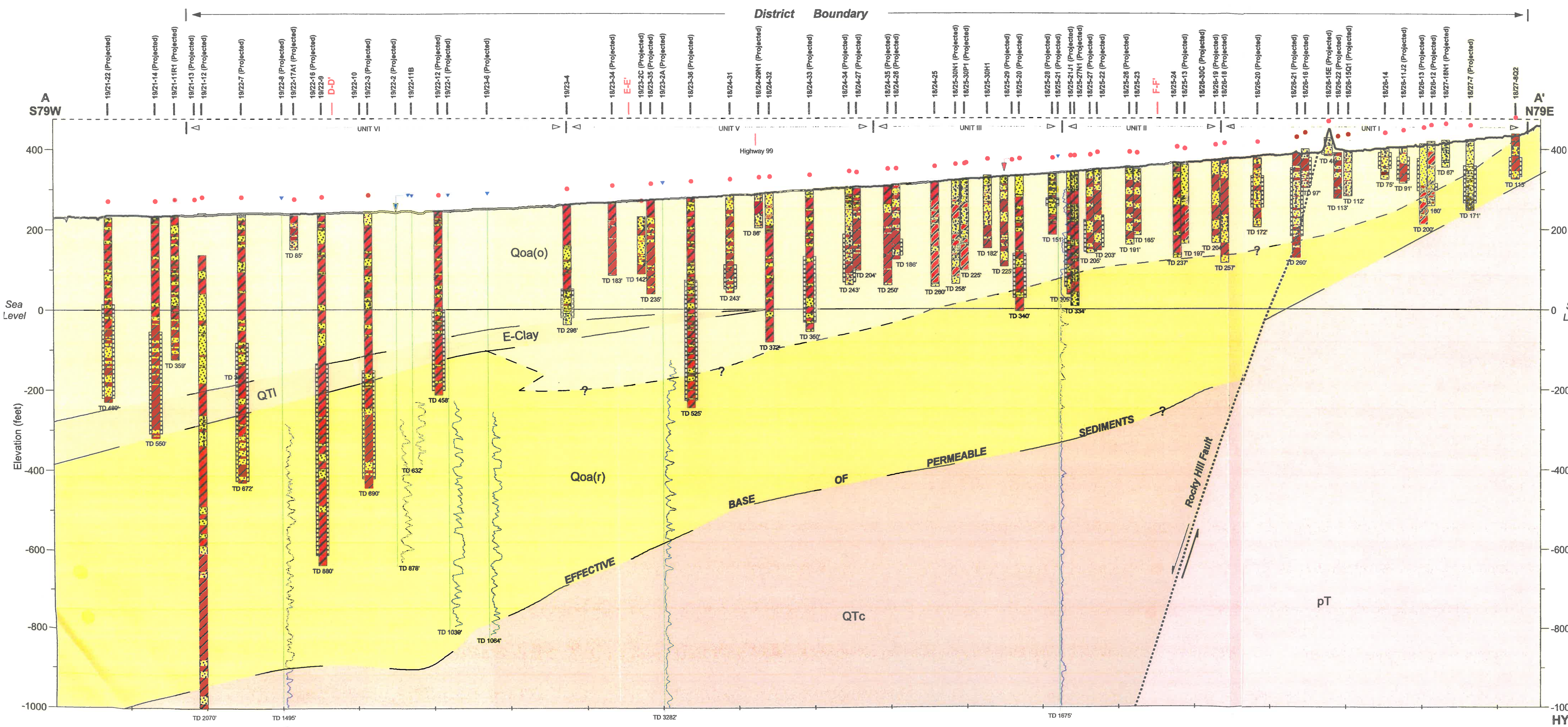
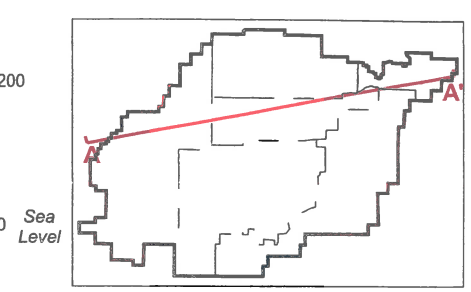
[For explanation of terms, see figure 1.]

# APPENDIX E

December 2003 (Revised July 2007)
Project No. 3087.004.07




Section Location



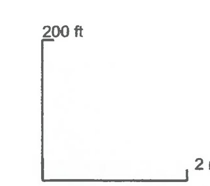
GENERAL NOTES:

1) Stratigraphic contacts are approximate and are interpreted from well and electric logs. Conditions vary both along and perpendicula to the section line.

2) Refer to Key to Cross Sections for descriptions of wells and electric log data shown above.

3) Wells and electric logs are projected to a distance of one mile onto the lines of the cross sections. Therefore stratigraphic contacts may not exactly correspond to the contact indications (lithology, shear strength, etc.) in the logs.

4) Legend on Plate 16




Vertical exaggeration approximate 50 times

## HYDROGEOLOGIC SECTION A-A'

Kaweah Delta Water Conservation District
Kings and Tulare Counties, California

PLATE 14

# Appendix 4C Water Quality Monitoring Schedule

## WATER QUALITY MONITORING SCHEDULE

Community System, > 3300 population, groundwater/agricultural (CLGA)

**UPDATED - September 2015**

| Chemical - Title 22 | MCL (mg/L) | EPA Method | Frequency (1) |
|---|---|---|---|
| **Primary Inorganics - Section 64432** | | | |
| Aluminum | 1 | | Every 3 years |
| Antimony | 0.006 | | Every 3 years |
| Arsenic | 0.010 | | Every 3 years |
| Barium | 1 | | Every 3 years |
| Beryllium | 0.004 | | Every 3 years |
| Cadmium | 0.005 | | Every 3 years |
| Chromium (Total Chromium) | 0.05 | | Every 3 years (2) |
| Hexavalent Chromium (Chrome 6) | 0.010 | 218.6 or 218.7 | 1 sample (2)(3) |
| *Cyanide* | 0.15 | | Waived |
| Fluoride | 2.0 | | Every 3 years |
| Mercury | 0.002 | | Every 3 years |
| Nickel | 0.1 | | Every 3 years |
| Perchlorate | 0.006 | | Every 3 years (4) |
| Selenium | 0.05 | | Every 3 years |
| Thallium | 0.002 | | Every 3 years |
| **Asbestos - Section 64432.2** | | | |
| Asbestos - Source Water | 7 MFL | | Waived |
| Asbestos - Distribution System sampling if Asbestos-Cement pipe used | 7 MFL | | Every 9 years if Aggressive Index ≤ 11.5 |
| **Nitrate/Nitrite - Section 64432.1** | | | |
| Nitrate (as N) | 10 | | Annually if < 5 mg/L (5) |
| Nitrite (as nitrogen) | 1 | | Every 3 years if <0.5 mg/L (6) |
| Nitrate + Nitrite (sum as nitrogen) | 10 | | N/A |
| **Secondary Standards - Table 64449-A** | | | |
| Aluminum | 0.2 | | Every 3 years |
| Color | 15 | | Every 3 years |
| Copper | 1.0 | | Every 3 years |
| Foaming Agents | 0.5 | | Every 3 years |
| Iron | 0.3 | | Every 3 years |
| Manganese | 0.05 | | Every 3 years |
| Methyl-*tert*-butyl ether (MTBE) | 0.005 | 502.2, 524.2 | Every 3 years |
| Odor | 3 | | Every 3 years |
| Silver | 0.1 | | Every 3 years |
| *Thiobencarb* | 0.001 | | Waived |
| Turbidity | 5 | | Every 3 years |
| Zinc | 5 | | Every 3 years |
| **General Minerals - Section 64449** | | | |
| Bicarbonate | N/A | | Every 3 years |
| Carbonate | N/A | | Every 3 years |
| Hydroxide Alkalinity | N/A | | Every 3 years |
| Calcium | N/A | | Every 3 years |
| Magnesium | N/A | | Every 3 years |
| Sodium | N/A | | Every 3 years |
| Hardness | N/A | | Every 3 years |
| pH | N/A | | Every 3 years |
| **Secondary Standards - Table 64449-B** | | | |
| TDS | 500-1000;1500 | | Every 3 years |
| Specific Conductance | 900-1600; 2200 | | Every 3 years |
| Chloride | 250-500;600 | | Every 3 years |
| Sulfate | 250-500;600 | | Every 3 years |

MCL = Maximum Contaminant Level

**Contact your district office with any questions.**

(1) Sampling shall be increased to quarterly following any result > MCL.

(2) After initial hexavalent chromium monitoring, total chromium may be used if total chromium results are < 0.010 mg/L. If total chromium result is ≥ 0.010 mg/L, monitoring for hexavalent chromium will be required.

(3) Hexavalent chromium shall be increased to quarterly sampling following any result > 0.010 mg/L.

(4) Perchlorate: This frequency applies if there were no detections in the initial monitoring.

(5) Nitrate (as N) replaces Nitrate (as NO3). Nitrate (as N) sampling shall increase to quarterly following any result ≥ 5 mg/L. Upon request, this may be reduced to an annual frequency after 4 quarters of monitoring. Beginning with Jan. 1, 2016, water systems shall comply with the Nitrate (as N) requirement.

(6) Nitrite sampling shall be increased to quarterly following any result ≥ 0.5 mg/L. Upon request, this may be reduced to an annual frequency after 4 quarters of monitoring.

WATER QUALITY MONITORING SCHEDULE

Community System, > 3300 population, groundwater/agricultural (CLGA)

**UPDATED - September 2015**

## Radiological Monitoring

| Radioactivity - Section 64442 | MCL | EPA Method | Frequency |
|---|---|---|---|
| Gross Alpha | 15 pCi/L | | Based on result of last sample (1) |
| Radium-226 | 5 pCi/L Combined | | When (GA-Uranium) > 5 pCi/L (2) |
| Radium-228 | Radium-226 + 228 | | Waived (1) |
| Uranium | 20 pCi/L | | When GA > 5 pCi/L (2) |
| **Man Made Radioactivity - Section 64443** | | | |
| Tritium | 20000 pCi/L | | Not Required |
| Strontium | 8 pCi/L | | Not Required |
| Gross Beta | 50 pCi/L | | Not Required |

**1. Routine Monitoring**

a) Routine monitoring frequency for Gross Alpha is based on last sample collected.

| Gross Alpha | Monitoring Frequency |
|---|---|
| Less than 3 pCi/L | 1 sample every 9 years |
| ≥ 3 and ≤ 7.5 pCi/L | 1 sample every 6 years |
| > 7.5 and ≤ 15 pCi/L | 1 sample every 3 years |

b) Routine monitoring frequency for Radium-228 will be waived if there is no MCL exceedance.

**2. Triggered Monitoring**

A frequency is generally not assigned to radium-226 or uranium as the monitoring for these constituents is dependent on the gross alpha results.

a) If the Gross Alpha particle activity is less than or equal to 5 pCi/L, analysis for Uranium is not required.

b) If the Gross Alpha particle activity for any single sample is greater than 5 pCi/L, analysis for Uranium in that same sample is required. If any single sample for Uranium is greater than 20 pCi/L, monitor at least 4 quarters for Uranium.

c) If the Gross Alpha particle activity is > 5 pCi/L, analysis for uranium may be used to obtain the radium-226 activity (GA - Uranium = Radium-226). If GA - Uranium > 0, contact your district office. If GA - Uranium < 0, report only the GA and Uranium results.

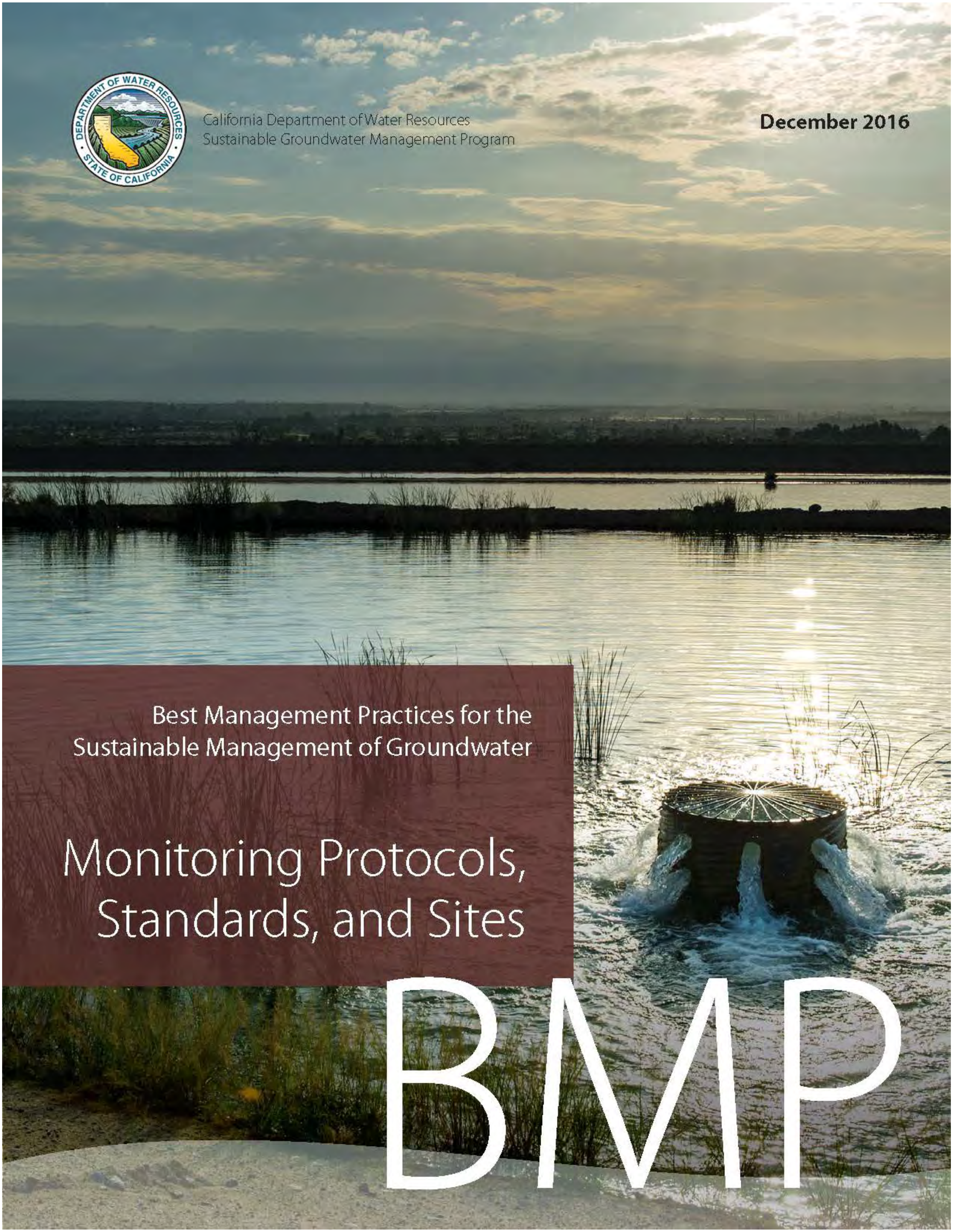
**Contact your district office if the MCL is exceeded, or for clarification on monitoring frequencies.**

# Appendix 4D DWR Provided Guidance Documents

***4Da Monitoring Protocols, Standards, and Sites Best Management Practices***

***4Db Monitoring Networks and Identification of Data Gaps Best Management Practices***

# Appendix 4Da Monitoring Protocols, Standards, and Sites Best Management Practices



California Department of Water Resources
Sustainable Groundwater Management Program

December 2016

Best Management Practices for the Sustainable Management of Groundwater

# Monitoring Protocols, Standards, and Sites

# BMP

State of California
**Edmund G. Brown Jr., Governor**

California Natural Resources Agency
**John Laird, Secretary for Natural Resources**

Department of Water Resources
**Mark W. Cowin, Director**

**Carl A. Torgersen,** Chief Deputy Director

Office of the Chief Counsel
Spencer Kenner

Public Affairs Office
Ed Wilson

Government and Community Liaison
Anecita S. Agustinez

Office of Workforce Equality
Stephanie Varrelman

Policy Advisor
Waiman Yip

Legislative Affairs Office
Kasey Schimke, Ass't Dir.

*Deputy Directors*

| | |
|---|---|
| **Gary Bardini** | **Integrated Water Management** |
| **William Croyle** | **Statewide Emergency Preparedness and Security** |
| **Mark Anderson** | **State Water Project** |
| **John Pacheco** (Acting) | **California Energy Resources Scheduling** |
| **Kathie Kishaba** | **Business Operations** |
| **Taryn Ravazzini** | **Special Initiatives** |

*Division of Integrated Regional Water Management*

**Arthur Hinojosa Jr.**, Chief

*Prepared under the direction of:*

**David Gutierrez**, Sustainable Groundwater Management Program Manager
**Rich Juricich**, Sustainable Groundwater Management Branch

*Prepared by:*

**Trevor Joseph**, BMP Project Manager

Timothy Godwin
Dan McManus
Mark Nordberg
Heather Shannon
Steven Springhorn

*With assistance from:*

DWR Region Office Staff

# Groundwater Monitoring Protocols, Standards, and Sites Best Management Practice

## 1. Objective

The objective of this *Best Management Practice* (BMP) is to assist in the development of Monitoring Protocols. The California Department of Water Resources (the Department or DWR) has developed this document as part of the obligation in the Technical Assistance chapter (Chapter 7) of the Sustainable Groundwater Management Act (SGMA) to support the long-term sustainability of California's groundwater *basins*. Information provided in this BMP provides technical assistance to Groundwater Sustainability Agencies (GSAs) and other stakeholders to aid in the establishment of consistent data collection processes and procedures. In addition, this BMP can be used by GSAs to adopt a set of sampling and measuring procedures that will yield similar data regardless of the monitoring personnel. Finally, this BMP identifies available resources to support the development of monitoring protocols.

This BMP includes the following sections:

1. Objective. A brief description of how and where monitoring protocols are required under SGMA and the overall objective of this BMP.
2. Use and Limitations. A brief description of the use and limitations of this BMP.
3. Monitoring Protocol Fundamentals. A description of the general approach and background of groundwater monitoring protocols.
4. Relationship of Monitoring Protocols to other BMPs. A description of how this BMP is connected with other BMPS.
5. Technical Assistance. Technical content providing guidance for regulatory sections.
6. Key Definitions. Descriptions of definitions identified in the GSP Regulations or SGMA.
7. Related Materials. References and other materials that provide supporting information related to the development of Groundwater Monitoring Protocols.

## 2. USE AND LIMITATIONS

BMPs developed by the Department provide technical guidance to GSAs and other stakeholders. Practices described in these BMPs do not replace the GSP Regulations, nor do they create new requirements or obligations for GSAs or other stakeholders. In addition, using this BMP to develop a GSP does not equate to an approval determination by the Department. All references to GSP Regulations relate to Title 23 of the California Code of Regulations (CCR), Division 2, Chapter 1.5, and Subchapter 2. All references to SGMA relate to California Water Code sections in Division 6, Part 2.74.

## 3. MONITORING PROTOCOL FUNDAMENTALS

Establishing data collection protocols that are based on best available scientific methods is essential. Protocols that can be applied consistently across all basins will likely yield comparable data. Consistency of data collection methods reduces uncertainty in the comparison of data and facilitates more accurate communication within basins as well as between basins.

Basic minimum technical standards of accuracy lead to quality data that will better support implementation of GSPs.

## 4. RELATIONSHIP OF MONITORING PROTOCOL TO OTHER BMPS

Groundwater monitoring is a fundamental component of SGMA, as each GSP must include a sufficient network of data that demonstrates measured progress toward the achievement of the sustainability goal for each basin. For this reason, a standard set of protocols need to be developed and utilized.

It is important that data is developed in a manner consistent with the basin setting, planning, and projects/management actions steps identified on **Figure 1** and the GSP Regulations. The inclusion of monitoring protocols in the GSP Regulations also emphasizes the importance of quality empirical data to support GSPs and provide comparable information from basin to basin.

**Figure 1** provides a logical progression for the development of a GSP and illustrates how monitoring protocols are linked to other related BMPs. This figure also shows the context of the BMPs as they relate to various steps to sustainability as outlined in the GSP Regulations. The monitoring protocol BMP is part of the Monitoring step identified in **Figure 1**.

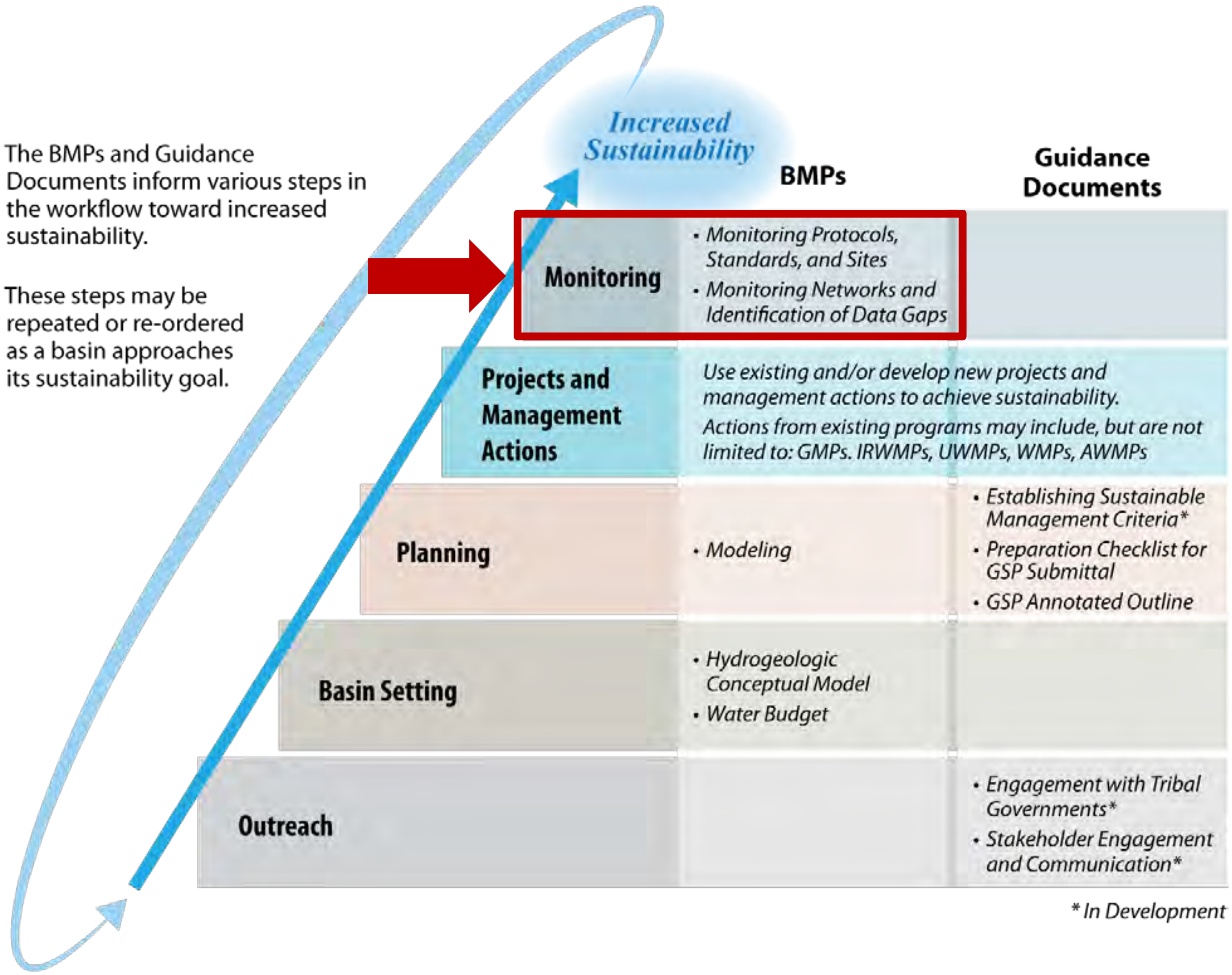



**Figure 1 – Logical Progression of Basin Activities Needed to Increase Basin Sustainability**

## 5. TECHNICAL ASSISTANCE

> *23 CCR §352.2. Monitoring Protocols. Each Plan shall include monitoring protocols adopted by the Agency for data collection and management, as follows:*
> *(a) Monitoring protocols shall be developed according to best management practices.*
> *(b) The Agency may rely on monitoring protocols included as part of the best management practices developed by the Department, or may adopt similar monitoring protocols that will yield comparable data.*
> *(c) Monitoring protocols shall be reviewed at least every five years as part of the periodic evaluation of the Plan, and modified as necessary.*

The GSP Regulations specifically call out the need to utilize protocols identified in this BMP, or develop similar protocols. The following technical protocols provide guidance based upon existing professional standards and are commonly adopted in various groundwater-related programs. They provide clear techniques that yield quality data for use in the various components of the GSP. They can be further elaborated on by individual GSAs in the form of standard operating procedures which reflect specific local requirements and conditions. While many methodologies are suggested in this BMP, it should be understood that qualified professional judgment should be used to meet the specific monitoring needs.

The following BMPs may be incorporated into a GSP's monitoring protocols section for collecting groundwater elevation data. A GSP that adopts protocols that deviate from these BMPs must demonstrate that they will yield comparable data.

### PROTOCOLS FOR ESTABLISHING A MONITORING PROGRAM

The protocol for establishment of a monitoring program should be evaluated in conjunction with the *Monitoring Network and Identification of Data Gaps* BMP and other BMPs. Monitoring protocols must take into consideration the *Hydrogeologic Conceptual Model, Water Budget, and Modeling* BMPs when considering the data needs to meet GSP objectives and the sustainability goal.

It is suggested that each GSP incorporate the Data Quality Objective (DQO) process following the U.S. EPA *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006). Although strict adherence to this method is not required, it does provide a robust approach to consider and assures that data is collected with a specific purpose in mind, and efforts for monitoring are as efficient as possible to achieve the objectives of the GSP and compliance with the GSP Regulations.

The DQO process presents a method that can be applied directly to the sustainability criteria quantitative requirements through the following steps.

1. State the problem – Define sustainability indicators and planning considerations of the GSP and sustainability goal.
2. Identify the goal – Describe the quantitative measurable objectives and minimum thresholds for each of the sustainability indicators.
3. Identify the inputs – Describe the data necessary to evaluate the sustainability indicators and other GSP requirements (i.e. water budget).
4. Define the boundaries of the study – This is commonly the extent of the Bulletin 118 groundwater basin or subbasin, unless multiple GSPs are prepared for a given basin. In that case, evaluation of the coordination plan and specifically how the monitoring will be comparable and meet the sustainability goals for the entire basin.
5. Develop an analytical approach – Determine how the quantitative sustainability indicators will be evaluated (i.e. are special analytical methods required that have specific data needs).
6. Specify performance or acceptance criteria – Determine what quality the data must have to achieve the objective and provide some assurance that the analysis is accurate and reliable.
7. Develop a plan for obtaining data – Once the objectives are known determine how these data should be collected. Existing data sources should be used to the greatest extent possible.

These steps of the DQO process should be used to guide GSAs to develop the most efficient monitoring process to meet the measurable objectives of the GSP and the sustainability goal. The DQO process is an iterative process and should be evaluated regularly to improve monitoring efficiencies and meet changing planning and project needs. Following the DQO process, GSAs should also include a data quality control and quality assurance plan to guide the collection of data.

Many monitoring programs already exist as part of ongoing groundwater management or other programs. To the extent possible, the use of existing monitoring data and programs should be utilized to meet the needs for characterization, historical record documentation, and continued monitoring for the SGMA program. However, an evaluation of the existing monitoring data should be performed to assure the data being collected meets the DQOs, regulatory requirements, and data collection protocol described in this BMP. While this BMP provides guidance for collection of various regulatory based requirements, there is flexibility among the various methodologies available to meet the DQOs based upon professional judgment (local conditions or project needs).

At a minimum, for each monitoring site, the following information or procedure should be collected and documented:

- Long-term access agreements. Access agreements should include year-round site access to allow for increased monitoring frequency.
- A unique identifier that includes a general written description of the site location, date established, access instructions and point of contact (if necessary), type of information to be collected, latitude, longitude, and elevation. Each monitoring location should also track all modifications to the site in a modification log.

## PROTOCOLS FOR MEASURING GROUNDWATER LEVELS

This section presents considerations for the methodology of collection of groundwater level data such that it meets the requirements of the GSP Regulations and the DQOs of the specific GSP. Groundwater levels are a fundamental measure of the status of groundwater conditions within a basin. In many cases, relationships of the sustainability indicators may be able to be correlated with groundwater levels. The quality of this data must consider the specific aquifer being monitored and the methodology for collecting these levels.

The following considerations for groundwater level measuring protocols should ensure the following:

- Groundwater level data are taken from the correct location, well ID, and screen interval depth
- Groundwater level data are accurate and reproducible
- Groundwater level data represent conditions that inform appropriate basin management DQOs
- All salient information is recorded to correct, if necessary, and compare data
- Data are handled in a way that ensures data integrity

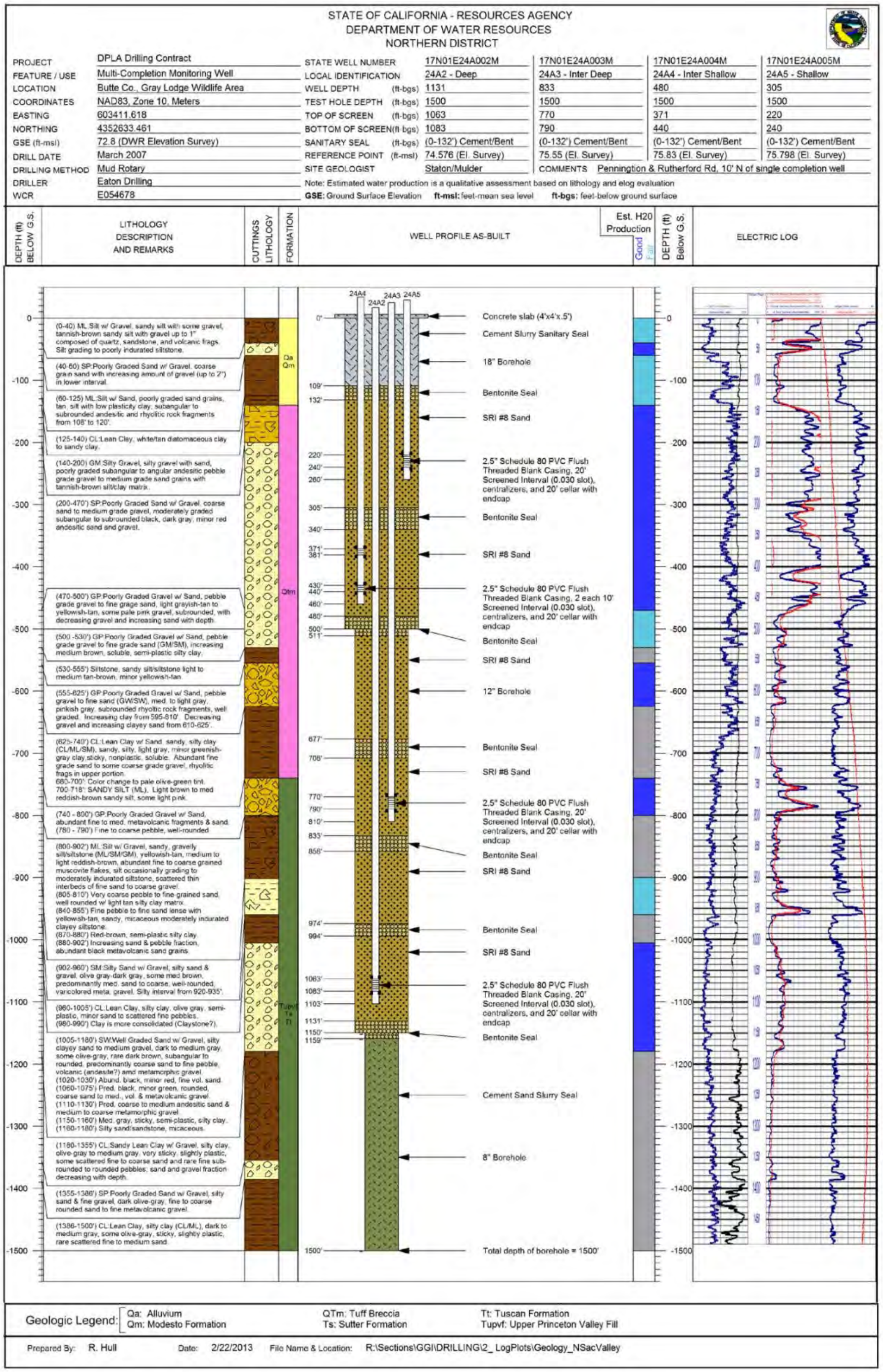
## General Well Monitoring Information

The following presents considerations for collection of water level data that include regulatory required components as well as those which are recommended.

- Groundwater elevation data will form the basis of basin-wide water-table and piezometric maps, and should approximate conditions at a discrete period in time. Therefore, all groundwater levels in a basin should be collected within as short a time as possible, preferably within a 1 to 2 week period.
- Depth to groundwater must be measured relative to an established Reference Point (RP) on the well casing. The RP is usually identified with a permanent marker, paint spot, or a notch in the lip of the well casing. By convention in open casing monitoring wells, the RP reference point is located on the north side of the well casing. If no mark is apparent, the person performing the measurement should measure the depth to groundwater from the north side of the top of the well casing.
- The elevation of the RP of each well must be surveyed to the North American Vertical Datum of 1988 (NAVD88), or a local datum that can be converted to NAVD88. The elevation of the RP must be accurate to within 0.5 foot. It is preferable for the RP elevation to be accurate to 0.1 foot or less. Survey grade global navigation satellite system (GNSS) global positioning system (GPS) equipment can achieve similar vertical accuracy when corrected. Guidance for use of GPS can be found at USGS http://water.usgs.gov/osw/gps/. Hand-held GPS units likely will not produce reliable vertical elevation measurement accurate enough for the casing elevation consistent with the DQOs and regulatory requirements.
- The sampler should remove the appropriate cap, lid, or plug that covers the monitoring access point listening for pressure release. If a release is observed, the measurement should follow a period of time to allow the water level to equilibrate.
- Depth to groundwater must be measured to an accuracy of 0.1 foot below the RP. It is preferable to measure depth to groundwater to an accuracy of 0.01 foot. Air lines and acoustic sounders may not provide the required accuracy of 0.1 foot.
- The water level meter should be decontaminated after measuring each well.

Where existing wells do not meet the base standard as described in the GSP Regulations or the considerations provided above, new monitoring wells may need to be constructed to meet the DQOs of the GSP. The design, installation, and documentation of new monitoring wells must consider the following:

- Construction consistent with California Well Standards as described in Bulletins 74-81 and 74-90, and local permitting agency standards of practice.
- Logging of borehole cuttings under the supervision of a California Professional Geologist and described consistent with the Unified Soil Classification System methods according to ASTM standard D2487-11.
- Written criteria for logging of borehole cuttings for comparison to known geologic formations, principal aquifers and aquitards/aquicludes, or specific marker beds to aid in consistent stratigraphic correlation within and across basins.
- Geophysical surveys of boreholes to aid in consistency of logging practices. Methodologies should include resistivity, spontaneous potential, spectral gamma, or other methods as appropriate for the conditions. Selection of geophysical methods should be based upon the opinion of a professional geologist or professional engineer, and address the DQOs for the specific borehole and characterization needs.
- Prepare and submit State well completion reports according to the requirements of §13752. Well completion report documentation should include geophysical logs, detailed geologic log, and formation identification as attachments. An example well completion as-built log is illustrated in **Figure 2.** DWR well completion reports can be filed directly at the Online System for Well Completion Reports (OSWCR) http://water.ca.gov/oswcr/index.cfm.




# Figure 2 – Example As-Built Multi-Completion Monitoring Well Log

## Measuring Groundwater Levels

Well construction, anticipated groundwater level, groundwater level measuring equipment, field conditions, and well operations should be considered prior collection of the groundwater level measurement. The USGS *Groundwater Technical Procedures* (Cunningham and Schalk, 2011) provide a thorough set of procedures which can be used to establish specific Standard Operating Procedures (SOPs) for a local agency. **Figure 3** illustrates a typical groundwater level measuring event and simultaneous pressure transducer download.


**Figure 3 – Collection of Water Level Measurement and Pressure Transducer Download**

The following points provide a general approach for collecting groundwater level measurements:

- Measure depth to water in the well using procedures appropriate for the measuring device. Equipment must be operated and maintained in accordance with manufacturer's instructions. Groundwater levels should be measured to the nearest 0.01 foot relative to the RP.
- For measuring wells that are under pressure, allow a period of time for the groundwater levels to stabilize. In these cases, multiple measurements should be collected to ensure the well has reached equilibrium such that no significant changes in water level are observed. Every effort should be made to ensure that a representative stable depth to groundwater is recorded. If a well does not stabilize, the quality of the value should be appropriately qualified as a

questionable measurement. In the event that a well is artesian, site specific procedures should be developed to collect accurate information and be protective of safety conditions associated with a pressurized well. In many cases, an extension pipe may be adequate to stabilize head in the well. Record the dimension of the extension and document measurements and configuration.

- The sampler should calculate the groundwater elevation as:

$$GWE = RPE - DTW$$

Where:

GWE = Groundwater Elevation
RPE = Reference Point Elevation
DTW = Depth to Water

The sampler must ensure that all measurements are in consistent units of feet, tenths of feet, and hundredths of feet. Measurements and RPEs should not be recorded in feet and inches.

**Recording Groundwater Levels**

- The sampler should record the well identifier, date, time (24-hour format), RPE, height of RP above or below ground surface, DTW, GWE, and comments regarding any factors that may influence the depth to water readings such as weather, nearby irrigation, flooding, potential for tidal influence, or well condition. If there is a questionable measurement or the measurement cannot be obtained, it should be noted. An example of a field sheet with the required information is shown in **Figure 4**. It includes questionable measurement and no measurement codes that should be noted. This field sheet is provided as an example. Standardized field forms should be used for all data collection. The aforementioned USGS *Groundwater Technical Procedures* offers a number of example forms.
- The sampler should replace any well caps or plugs, and lock any well buildings or covers.
- All data should be entered into the GSA data management system (DMS) as soon as possible. Care should be taken to avoid data entry mistakes and the entries should be checked by a second person for compliance with the DQOs.

STATE OF CALIFORNA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
**WELL DATA**

| STATE WELL NUMBER | COUNTY | REFERENCE POINT ELEV. | MEASURING AGENCY |
|---|---|---|---|
| | | | DWR |

| NO MEASUREMENT | QUESTIONABLE MEASUREMENT |
|---|---|
| 0. Measurement discontinued | 0. Caved or deepened |
| 1. Pumping | 1. Pumping |
| 2. Pump house locked | 2. Nearby pump operating |
| 3. Tape hung up | 3. Casing leaky or wet |
| 4. Can't get tape in casing | 4. Pumped recently |
| 5. Unable to locate well | 5. Air or pressure gauge measurement |
| 6. Well has been destroyed | 6. Other |
| 7. Special | 7. Recharge operation at or nearby well |
| 8. Casing leaky or wet | 8. Oil in casing |
| 9. Temporarily inaccessible | |

| DATE | N M | Q M | TAPE AT RP | TAPE AT WS | RP to WS | OBSR VR | COMMENTS |
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DWR 1213

**Figure 4 – Example of Water Level Well Data Field Collection Form**

**Pressure Transducers**

Groundwater levels and/or calculated groundwater elevations may be recorded using pressure transducers equipped with data loggers installed in monitoring wells. When installing pressure transducers, care must be exercised to ensure that the data recorded by the transducers is confirmed with hand measurements.

The following general protocols must be followed when installing a pressure transducer in a monitoring well:

- The sampler must use an electronic sounder or chalked steel tape and follow the protocols listed above to measure the groundwater level and calculate the groundwater elevation in the monitoring well to properly program and reference the installation. It is recommended that transducers record measured groundwater level to conserve data capacity; groundwater elevations can be calculated at a later time after downloading.
- The sampler must note the well identifier, the associated transducer serial number, transducer range, transducer accuracy, and cable serial number.
- Transducers must be able to record groundwater levels with an accuracy of at least 0.1 foot. Professional judgment should be exercised to ensure that the data being collected is meeting the DQO and that the instrument is capable. Consideration of the battery life, data storage capacity, range of groundwater level fluctuations, and natural pressure drift of the transducers should be included in the evaluation.
- The sampler must note whether the pressure transducer uses a vented or non-vented cable for barometric compensation. Vented cables are preferred, but non-vented units provide accurate data if properly corrected for natural barometric pressure changes. This requires the consistent logging of barometric pressures to coincide with measurement intervals.
- Follow manufacturer specifications for installation, calibration, data logging intervals, battery life, correction procedure (if non-vented cables used), and anticipated life expectancy to assure that DQOs are being met for the GSP.
- Secure the cable to the well head with a well dock or another reliable method. Mark the cable at the elevation of the reference point with tape or an indelible marker. This will allow estimates of future cable slippage.
- The transducer data should periodically be checked against hand measured groundwater levels to monitor electronic drift or cable movement. This should happen during routine site visits, at least annually or as necessary to maintain data integrity.

- The data should be downloaded as necessary to ensure no data is lost and entered into the basin's DMS following the QA/QC program established for the GSP. Data collected with non-vented data logger cables should be corrected for atmospheric barometric pressure changes, as appropriate. After the sampler is confident that the transducer data have been safely downloaded and stored, the data should be deleted from the data logger to ensure that adequate data logger memory remains.

## PROTOCOLS FOR SAMPLING GROUNDWATER QUALITY

The following protocols can be incorporated into a GSP's monitoring protocols for collecting groundwater quality data. More detailed sampling procedures and protocols are included in the standards and guidance documents listed at the end of this BMP. A GSP that adopts protocols that deviate from these BMPs must demonstrate that the adopted protocols will yield comparable data.

In general, the use of existing water quality data within the basin should be done to the greatest extent possible if it achieves the DQOs for the GSP. In some cases it may be necessary to collect additional water quality data to support monitoring programs or evaluate specific projects. The USGS *National Field Manual for the Collection of Water Quality Data* (Wilde, 2005) should be used to guide the collection of reliable data. **Figure 5** illustrates a typical groundwater quality sampling setup.

**Figure 5 – Typical Groundwater Quality Sampling Event**

All analyses should be performed by a laboratory certified under the State Environmental Laboratory Accreditation Program. The specific analytical methods are beyond the scope of this BMP, but should be commiserate with other programs evaluating water quality within the basin for comparative purposes.

***Groundwater quality sampling protocols should ensure that:***

- Groundwater quality data are taken from the correct location
- Groundwater quality data are accurate and reproducible
- Groundwater quality data represent conditions that inform appropriate basin management and are consistent with the DQOs
- All salient information is recorded to normalize, if necessary, and compare data
- Data are handled in a way that ensures data integrity

The following points are general guidance in addition to the techniques presented in the previously mentioned USGS *National Field Manual for the Collection of Water Quality Data.*

***Standardized protocols include the following:***

- Prior to sampling, the sampler must contact the laboratory to schedule laboratory time, obtain appropriate sample containers, and clarify any sample holding times or sample preservation requirements.
- Each well used for groundwater quality monitoring must have a unique identifier. This identifier must appear on the well housing or the well casing to avoid confusion.
- In the case of wells with dedicated pumps, samples should be collected at or near the wellhead. Samples should not be collected from storage tanks, at the end of long pipe runs, or after any water treatment.
- The sampler should clean the sampling port and/or sampling equipment and the sampling port and/or sampling equipment must be free of any contaminants. The sampler must decontaminate sampling equipment between sampling locations or wells to avoid cross-contamination between samples.
- The groundwater elevation in the well should be measured following appropriate protocols described above in the groundwater level measuring protocols.
- For any well not equipped with low-flow or passive sampling equipment, an adequate volume of water should be purged from the well to ensure that the groundwater sample is representative of ambient groundwater and not stagnant water in the well casing. Purging three well casing volumes is generally

considered adequate. Professional judgment should be used to determine the proper configuration of the sampling equipment with respect to well construction such that a representative ambient groundwater sample is collected. If pumping causes a well to be evacuated (go dry), document the condition and allow well to recover to within 90% of original level prior to sampling. Professional judgment should be exercised as to whether the sample will meet the DQOs and adjusted as necessary.

- Field parameters of pH, electrical conductivity, and temperature should be collected for each sample. Field parameters should be evaluated during the purging of the well and should stabilize prior to sampling. Measurements of pH should only be measured in the field, lab pH analysis are typically unachievable due to short hold times. Other parameters, such as oxidation-reduction potential (ORP), dissolved oxygen (DO) (in situ measurements preferable), or turbidity, may also be useful for meeting DQOs of GSP and assessing purge conditions. All field instruments should be calibrated daily and evaluated for drift throughout the day.
- Sample containers should be labeled prior to sample collection. The sample label must include: sample ID (often well ID), sample date and time, sample personnel, sample location, preservative used, and analytes and analytical method.
- Samples should be collected under laminar flow conditions. This may require reducing pumping rates prior to sample collection.
- Samples should be collected according to appropriate standards such as those listed in the *Standard Methods for the Examination of Water and Wastewater*, USGS *National Field Manual for the Collection of Water Quality Data,* or other appropriate guidance. The specific sample collection procedure should reflect the type of analysis to be performed and DQOs.
- All samples requiring preservation must be preserved as soon as practically possible, ideally at the time of sample collection. Ensure that samples are appropriately filtered as recommended for the specific analyte. Entrained solids can be dissolved by preservative leading to inconsistent results of dissolve analytes. Specifically, samples to be analyzed for metals should be field-filtered prior to preservation; do not collect an unfiltered sample in a preserved container.
- Samples should be chilled and maintained at 4 °C to prevent degradation of the sample. The laboratory's Quality Assurance Management Plan should detail appropriate chilling and shipping requirements.

- Samples must be shipped under chain of custody documentation to the appropriate laboratory promptly to avoid violating holding time restrictions.
- Instruct the laboratory to use reporting limits that are equal to or less than the applicable DQOs or regional water quality objectives/screening levels.

***Special protocols for low-flow sampling equipment***

In addition to the protocols listed above, sampling using low-flow sample equipment should adopt the following protocols derived from EPA's *Low-flow (minimal drawdown) ground-water sampling procedures* (Puls and Barcelona, 1996). These protocols apply to low-flow sampling equipment that generally pumps between 0.1 and 0.5 liters per minute. These protocols are not intended for bailers.

***Special protocols for passive sampling equipment***

In addition to the protocols listed above, passive diffusion samplers should follow protocols set forth in USGS Fact Sheet 088-00.

**PROTOCOLS FOR MONITORING SEAWATER INTRUSION**

Monitoring seawater intrusion requires analysis of the chloride concentrations within groundwater of each principal aquifer subject to seawater intrusion. While no significant standardized approach exists, the methodologies described above for degraded water quality can be applied for the collection of groundwater samples. In addition to the protocol described above, the following protocols should be followed:

- Water quality samples should be collected and analyzed at least semi-annually. Samples will be analyzed for dissolved chloride at a minimum. It may be beneficial to include analyses of iodide and bromide to aid in determination of salinity source. More frequent sampling may be necessary to meet DQOs of GSP. The development of surrogate measures of chloride concentration may facilitate cost-effective means to monitor more frequently to observe the range of conditions and variability of the flow dynamics controlling seawater intrusion.
- Groundwater levels will be collected at a frequency adequate to characterize changes in head in the vicinity of the leading edge of degraded water quality in each principal aquifer. Frequency may need to be increased in areas of known preferential pathways, groundwater pumping, or efficacy evaluation of mitigation projects.
- The use of geophysical surveys, electrical resistivity, or other methods may provide for identification of preferential pathways and optimize monitoring well placement and evaluation of the seawater intrusion front. Professional judgment

should be exercised to determine the appropriate methodology and whether the DQOs for the GSP would be met.

**PROTOCOLS FOR MEASURING STREAMFLOW**

Monitoring of streamflow is necessary for incorporation into water budget analysis and for use in evaluation of stream depletions associated with groundwater extractions. The use of existing monitoring locations should be incorporated to the greatest extent possible. Many of these streamflow monitoring locations currently follow the protocol described below.

Establishment of new streamflow discharge sites should consider the existing network and the objectives of the new location. Professional judgment should be used to determine the appropriate permitting that may be necessary for the installation of any monitoring locations along surface water bodies. Regular frequent access will be necessary to these sites for the development of ratings curves and maintenance of equipment.

To establish a new streamflow monitoring station special consideration must be made in the field to select an appropriate location for measuring discharge. Once a site is selected, development of a relationship of stream stage to discharge will be necessary to provide continuous estimates of streamflow. Several measurements of discharge at a variety of stream stages will be necessary to develop the ratings curve correlating stage to discharge. The use of Acoustic Doppler Current Profilers (ADCPs) can provide accurate estimates of discharge in the correct settings. Professional judgment must be exercised to determine the appropriate methodology. Following development of the ratings curve a simple stilling well and pressure transducer with data logger can be used to evaluate stage on a frequent basis. A simple stilling well and staff gage is illustrated in **Figure 6**.

Streamflow measurements should be collected, analyzed, and reported in accordance with the procedures outlined in USGS Water Supply Paper 2175, *Volume 1. – Measurement of Stage Discharge* and *Volume 2. – Computation of Discharge.* This methodology is currently being used by both the USGS and DWR for existing streamflow monitoring throughout the State.

**Figure 6 – Simple Stilling Well and Staff Gage Setup**

## PROTOCOLS FOR MEASURING SUBSIDENCE

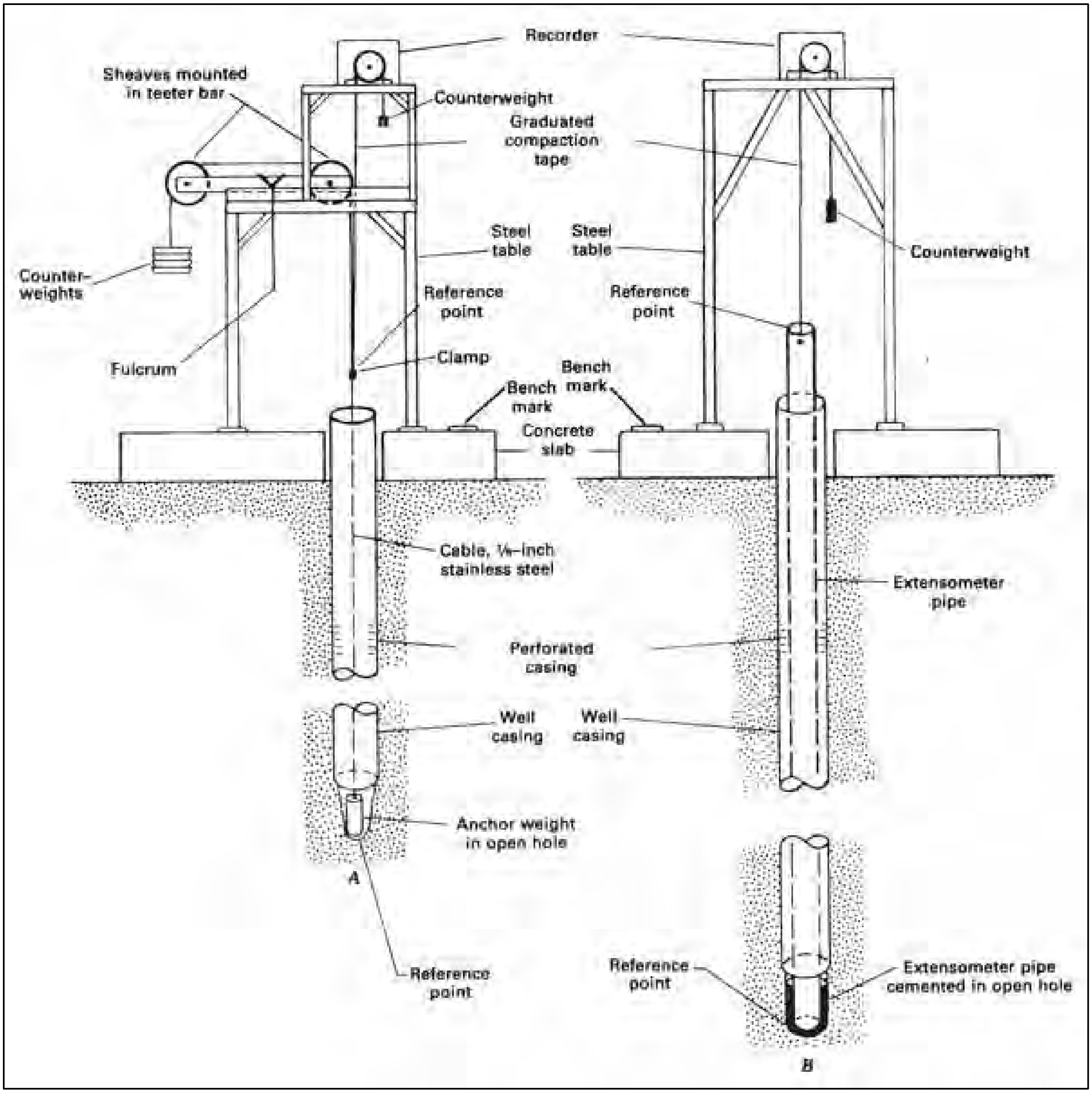
Evaluating and monitoring inelastic land subsidence can utilize multiple data sources to evaluate the specific conditions and associated causes. To the extent possible, the use of existing data should be utilized. Subsidence can be estimated from numerous techniques, they include: level surveying tied to known stable benchmarks or benchmarks located outside the area being studied for possible subsidence; installing and tracking changes in borehole extensometers; obtaining data from continuous GPS (CGPS) locations, static GPS surveys or Real-Time-Kinematic (RTK) surveys; or analyzing Interferometric Synthetic Aperture Radar (InSAR) data. No standard procedures exist for collecting data from the potential subsidence monitoring approaches. However, an approach may include:

- Identification of land subsidence conditions.
    - Evaluate existing regional long-term leveling surveys of regional infrastructure, i.e. roadways, railroads, canals, and levees.
    - Inspect existing county and State well records where collapse has been noted for well repairs or replacement.
    - Determine if significant fine-grained layers are present such that the potential for collapse of the units could occur should there be significant depressurization of the aquifer system.

  - Inspect geologic logs and the hydrogeologic conceptual model to aid in identification of specific units of concern.
  - Collect regional remote-sensing information such as InSAR, commonly provided by USGS and NASA. Data availability is currently limited, but future resources are being developed.
- Monitor regions of suspected subsidence where potential exists.
  - Establish CGPS network to evaluate changes in land surface elevation.
  - Establish leveling surveys transects to observe changes in land surface elevation.
  - Establish extensometer network to observe land subsidence. An example of a typical extensometer design is illustrated in **Figure 7**. There are a variety of extensometer designs and they should be selected based on the specific DQOs.

Various standards and guidance documents for collecting data include:

- Leveling surveys must follow surveying standards set out in the California Department of Transportation's Caltrans Surveys Manual.
- GPS surveys must follow surveying standards set out in the California Department of Transportation's Caltrans Surveys Manual.
- USGS has been performing subsidence surveys within several areas of California. These studies are sound examples for appropriate methods and should be utilized to the extent possible and where available:
  - http://ca.water.usgs.gov/land_subsidence/california-subsidence-measuring.html
- Instruments installed in borehole extensometers must follow the manufacturer's instructions for installation, care, and calibration.
- Availability of InSAR data is improving and will increase as programs are developed. This method requires expertise in analysis of the raw data and will likely be made available as an interpretative report for specific regions.




## Figure 7 – Simplified Extensometer Diagram

## 6. KEY DEFINITIONS

The key definitions and sections related to Groundwater Monitoring Protocols, Standards, and Sites outlined in applicable SGMA code and regulations are provided below for reference.

**Groundwater Sustainability Plan Regulations (California Code of Regulations §351)**

- §351(h) "Best available science" refers to the use of sufficient and credible information and data, specific to the decision being made and the time frame available for making that decision, that is consistent with scientific and engineering professional standards of practice.
- §351(i) "Best management practice" refers to a practice, or combination of practices, that are designed to achieve sustainable groundwater management and have been determined to be technologically and economically effective, practicable, and based on best available science.

**Monitoring Protocols Reference**

§352.2. Monitoring Protocols

Each Plan shall include monitoring protocols adopted by the Agency for data collection and management, as follows:

(a) Monitoring protocols shall be developed according to best management practices.

(b) The Agency may rely on monitoring protocols included as part of the best management practices developed by the Department, or may adopt similar monitoring protocols that will yield comparable data.

(c) Monitoring protocols shall be reviewed at least every five years as part of the periodic evaluation of the Plan, and modified as necessary.

**SGMA Reference**

§10727.2. Required Plan Elements

(f) Monitoring protocols that are designed to detect changes in groundwater levels, groundwater quality, inelastic surface subsidence for basins for which subsidence has been identified as a potential problem, and flow and quality of surface water that directly affect groundwater levels or quality or are caused by groundwater extraction in the basin. The monitoring protocols shall be designed to generate information that promotes efficient and effective groundwater management.

# 7. Related Materials

## CASE STUDIES

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**ONLINE RESOURCES**

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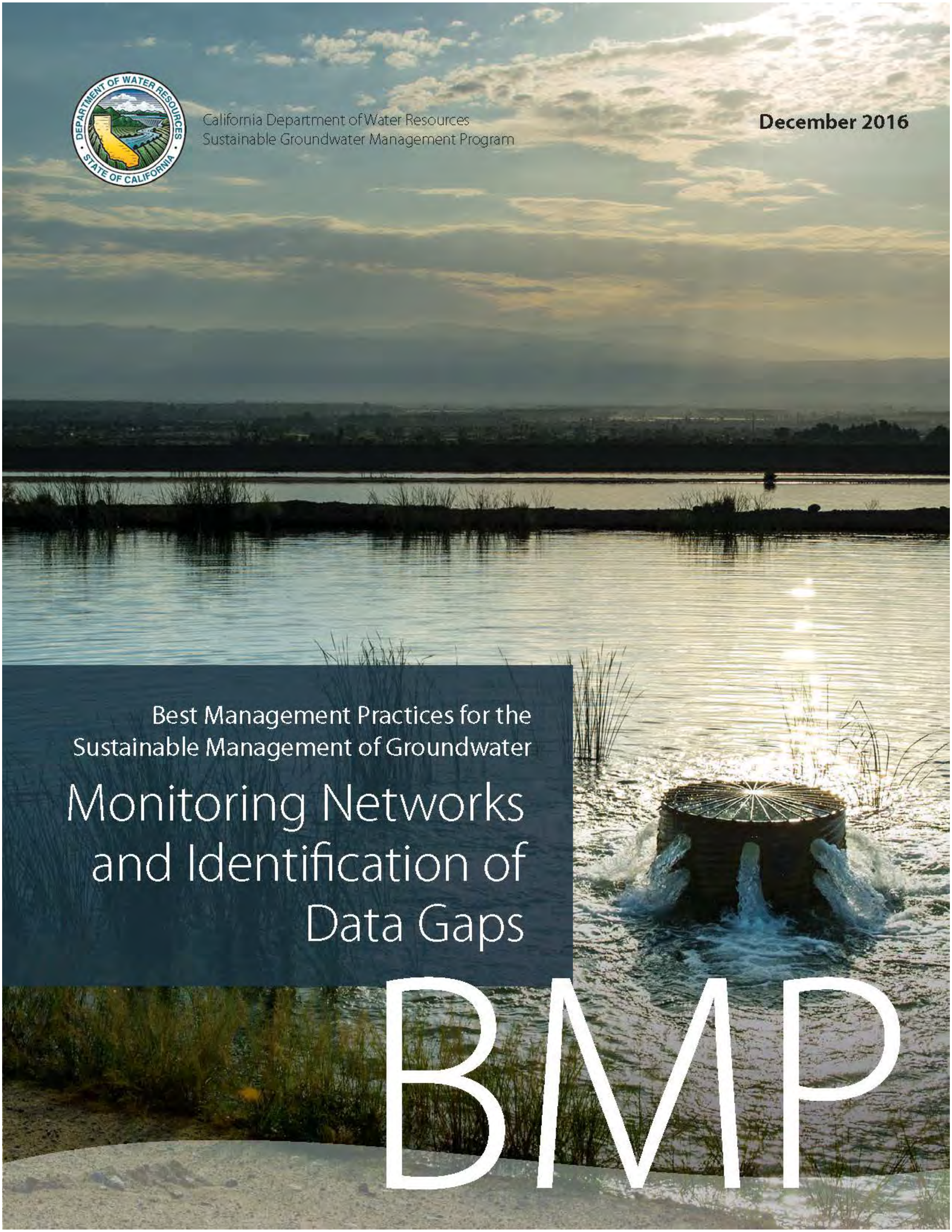
Measuring Land Subsidence web page. U.S. Geological Survey. http://ca.water.usgs.gov/land_subsidence/california-subsidence-measuring.html

USGS Global Positioning Application and Practice web page. U.S. Geological Survey. http://water.usgs.gov/osw/gps/

# Appendix 4Db Monitoring Networks and Identification of Data Gaps Best Management Practices



California Department of Water Resources
Sustainable Groundwater Management Program

December 2016

Best Management Practices for the Sustainable Management of Groundwater

# Monitoring Networks and Identification of Data Gaps

# BMP

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# Monitoring Networks and Identification of Data Gaps Best Management Practice

## 1. Objective

The objective of this Best Management Practice (BMP) is to assist in the development of Monitoring Networks and Identification of Data Gaps. The California Department of Water Resources (the Department or DWR) has developed this document as part of the obligation in the Technical Assistance chapter (Chapter 7) of the Sustainable Groundwater Management Act (SGMA) to support the long-term sustainability of California's groundwater *basins*. Information provided in this BMP provides technical assistance to Groundwater Sustainability Agencies (GSAs) and other stakeholders to aid in the development of a monitoring network that is capable of providing sustainability indicator data of sufficient accuracy and quantity to demonstrate that the basin is being sustainably managed. In addition, this BMP is intended to provide information on how to identify and plan to resolve data gaps to reduce uncertainty that may be necessary to improve the ability of the GSP to achieve the sustainability goal for the basin.

This BMP includes the following sections:

1. Objective. A brief description of how and where monitoring networks are required under Sustainable Groundwater Management Act (SGMA) and the overall objective of this BMP.
2. Use and Limitations. A brief description of the use and limitations of this BMP.
3. Monitoring Network Fundamentals. A description of the general approach and background of groundwater monitoring networks.
4. Relationship of Monitoring Network to other BMPs. A description of how this BMP is connected with other BMPs.
5. Technical Assistance. Technical content of BMP providing guidance for regulatory sections.
6. Key Definitions. Descriptions of those definitions identified in the GSP Regulations, SGMA, or Basin Boundary Regulations.
7. Related Materials. References and other materials that provide supporting information related to the development of Groundwater Monitoring Networks.

## 2. USE AND LIMITATIONS

BMPs developed by the Department provide technical guidance to GSAs and other stakeholders. Practices described in these BMPs do not replace the GSP Regulations, nor do they create new requirements or obligations for GSAs or other stakeholders. In addition, using this BMP to develop a GSP does not equate to an approval determination by the Department. All references to GSP Regulations relate to Title 23 of the California Code of Regulations (CCR), Division 2, Chapter 1.5, and Subchapter 2. All references to SGMA relate to California Water Code sections in Division 6, Part 2.74.

## 3. MONITORING NETWORK FUNDAMENTALS

Monitoring is a fundamental component necessary to measure progress toward the achievement of any management goal. A monitoring network must have adequate spatial and temporal collection of multiple datasets, including groundwater levels, water quality information, land surface elevation, and surface water discharge conditions to demonstrate compliance with the GSP Regulations.

SGMA requires GSAs to establish and track locally defined significant and unreasonable conditions for each of the sustainability indicators. In addition, the collection of data from a robust network is required to ensure that uncertainty is appropriately reduced during the analysis of these datasets. Data collected in an organized and consistent manner will aid in ensuring that the interpretations of the data are as accurate as possible. Also, the consistency of the types, methods, and timing of data collection facilitate the sharing of data across basin boundaries or within basins.

Analyzing data from an adequate monitoring network within a basin can lead to refinement of the understanding of the dynamic flow conditions; this leads to the optimization of sustainable groundwater management.

## 4. RELATIONSHIP OF MONITORING NETWORKS TO OTHER BMPS

Groundwater monitoring is a fundamental component of SGMA as each GSP must include a sufficient network that provides data that demonstrate measured progress toward achievement of the sustainability goal for each basin. For this reason, a sufficient network will need to be developed and utilized to accomplish this component of SGMA.

It is important that data are developed in a manner consistent with the basin setting, planning, and projects/management actions steps identified on **Figure 1** and the GSP

Regulations. The inclusion of monitoring protocols in the GSP Regulations also emphasizes the importance of quality empirical data to support GSPs and provide comparable information from basin to basin.

**Figure 1** provides a logical progression for the development of a GSP and illustrates how monitoring networks are linked to other related BMPs. This figure also shows the context of the BMPs as they relate to various steps to sustainability as outlined in the GSP Regulations. The monitoring protocol BMP is part of the Monitoring step identified in the logical progression illustration in **Figure 1**.

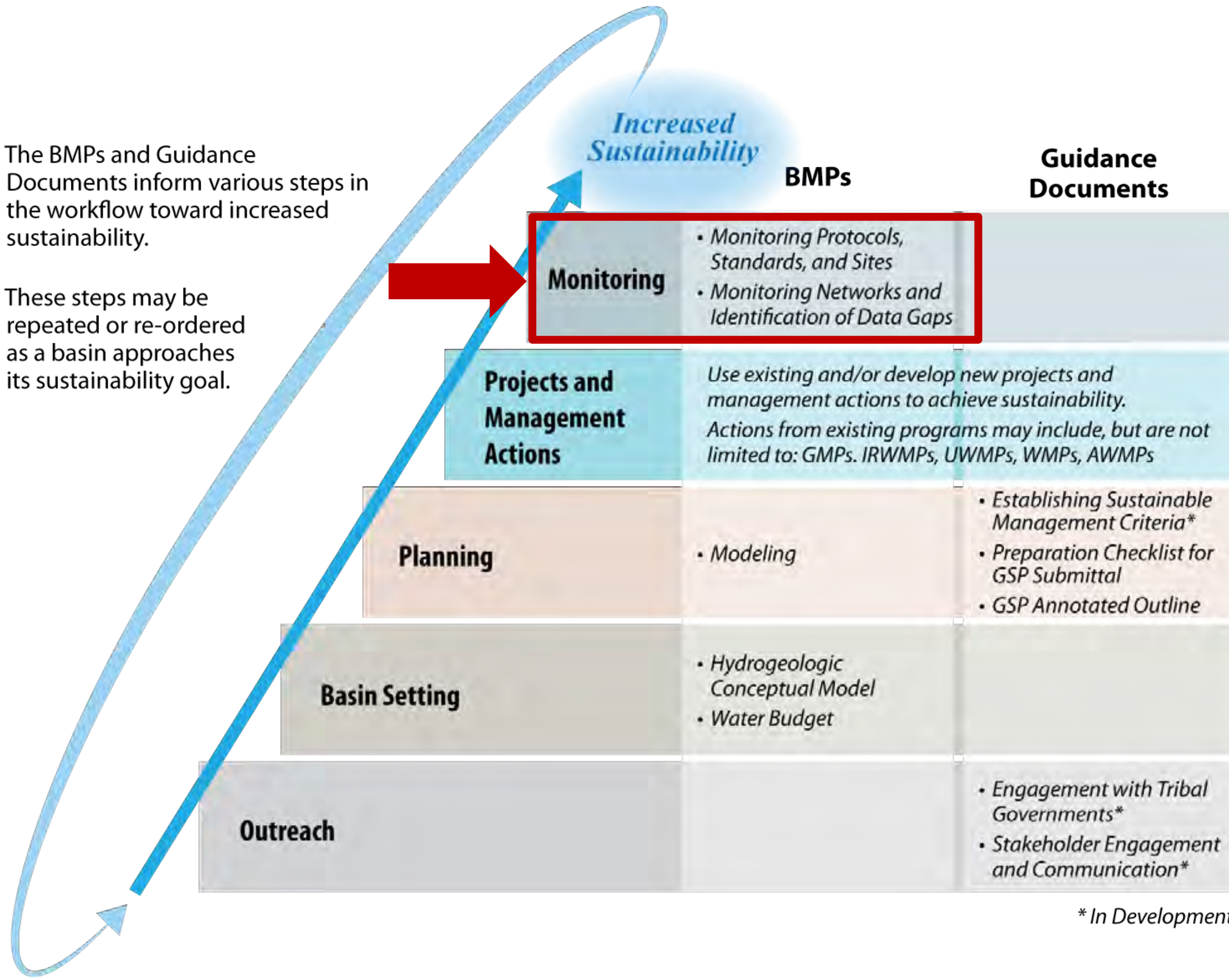


**Figure 1 – Logical Progression of Basin Activities Needed to Increase Basin Sustainability**

## 5. Technical Assistance

This section provides technical assistance to support the development monitoring networks and identification of data gaps.

### GENERAL MONITORING NETWORKS

***23 CCR §354.32 Introduction to Monitoring Networks* and *§354.34 (a) and (b) Monitoring Network***

> ***23 CCR §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.*
>
> ***23 CCR §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. (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 distribution 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.*
> *(2) Monitor impacts to the beneficial uses or users of groundwater.*
> *(3) Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds.*
> *(4) Quantify annual changes in water budget components.*

The GSP Regulations require GSAs to develop a monitoring network. The monitoring network must be capable of capturing data on a sufficient temporal frequency and spatial distribution to demonstrate short-term, seasonal, and long-term trends in basin conditions for each of the sustainability indicators, and provide enough information to evaluate GSP implementation. A monitoring network should be developed in such a way that it demonstrates progress toward achieving measureable objectives.

As described in the Monitoring Protocols, Standards, and Sites BMP, it is suggested that each GSP incorporate the Data Quality Objective (DQO) process following the US EPA *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006). Although strict adherence to this method is not required, it does provide a robust approach to ensuring data is collected with a specific purpose in mind, and efforts for monitoring are as efficient as possible to achieve the objectives of the GSP and compliance with the GSP Regulations.

The DQO process presents a method that can be applied directly to the sustainability criteria quantitative requirements through the following steps:

1. State the problem – define sustainability indicators and planning considerations of the GSP and sustainability goal
2. Identify the goal – describe the quantitative measurable objectives and minimum thresholds for each of the sustainability indicators
3. Identify the inputs – describe the data necessary to evaluate the sustainability indicators and other GSP requirements (i.e., water budget)
4. Define the boundaries of the study – This is commonly the extent of the Bulletin 118 groundwater basin or subbasin, unless multiple GSPs are prepared for a given basin. In that case, evaluation of the coordination plan and specifically how the monitoring will be comparable and meet the sustainability goals for the entire basin should be described
5. Develop an analytical approach – Determine how the quantitative sustainability indicators will be evaluated (i.e., are special analytical methods required that have specific data needs)
6. Specify performance or acceptance criteria – Determine what quality the data must have to achieve the objective and provide some assurance that the analysis is accurate and reliable
7. Develop a plan for obtaining data – Once the objectives are known determine how these data should be collected. Existing data sources should be used to the greatest extent possible

These steps of the DQO process should be used to guide GSAs to development of the most efficient monitoring process to meet the measurable objectives of the GSP and the sustainability goal. The DQO process is an iterative process and should be evaluated regularly to improve monitoring efficiencies and meet changing planning and project needs. Following the DQO process GSAs should also include a data quality control and quality assurance plan to guide the collection of data.

GSAs should first evaluate their existing monitoring network and existing datasets when developing the monitoring network for their GSP, such as the California Statewide Groundwater Elevation Monitoring (CASGEM) program. The *Assessment and Improvement of Monitoring Network* Section of the Regulations describes a process by which GSAs can identify and fill in gaps in their monitoring network. The existing monitoring networks may require evaluation to ensure they meet the DQOs necessary for the GSP. Other considerations for developing a monitoring network include:

- <u>Degree of monitoring.</u> The degree of monitoring should be consistent with the level of groundwater use and need for various levels of monitoring density and frequency. Areas that are subject to greater groundwater pumping, greater fluctuations in conditions, significant recharge areas, or specific projects may require more monitoring (temporal and/or spatial) than areas that experience less activity or are more static.
- <u>Access Issues.</u> GSAs may have to deal with access issues such as unwilling landowners, access agreements, destroyed wells, or other safety concerns with accessing a monitoring site.
- <u>Adjacent Basins.</u> Understanding conditions at or across basin boundaries is important. GSAs should coordinate with adjacent basins on monitoring efforts to be consistent both temporally and spatially. Coordinated efforts and shared data will help GSAs understand their basins' conditions better and potentially better understand groundwater flow conditions across boundaries.
- <u>Consider all sustainability indicators.</u> GSAs should look for ways to efficiently use monitoring sites to collect data for more than one or all of the sustainability indicators. Similarly, when installing a new monitoring site, GSAs should take that opportunity to gather as much information about the subsurface conditions as possible.

There are many other considerations that GSAs must understand when developing monitoring networks that are specific to the various sustainability indicators: chronic lowering of groundwater levels, reduction of groundwater storage, seawater intrusion, degraded water quality, land subsidence, or depletions of interconnected surface waters. In addition, establishment of a monitoring network should be evaluated in conjunction with the Monitoring Protocols, Standards, and Sites; Hydrogeologic Conceptual Model (HCM); Water Budget; and Modeling BMPs when considering the data needs to meet GSP measurable objectives and the sustainability goal.

## SPECIFIC MONITORING NETWORKS

***23 CCR §354.34(d)-(j):***

*(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.*

*(e) A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.*

*(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.*

*(2) Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow.*

*(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.*

*(4) Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.*

*(g) Each Plan shall describe the following information about the monitoring network:*

*(1) Scientific rationale for the monitoring site selection process.*

*(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.*

*(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.*

*(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.*

*(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.*

*(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.*

Monitoring data provide the basis for demonstrating that undesirable results are avoided and are necessary for adequately managing the basin. The undesirable result associated with each sustainability indicator is based on a unique set of representative monitoring points. Therefore, a single monitoring network may not be appropriate to address all sustainability indicators. The monitoring network will consist of an adequate magnitude of monitoring locations that will characterize the groundwater flow regime such that a GSA will have the ability to predict sustainability indicator responses to management actions and document those results. The data collected from these networks will be the foundation for communication to other connected basins as one may affect another. The transparent availability of data is intended to alleviate conflict by demonstrating conditions in a consistent manner such that assessment of the sustainability indicators is relatively consistent from basin to basin.

The use of existing monitoring networks established during implementation of CASGEM, Irrigated Lands Reporting Program (IRLP), Groundwater Ambient Monitoring and Assessment Program (GAMA), National Groundwater Monitoring Network, Existing Groundwater Management Planning, and other local programs could be used for a base monitoring network from which to build. These networks should be evaluated for compliance with GSP Regulations and DQOs.

This section addresses the design and installation of monitoring networks and sites. Agencies must address a number of issues prior to designing the monitoring site, including, but not limited to, establishing the reason for installing the monitoring site, obtaining access agreements, assessing how the monitoring site may improve the basin conceptual model, assessing how the monitoring site may reduce uncertainty, etc. Where management areas are established, each area must be considered when developing the monitoring network for each sustainability indicator.

Professional judgement will be essential to determining the degree of monitoring that will be necessary to meet the needs for the GSP. This BMP provides guidance, but should be coupled with site-specific monitoring needs to address the complexities of the groundwater basin and DQOs.

The following sections are organized by each of the sustainability indicators. These considerations should be applied to the network as a whole to ensure the quality of the data is consistent and reliable, and so that sound representative monitoring locations can be established, as described in the Representative Monitoring Points (RMP) section of this BMP.

## A. Chronic Lowering of Groundwater Levels

> ***§354.34(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.*
> *(B) Static groundwater elevation measurements shall be collected at least two times per year, to represent seasonal low and seasonal high groundwater conditions.*

The observation and collection of groundwater level data is the cornerstone of data collected for SGMA compliance. Design of the groundwater level data monitoring network will be dependent upon the initial hydrogeologic conceptual model and will likely undergo refinement both temporally and spatially as management in the basin progresses. This isn't to say that the monitoring network will continually expand, but rather, through increased understanding, be more refined to gather the necessary information in the most efficient way possible to demonstrate sustainability, and exercise the basin to maintain conditions consistent with the sustainability goal and sustainable yield of the basin. The use of groundwater levels as a surrogate for other sustainability indicators will require reliable, consistent, high-quality, defendable data to demonstrate the relationship prior to use as a surrogate for other sustainability indicators.

Wells that are part of the monitoring program should be dedicated groundwater monitoring wells with known construction information. The selection of wells should be aquifer-specific and wells that are screened across more than one aquifer should be avoided where possible. If existing wells are used, the perforated intervals should be known to be able to utilize water level or other data collected from that well. Development of the monitoring well network must evaluate and consider both unconfined and confined aquifers, and assess where pumping wells are screened that affect monitoring at these locations. Agricultural or municipal wells can be used temporarily until either dedicated monitoring wells can be installed or an existing well can be identified that meets the above criteria. If agricultural or municipal wells are used for monitoring, the wells must be screened across a single water-bearing unit, and care must be taken to ensure that pumping drawdown has sufficiently recovered before collecting data from a well.

Each well selected for inclusion in the monitoring network should be evaluated to ensure that water level data obtained meet the DQOs for that well. For example, some wells may be directly influenced by nearby pumping, or injection and observation of the aquifer response may be the purpose of the well. Otherwise, the network should contain an adequate number of wells to observe the overall static conditions and the specific project effects. Well construction details and pumping information for active and inactive wells located in the area of the selected monitoring well location should be reviewed to determine whether construction details or pumping activity at those wells could affect water level or water quality data for the selected monitoring site.

There is no definitive rule for the density of groundwater monitoring points needed in a basin. **Table 1** was adopted from the *CASGEM Groundwater Elevation Monitoring Guidelines* (DWR, 2010). This table summarizes existing references to quantify the density of monitoring wells per hundred square miles. While these estimates may provide guidance, the necessary monitoring point density for GSP depends on local geology, extent of groundwater use, and how the GSPs define undesirable results. The use of Hopkins (1984) analysis incorporates a relative well density based on the degree of groundwater use within a given area. Professional judgement will be essential to determining an adequate level of monitoring, frequency, and density based on the DQOs and the need to observe aquifer response to high pumping areas, cones of depression, significant recharge areas, and specific projects.

### Table 1. Monitoring Well Density Considerations

| Reference | Monitoring Well Density (wells per 100 miles$^2$) |
|---|---|
| Heath (1976) | 0.2 - 10 |
| Sophocleous (1983) | 6.3 |
| Hopkins (1984)<br>Basins pumping more than 10,000 acre-feet/year per 100 miles$^2$ | 4.0 |
| Basins pumping between 1,000 and 10,000 acre-feet/year per 100 miles$^2$ | 2.0 |
| Basins pumping between 250 and 1,000 acre-feet/year per 100 miles$^2$ | 1.0 |
| Basins pumping between 100 and 250 acre-feet/year per 100 miles$^2$ | 0.7 |

In addition to monitoring well network density, the frequency of monitoring to characterize the groundwater dynamics within a basin or area is important. The discussion presented in the *National Framework for Ground-water Monitoring in the United States* (ACWI, 2013) utilizes a degree of groundwater use and aquifer characteristics to aid in determining an appropriate frequency. **Figure 2** (ACWI, 2013) and **Table 2** (ACWI, 2013) describe these considerations and provide recommended frequency of long-term monitoring. It should be noted that the initial characterization is not included; the initial characterization of a monitoring location will require more frequent monitoring to establish the dynamic range and identification of external stresses affecting the groundwater level. An understanding of the full range of monitoring well conditions should be reached prior to establishing a long-term monitoring frequency. The considerations presented in **Figure 2** and **Table 2** should be evaluated to determine if the guidance meets the DQOs to support the GSP. Professional judgment should be used to refine the monitoring frequency and density.

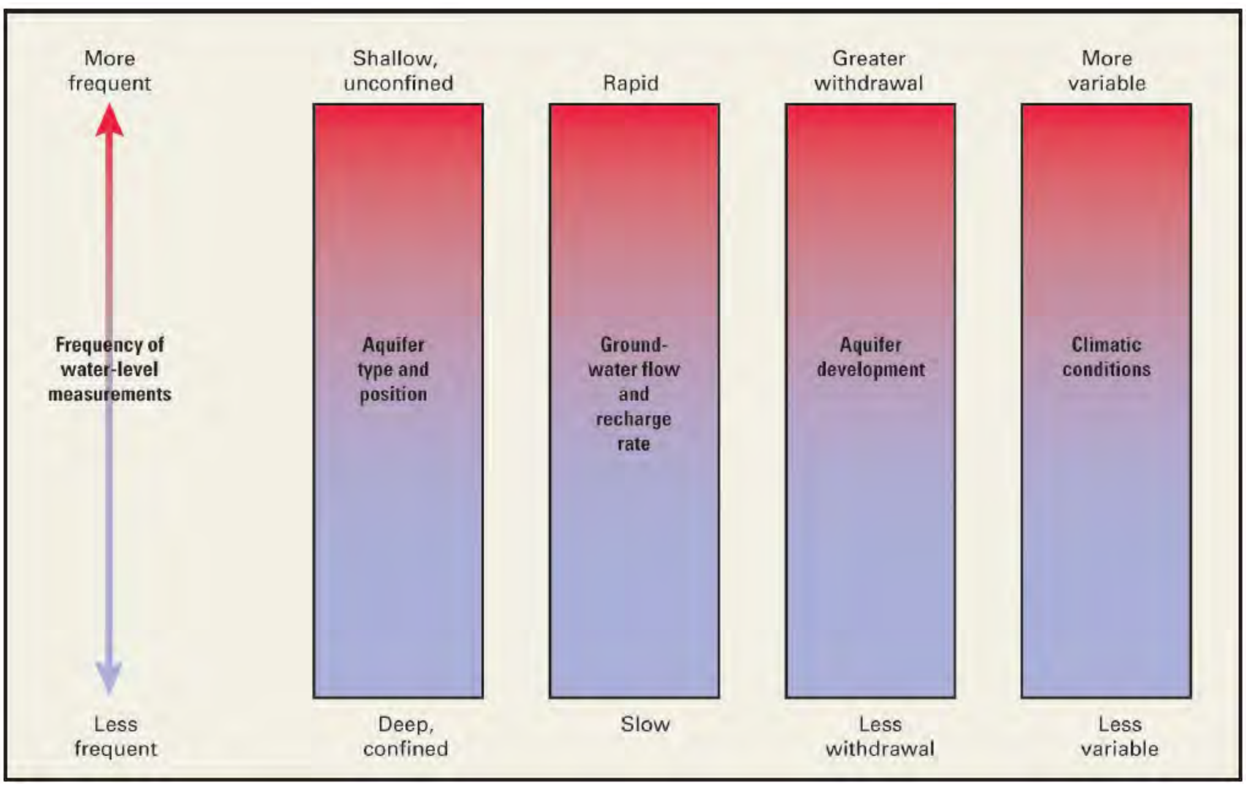


**Figure 2. Factors Determining Frequency of Monitoring Groundwater Levels (Taylor and Alley, 2001, adapted from ACWI, 2013)**

**Table 2. Monitoring Frequency Based on Aquifer Properties and Degree of Use (adapted from ACWI, 2013)**

| Aquifer Type | Nearby Long-Term Aquifer Withdrawals | | |
|---|---|---|---|
| | Small Withdrawals | Moderate Withdrawals | Large Withdrawals |
| **Unconfined** | | | |
| "low" recharge (<5 in/yr) | Once per quarter | Once per quarter | Once per month |
| "high" recharge (>5 in/yr) | Once per quarter | Once per month | Once per day |
| **Confined** | | | |
| "low" hydraulic conductivity (<200 ft/d) | Once per quarter | Once per quarter | Once per month |
| "high" hydraulic conductivity (>200 ft/d) | Once per quarter | Once per month | Once per day |

The discussion below provides specific management practices for implementation of the GSP, where the general approaches for considering monitoring network density and frequency described above provide some guidance for the expectations for network design.

- New wells must meet applicable well installation standards set in California DWR Bulletin 74-81 and 74-90, or as updated.
- Groundwater level data will be collected from each principal aquifer in the basin.
- Groundwater level data must be sufficient to produce seasonal maps of potentiometric surfaces or water table surfaces throughout the basin that clearly identify changes in groundwater flow direction and gradient.
- Groundwater levels will be collected during the middle of October and March for comparative reporting purposes.
    - While semi-annual monitoring is required, more frequent, quarterly, monthly, or daily monitoring may be necessary to provide a more robust understanding of groundwater dynamics within the system.
    - Agencies will need to adjust the monitoring frequency to address uncertainty, such as in specific places where sustainability indicators are of concern, or to track specific management actions and projects as they are implemented.
    - Select wells should be monitored frequently enough to characterize the season high and low within the basin.

- Data must be sufficient for mapping groundwater depressions, recharge areas, and along margins of basins where groundwater flow is known to enter or leave a basin.
- Well density must be adequate to determine changes in storage.
- Data must be able to demonstrate the interconnectivity between shallow groundwater and surface water bodies, where appropriate.
- Data must be able to map the effects of management actions, i.e., managed aquifer recharge or hydraulic seawater intrusion barriers.
- Data must be able to demonstrate conditions at basin boundaries.
    - Agencies may consider coordinating monitoring efforts with adjacent basins to provide consistent data across basin boundaries.
    - Agencies may consider characterization and continued impacts of internal hydraulic boundary conditions, such as faults, disconformities, or other internal boundary types.
- Data must be able to characterize conditions and monitor adverse impacts as they may affect the beneficial uses and users identified within the basin.

**Additional Information:**

Ground-Water-Level Monitoring and the Importance of Long-Term Water-Level Data
http://pubs.usgs.gov/circ/circ1217/pdf/circ1217_final.pdf

A National Framework for Ground-Water Monitoring in the United States
Fact Sheet: http://acwi.gov/sogw/NGWMN_InfoSheet_final.pdf
Full Report: http://acwi.gov/sogw/ngwmn_framework_report_july2013.pdf

Statistical Design of Water-Level Monitoring Networks
http://pubs.usgs.gov/circ/circ1217/pdf/pt4.pdf

Design of Ground-Water Level Observation-Well Programs
http://onlinelibrary.wiley.com/doi/10.1111/j.1745-6584.1976.tb03635.x/epdf

## B. Reduction of Groundwater Storage

> ***23 CCR §354.34(c)(2):*** *Reduction of Groundwater Storage. Provide an estimate of the change in annual groundwater in storage.*

While reduction in groundwater storage is not a directly measureable condition, it does rely heavily on the collection of accurate groundwater levels, as described in the preceding section, and a robust understanding of the HCM and textural observations from boreholes. The identification in the HCM of discrete aquifer units and surrounding aquitards will be essential in assessing changes in groundwater storage. The changes in groundwater levels reflect changes in storage and can thus be estimated with assumptions of thickness of units, porosity, and connectivity. These observations will be essential for use in calculating the water budget; see the Water Budget BMP for more detail.

Estimates of changes in storage are available from remote sensing-based investigations, but should be used cautiously as they tend to be regional in nature and may not provide the level of accuracy necessary to fully determine the conditions within the basin. The National Aeronautics and Space Administration (NASA) mission, Gravity Recovery and Climate Experiment (GRACE) satellites provide analysis results of differential gravity response associated with changes in groundwater occurrence and terrestrial water storage, http://www.nasa.gov/mission_pages/Grace/#.WATU_fkrKUk .

## C. Seawater Intrusion

> ***23 CCR §354.34(c)(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.*

The monitoring network for seawater intrusion must capture changes in water quality conditions associated with the dynamic seawater-freshwater interface along coastal aquifers. This system is largely controlled by differences in water density and hydraulic head to maintain the advancement of the seawater front. A robust understanding is necessary to identify the preferential flow pathways where seawater can intrude inland and associate with freshwater groundwater extractions or declines in head. The following practices should be considered, at a minimum, to provide data supporting the assessment of seawater intrusion:

- Monitoring groundwater elevation in all seawater intrusion-specific monitoring locations should be consistent with the water level monitoring network and protocols described in this and the Monitoring Protocol, Standards, and Sites BMP.
- Monitor groundwater quality data from each principal aquifer in the basin that is currently, or may be in the future, impacted by seawater intrusion.
    - The spatial density must be adequate to map an isocontour of chloride advancement front as a representation of seawater. It may be useful to include other ions such as bromide and iodide for evaluation of source of high salinity water.
    - Monitoring should occur at least quarterly and correspond with seasonal highs and lows, or more frequently as appropriate. Professional judgment should be used to evaluate the necessary frequency and density of monitoring to meet the DQOs.
    - The above points do not include initial characterization, where more frequent monitoring may be necessary to evaluate the full dynamic range of aquifer response and associated seawater intrusion.
- Collect groundwater quality data from each principal aquifer in the basin that is currently, or may be in the future, impacted by degraded water quality.
    - Agencies should use, to the greatest degree possible, existing water quality monitoring data. For example, these could include ILRP, GAMA, existing Regional Water Quality Control Board (RWQCB) monitoring and remediation programs, and drinking water source assessment programs.
    - Collection of water quality samples are required to be analyzed for chloride concentration.
        - Additional analytes may be desirable for characterization and planning of mitigation measures.
        - The use of a surrogate must be demonstrated through correlative analysis and should be periodically quantitatively assessed following implementation of use.
- Define the three-dimensional extent of any existing seawater intrusion, or degraded water quality.
- Samples should be sufficient for mapping movement of seawater or degraded water quality.

- Samples should be sufficient to assess groundwater quality impacts on beneficial uses and users.

Spatial distribution of monitoring locations may be optimized by including geophysical techniques to identify the preferential pathways controlling seawater intrusion, and target critical connections to existing water supply wells and mitigation efforts.

### D. Degraded Water Quality

> ***23 CCR §354.34(c)(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.*

Groundwater quality monitoring networks should be designed to demonstrate that the degraded water quality sustainability indicator is being observed for the purpose of meeting the sustainability goal. The monitoring network should consist largely as supplemental monitoring locations where known groundwater contamination plumes under existing regulatory management and monitoring exist, and additional safeguards for plume migration are necessary. In addition, some monitoring may be necessary to address other degraded water quality issues in which migration could impact beneficial uses of water, including, but not limited to, unregulated contaminant plumes and naturally occurring water quality impacts. Seawater intrusion and degraded water quality are naturally related, as many practices are interchangeable. The following represent specific practices to be employed in the execution of the GSP:

- Monitor groundwater quality data from each principal aquifer in the basin that is currently, or may be in the future, impacted by degraded water quality.
    - The spatial distribution must be adequate to map or supplement mapping of known contaminants.
    - Monitoring should occur based upon professional opinion, but generally correlate to the seasonal high and low, or more frequent as appropriate.
        - Where regulated plumes exist, monitoring should coincide with regulatory monitoring for plume migration comparison purposes.
        - Where unregulated degraded water quality occurs, monitoring should be consistent with the degree of groundwater use in the regions of the known impacts.
- Collect groundwater quality data from each principal aquifer in the basin that is currently, or may be in the future, impacted by degraded water quality.

  - Agencies should use existing water quality monitoring data to the greatest degree possible. For example, these could include ILRP, GAMA, existing RWQCB monitoring and remediation programs, and drinking water source assessment programs.
- Define the three-dimensional extent of any existing degraded water quality impact.
- Data should be sufficient for mapping movement of degraded water quality.
- Data should be sufficient to assess groundwater quality impacts to beneficial uses and users.
- Data should be adequate to evaluate whether management activities are contributing to water quality degradation.

**Additional References:**

Framework for a ground-water quality monitoring and assessment program for California (GAMA)
http://pubs.usgs.gov/wri/wri034166/

Estimation of aquifer scale proportion using equal area grids: Assessment of regional scale groundwater quality
http://ca.water.usgs.gov/projects/gama/pdfs/Belitz_etal_2010_wrcr12701.pdf

### *E.* Land Subsidence

> ***23 CCR §354.34(c)(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.*

Inelastic land subsidence has been recognized in California for many decades. Observation of land subsidence sustainability indicators can utilize numerous techniques, including levelling surveying tied to known benchmarks, installing and tracking changes in borehole extensometers, monitoring continuous global position system (CGPS) locations, or analyzing interferometric synthetic aperture radar (InSAR) data. As with most sustainability indicators, conditions of subsidence, or lack thereof, can be correlated to groundwater levels as a surrogate. Each of these approaches uses different measuring points and techniques, and is tailored for specific data needs and geologic conditions.

Existing data should be used to the greatest extent. The USGS has conducted numerous studies and much of the data can be located through their webpage and reports: http://ca.water.usgs.gov/land_subsidence/index.html . In addition, DWR has developed supporting studies and data available in the Groundwater Information Center interactive maps and reports: http://www.water.ca.gov/groundwater/gwinfo/index.cfm. The use of existing regular surveys of state infrastructure may also present a record of historical changes in elevation along roadways and canals. Prior to development of a specific subsidence monitoring network a screening level analysis should be conducted. The screening of subsidence occurrence should include:

- Review of the HCM and understanding of grain-size distributions and potential for subsidence to occur.
- Review of any known regional or correlative geologic conditions where subsidence has been observed.
- Review of historic range of groundwater levels in the principal aquifers of the basin.
- Review of historic records of infrastructure impacts, including, but not limited to, damage to pipelines, canals, roadways, or bridges, or well collapse potentially associated with land surface elevation changes.
- Review of remote sensing results such as InSAR or other land surface monitoring data.
- Review of existing CGPS surveys.

In general, the network should be designed to provide consistent, accurate, and reproducible results. Where subsidence conditions are occurring or believed to occur, a specific monitoring network should be established to observe the sustainability indicator such that the sustainability goal can be met. The following approaches can be used independently or in coordination with multiple methods and should be evaluated with the specific conditions and objectives in mind. Various standards and guidance documents that must be adhered to when developing a monitoring network include:

- Levelling surveys must follow surveying standards set out in the California Department of Transportation's *Caltrans Surveys Manual*. Specific websites where additional information can be found include:
  - http://www.dot.ca.gov/hq/row/landsurveys/
  - http://www.ngs.noaa.gov/datasheets/
  - https://www.ngs.noaa.gov/FGCS/tech_pub/1984-stds-specs-geodetic-control-networks.htm#3.5

- CGPS surveys must follow surveying standards set out in the California Department of Transportation's *Caltrans Surveys Manual*. Specific websites where additional data can be found include:
  - http://www.dot.ca.gov/hq/row/landsurveys/
  - http://www.ngs.noaa.gov/CORS/
  - http://www.unavco.org/instrumentation/networks/status/pbo
  - http://www.dot.ca.gov/dist6/surveys/CVSRN/sitemap.htm
  - http://sopac.ucsd.edu/map.shtml

- The construction and use of borehole extensometers can yield information about total and unit-specific subsidence rates depending upon construction and purpose. Specific sites where additional data can be found include:
  - Extensometer methods commonly used by the USGS http://hydrologie.org/redbooks/a151/iahs_151_0169.pdf
  - Extensometry principles (p. 20-29) http://wwwrcamnl.wr.usgs.gov/rgws/Unesco/
  - Examples of extensometer construction, instrumentation, and data interpretation
    - Single-stage pipe extensometer (Edwards Air Force Base, CA; 1990), p. 20-23: http://pubs.usgs.gov/wri/2000/wri004015/
    - Dual-stage pipe extensometer (Lancaster, CA; 1995), p. 8-12: http://pubs.usgs.gov/of/2001/ofr01414/
    - Dual-stage pipe extensometer (San Lorenzo, CA; 2008), p. 12-13: https://pubs.er.usgs.gov/publication/ds890

- The use of InSAR data can be useful for screening and regular monitoring, especially as the technology becomes more widely available and usable. Specific sites where additional data can be found are listed below.
  - Interferometric Synthetic Aperture Radar (InSAR) techniques are an effective way to measure changes in land-surface altitude over large areas. Some basic information about InSAR can be found here:
    - https://pubs.usgs.gov/fs/fs-051-00/pdf/fs-051-00.pdf
    - http://pubs.usgs.gov/fs/fs06903/pdf/fs06903.pdf
  - Raw data (not processed into interferograms) are available from a variety of foreign space agencies or their distributors at variable costs (including free):
    - European Space Agency http://www.esa.int/ESA
    - Japanese Space Exploration Agency http://global.jaxa.jp/
    - Italian Space Agency http://www.asi.it/en

  - Canadian Space Agency http://www.asc-csa.gc.ca/eng/
  - German Aerospace Center http://www.dlr.de/dlr/en/desktopdefault.aspx/tabid-10002/
- Data Processing: Processing raw data to high-quality InSAR data is not a trivial task.
  - Open source/research-grade software packages and commercially available software packages. A list of available software can be found here: http://www.unavco.org/software/data-processing/sar-software/sar-software.html
  - There are commercial companies that process InSAR data.
  - Processing raw data to quality-controlled InSAR data is an essential part of InSAR processing because of the numerous common sources of error. Discussions of these error sources are found here:
    - http://pubs.usgs.gov/sir/2014/5075/
    - https://pubs.er.usgs.gov/publication/sir20135142

## F. Depletion of Interconnected Surface Water

> ***23 CCR §354.34(c))(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.*
> *(B) Identifying the approximate date and location where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable.*
> *(C) Temporal change in conditions due to variations in stream discharge and regional groundwater extraction.*
> *(D) Other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water.*

Monitoring of the interconnected surface water depletions requires the use of tools, commonly modeling approaches, to estimate the depletions associated with groundwater extraction. Models require assumptions be made to constrain the numerical model solutions. These assumptions should be based on empirical observations determining the extent of the connection of surface water and groundwater systems, the timing of those connections, the flow dynamics of both the surface water and groundwater systems, and hydrogeologic properties of the geologic framework connecting these systems.

The following components should be included in the establishment of a monitoring network:

- Use existing stream gaging and groundwater level monitoring networks to the extent possible.

- Establish stream gaging along sections of known surface water groundwater connection.
    - All streamflow measurements should be collected, analyzed, and reported in accordance with the procedures outlined in USGS Water Supply Paper 2175, *Volume 1. - Measurement of Stage Discharge* and *Volume 2. - Computation of Discharge.*
        - https://pubs.er.usgs.gov/publication/wsp2175_vol1
        - https://pubs.er.usgs.gov/publication/wsp2175
    - Specific websites where additional information can be found include:
        - General source: http://water.usgs.gov/nsip/
        - Standards for the Analysis and Processing of Surface-Water Data and Information Using Electronic Methods https://pubs.er.usgs.gov/publication/wri20014044
        - USGS Streamflow Information
            - Real-time Streamflow Data for the Nation
            - Historical Streamflow Data for the Nation
            - WaterWatch
            - StreamStats
    - Location selection must account for surface water diversions and return flows; or select gaging locations and reaches over which no diversions or return flows exist.

- Establish a shallow groundwater monitoring well network to characterize groundwater levels adjacent to connected streams and hydrogeologic properties.
    - Network should extend perpendicular and parallel to stream flow to provide adequate characterization to constrain model development.
    - Monitor to capture seasonal pumping conditions in vicinity-connected surface water bodies.

- Identify and quantify both timing and volume of groundwater pumping within approximately 3 miles of the stream or as appropriate for the flow regime.

- Establish qualitative monitoring by use of GPS survey of the timing and position along stream where ephemeral or intermittent streams cease to flow. Should be conducted annually or as appropriate to capture stream flow change.

It may be beneficial to conduct other initial characterization surveys to establish an appropriate monitoring method to develop assumptions for a model or other technique to estimate depletion of surface water. These may include:

- Stream bed conductance surveys
- Aquifer testing for hydrogeologic properties
- Isotopic studies to determine source areas
- Geochemical studies to determine source areas
- Geophysical techniques to determine connectivity to stream channels and preferential flow pathways.

## REPRESENTATIVE MONITORING POINTS

The use of RMPs, which are a subset of a basin's complete monitoring network as demonstrated in **Figure 3,** can be used to consolidate reporting of quantitative observations of the sustainability indicators.

> ***23 CCR §354.36. Representative Monitoring (a)-(c):*** *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.*
> *(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.*
> *(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.*
> *(c) The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area.*

In this figure, the complete monitoring network is represented by black dots. The RMPs for each sustainability indicator are represented by various colored bull's-eyes. In this example, the network of RMPs is unique for each sustainability indicator. Agencies can adopt a single network of RMPs or have a unique set of RMPs for each sustainability indicator.

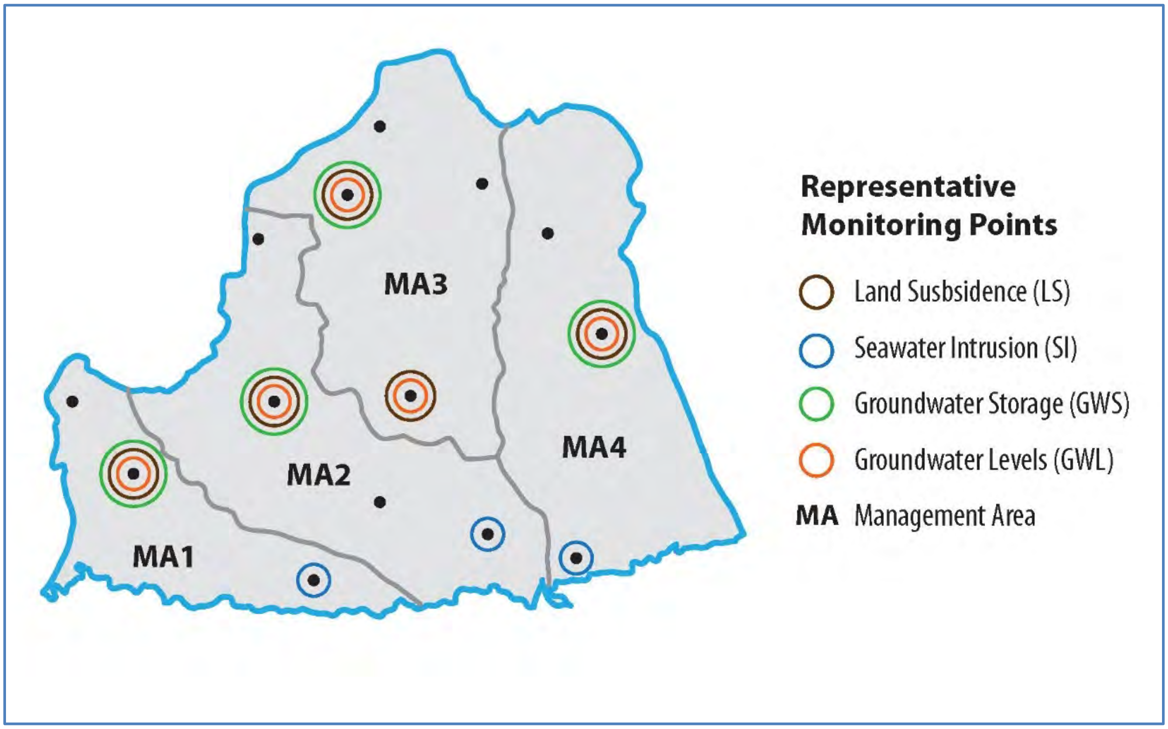


**Figure 3: Representative Monitoring Points**

If RMPs are used to represent groundwater elevations from a number of surrounding monitoring wells, the GSP should demonstrate that each RMP's historical measured groundwater elevations, groundwater elevation trends, and seasonal fluctuations are similar to the historical measurements in the surrounding monitoring wells. If RMPs are used to represent groundwater quality from a number of surrounding monitoring wells, the GSP should demonstrate that each RMP's historical measured groundwater quality and groundwater quality trends are similar to historical measurements in the surrounding monitoring wells.

The use of groundwater levels as a proxy may be utilized where clear correlation can be made for each sustainability indicator. The use of the proxy can facilitate the illustration of where minimum thresholds and measureable objectives occur. A series of RMPs or a single RMP may be adequate to characterize a management area or basin. Use of the RMP should include identification and description of possible interference with the monitoring objective.

## NETWORK ASSESSMENT AND IMPROVEMENTS

***23 CCR §354.38. Assessment and Improvement of Monitoring Network (a)-(e)***
*(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.*
*(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.*
*(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.*
*(2) Local issues and circumstances that limit or prevent monitoring.*
*(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.*
*(e) Each Agency shall adjust the monitoring frequency and distribution 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.*
*(2) Highly variable spatial or temporal conditions.*
*(3) Adverse impacts to beneficial uses and users of groundwater.*
*(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.*

Network assessment and improvements are commonly identified as 'data gaps' in the monitoring network and refer to "a lack of information that significantly affects the understanding of basin setting or evaluation of the efficacy of the Plan implementation, and could limit the ability to assess whether a basin is being sustainably managed." The monitoring network is a key component in the development of GSPs and will influence the development and understanding of the basin setting, including the hydrogeologic conceptual model, groundwater conditions, and water budget; and proposed minimum thresholds and measurable objectives. GSAs should consider previous analyses of data gaps of their monitoring network through existing programs, such as CASGEM monitoring plans. **Figure 4** shows a flowchart that demonstrates a process that GSAs should use to identify and address data gaps.

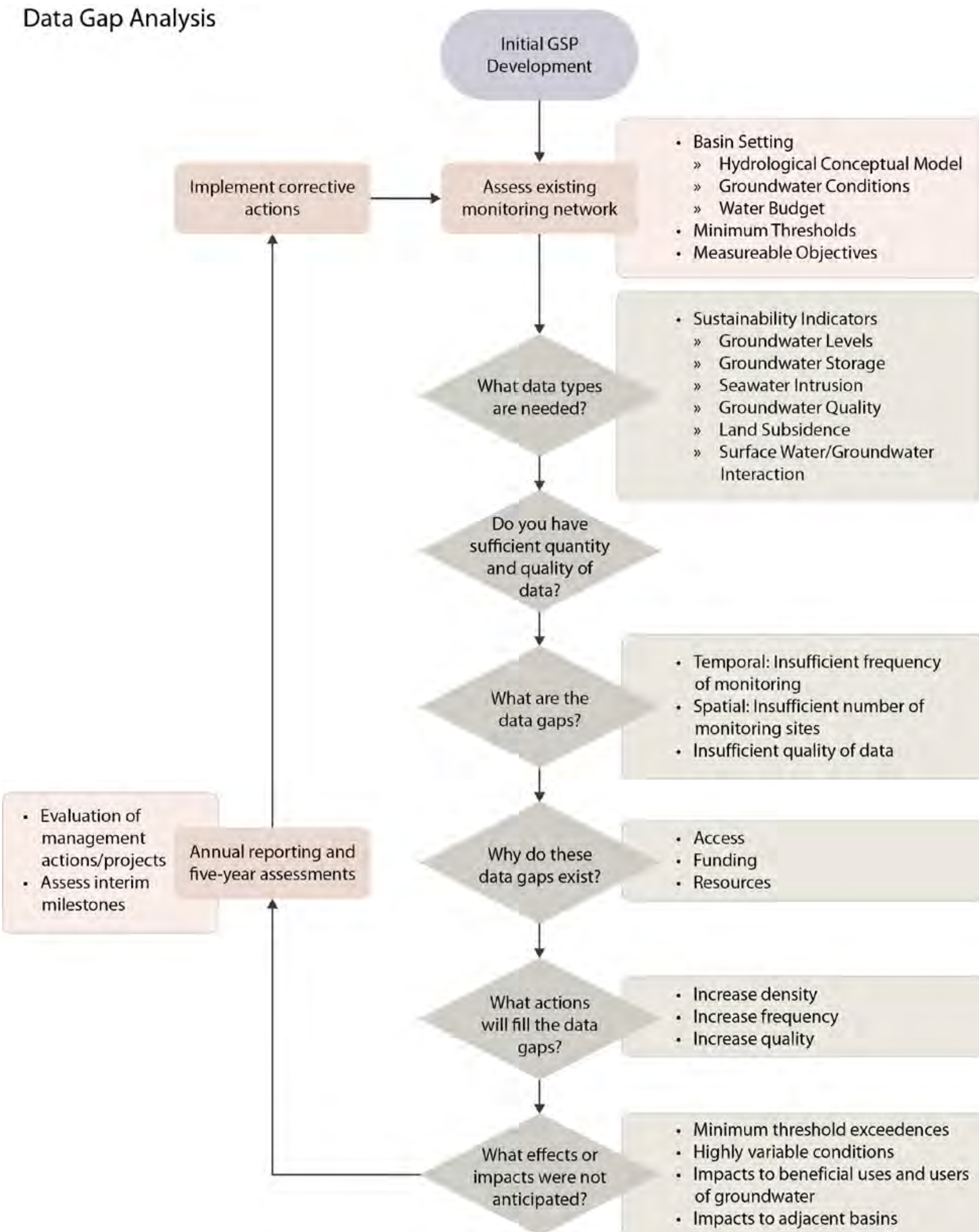


**Figure 4. Data Gap Analysis Flow Chart**

Professional judgment will be needed from GSAs to identify possible data gaps in their monitoring network of the sustainability indicators. Data gaps can result from monitoring information that is not of sufficient quantity or quality. Data of insufficient quantity typically result from missing or incomplete information, either temporally or spatially. Examples of temporal data gaps include a hydrograph with data that is too infrequent, has inconsistent intervals, or has a short historical record, as shown in **Figure 5**. Spatial data gaps may occur from a monitoring network with low or uneven density in three dimensions, as shown in **Figure 6**.

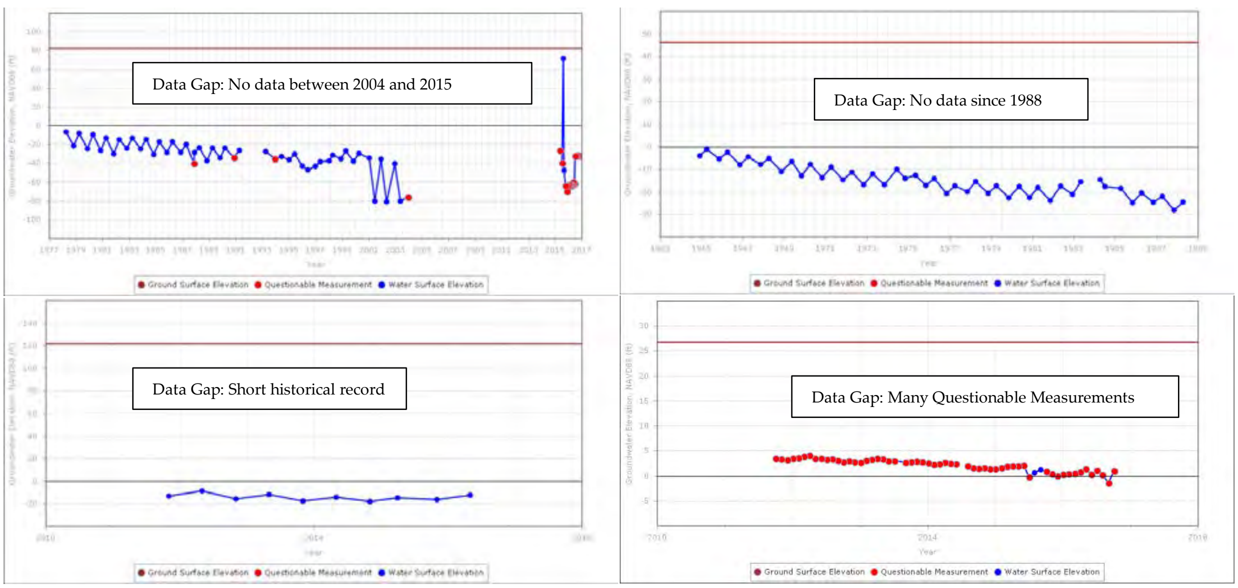


Figure 5. Examples of Hydrographs with Temporal Data Gaps

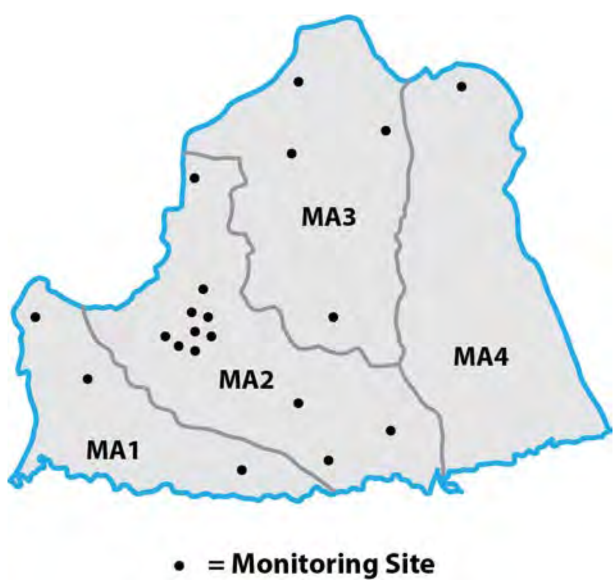


Figure 6. Example Monitoring Network with Spatial Data Gaps

Poor quality data may also be the cause of data gaps. Data must be of sufficient quality to enable scientifically defensible decisions. Poor quality data may at times be worse than no data because it could lead to incorrect assumptions or biases. Some things to consider when questioning the quality of data include: collection conditions and methods, sampling quality assurance/quality control, and proper calibration of meters/equipment. As part of the CASGEM program, DWR reports groundwater elevation data from local agencies, which include the option for "Questionable Measurement Codes." These codes are one way of identifying poor quality data.

There may be various reasons for data gaps, including site access, funding, and lack of staffing resources. By identifying and correcting the reasons behind data gaps, GSAs may be able to avoid further data gaps.

Direct actions GSAs could take to fill data gaps include:

- Increasing the frequency of monitoring. For instance, some groundwater elevation measurements are taken twice a year in the spring and fall, but perhaps those measurements need to be increased to quarterly, monthly, or more frequently, if needed.
- Increasing the spatial distribution and density of the monitoring network.
- Increasing the quality of data through improved collection methods and data management methods.

As GSPs are implemented, GSAs may identify other data gaps, especially if there are minimum threshold exceedances, highly variable spatial or temporal conditions, adverse impacts to beneficial uses and users of groundwater, and impacts to adjacent basins' ability to achieve sustainability. Any or all of these conditions may indicate a need to refine the monitoring network.

Agencies are required to assess their monitoring networks every five years. During those assessments, data gaps may also be identified as agencies monitor the progress of their management actions/projects and the status of their interim milestones. These regular assessments will allow the GSAs to adaptively manage, focus, and prioritize future monitoring.

## DATA REPORTING

> ***23 CCR §352.6. Data Management System***
> *Each Agency shall develop and maintain a data management system that is capable of storing and reporting information relevant to the development or implementation of the Plan and monitoring of the basin.*

The use of a Data Management System (DMS) is required for all GSPs. The DMS should include clear identification of all monitoring sites and a description of the quality assurance and quality control checks performed on the data being entered. Uploading of the collected data should occur immediately following collection to address any quality concerns in a timely manner and prevent the potential for development of data gaps. Coordination of data structures between adjacent basins will facilitate data sharing and increase data transparency.

DWR will be providing an update to this BMP as the suggested data structure is developed, as necessary.

# 6. KEY DEFINITIONS

## SGMA DEFINITIONS (CALIFORNIA WATER CODE §10721)

(r) "Planning and implementation horizon" means a 50-year time period over which a groundwater sustainability agency determines that plans and measures will be implemented in a basin to ensure that the basin is operated within its sustainable yield.

(u) "Sustainability goal" means the existence and implementation of one or more groundwater sustainability plans that achieve sustainable groundwater management by identifying and causing the implementation of measures targeted to ensure that the applicable basin is operated within its sustainable yield.

(v) "Sustainable groundwater management" means the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results.

(w) "Sustainable yield" means the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result.

(x) "Undesirable result" means one or more of the following effects caused by groundwater conditions occurring throughout the basin:

(1) Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods.

(2) Significant and unreasonable reduction of groundwater storage.

(3) Significant and unreasonable seawater intrusion.

(4) Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.

(5) Significant and unreasonable land subsidence that substantially interferes with surface land uses.

(6) Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.

## GSP REGULATIONS DEFINITIONS (CALIFORNIA CODE OF REGULATIONS §351)

(l) “Data gap” refers to a lack of information that significantly affects the understanding of the basin setting or evaluation of the efficacy of Plan implementation, and could limit the ability to assess whether a basin is being sustainably managed.

(o) “Interconnected surface water” refers to surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted.

(q) “Interim milestone” refers to a target value representing measurable groundwater conditions, in increments of five years, set by an Agency as part of a Plan.

(s) “Measurable objectives” refer to specific, quantifiable goals for the maintenance or improvement of specified groundwater conditions that have been included in an adopted Plan to achieve the sustainability goal for the basin.

(t) “Minimum threshold” refers to a numeric value for each sustainability indicator used to define undesirable results.

(u) “NAD83” refers to the North American Datum of 1983 computed by the National Geodetic Survey, or as modified.

(v) “NAVD88” refers to the North American Vertical Datum of 1988 computed by the National Geodetic Survey, or as modified.

(y) “Plan implementation” refers to an Agency’s exercise of the powers and authorities described in the Act, which commences after an Agency adopts and submits a Plan or Alternative to the Department and begins exercising such powers and authorities.

(aa) “Principal aquifers” refer to aquifers or aquifer systems that store, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems.

(ab) “Reference point” refers to a permanent, stationary and readily identifiable mark or point on a well, such as the top of casing, from which groundwater level measurements are taken, or other monitoring site.

(ac) “Representative monitoring” refers to a monitoring site within a broader network of sites that typifies one or more conditions within the basin or an area of the basin.

(ad) “Seasonal high” refers to the highest annual static groundwater elevation that is typically measured in the Spring and associated with stable aquifer conditions following a period of lowest annual groundwater demand.

(ae) "Seasonal low" refers to the lowest annual static groundwater elevation that is typically measured in the Summer or Fall, and associated with a period of stable aquifer conditions following a period of highest annual groundwater demand.

(ag) "Statutory deadline" refers to the date by which an Agency must be managing a basin pursuant to an adopted Plan, as described in Water Code Sections 10720.7 or 10722.4.

(ah) "Sustainability indicator" refers to any of the effects caused by groundwater conditions occurring throughout the basin that, when significant and unreasonable, cause undesirable results, as described in Water Code Section 10721(x).

(ai) "Uncertainty" refers to a lack of understanding of the basin setting that significantly affects an Agency's ability to develop sustainable management criteria and appropriate projects and management actions in a Plan, or to evaluate the efficacy of Plan implementation, and therefore may limit the ability to assess whether a basin is being sustainably managed.

## 7. Related Materials

### NETWORK DESIGN

- Design of a Real-Time Ground-Water Level Monitoring Network and Portrayal of Hydrologic Data in Southern Florida
  - http://fl.water.usgs.gov/PDF_files/wri01_4275_prinos.pdf

- Optimization of Water-Level Monitoring Networks in the Eastern Snake River Plain Aquifer Using a Kriging-Based Genetic Algorithm Method
  - http://pubs.usgs.gov/sir/2013/5120/pdf/sir20135120.pdf

### GUIDANCE

California Department of Water Resources, 2010. *California statewide groundwater elevation monitoring (CASGEM) groundwater elevation monitoring guidelines*, December, 36 p. http://www.water.ca.gov/groundwater/casgem/documents.cfm

Heath, R. C., 1976. *Design of ground-water level observation-well programs*: Ground Water, V. 14, no. 2, p. 71-77.

Hopkins, J., 1994. *Explanation of the Texas Water Development Board groundwater level monitoring program and water-level measuring manual*: UM-52, 53 p. http://www.twdb.texas.gov/groundwater/docs/UMs/UM-52.pdf

Sophocleous, M., 1983. *Groundwater observation network design for the Kansas groundwater management districts, USA*: Journal of Hydrology, vol.61, pp 371-389.

Subcommittee on ground water of the advisory committee on water information, 2013. A National Framework for Ground-Water Monitoring in the United States, 168 p. http://acwi.gov/sogw/ngwmn_framework_report_july2013.pdf

# Appendix 5

***5A Technical Approach for Developing Chronic Lowering of Groundwater Levels Sustainable Management Criteria in the Kaweah Subbasin***

***5B Groundwater Level Sustainable Management Criteria Hydrographs***

***5C Potential Well Impact Summary***

***5D Water Storage Additions – An Alternative Approach***

***5E Technical Approach for Developing Subsidence Sustainable Management Criteria in the Kaweah Subbasin***

# Appendix 5A Technical Approach for Developing Chronic Lowering of Groundwater Levels Sustainable Management Criteria in the Kaweah Subbasin

July 27, 2022

# Technical Approach for Developing Chronic Lowering of Groundwater Levels Sustainable Management Criteria in the Kaweah Subbasin

*Prepared for:*

East Kaweah Groundwater Sustainability Agency
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## Tables



## Figures

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# ACRONYMS & ABBREVIATIONS

DWR ..............California Department of Water Resources
EKGSA ..........East Kaweah Groundwater Sustainability Agency
GKGSA..........Greater Kaweah Groundwater Sustainability Agency
GSA................Groundwater Sustainability Agency
GSP ................Groundwater Sustainability Plan
MKGSA .........Mid-Kaweah Groundwater Sustainability Agency
MO .................measurable objective
MT..................minimum threshold
SGMA ............Sustainable Groundwater Management Act
SMC ..............Sustainable Management Criteria
Subbasin.........Kaweah Subbasin
WCR ..............Well Completion Report

# 1 INTRODUCTION

This technical report describes the methodology applied to a revision of the chronic lowering of groundwater level sustainable management criteria (SMC) for the San Joaquin Valley - Kaweah Subbasin (Subbasin). The revisions are in response to the California Department of Water Resources (DWR) incomplete determination of the three Groundwater Sustainability Plans (GSPs) submitted in January 2020. The three GSPs are being implemented by three Groundwater Sustainability Agencies (GSAs) covering the entirety of the Subbasin: East Kaweah GSA, Greater Kaweah GSA, and Mid-Kaweah GSA (Figure 1).

DWR provided a staff report with a statement of findings explaining the incomplete determination for the Subbasin GSPs. The staff report states, "The Plan does not define sustainable management criteria for chronic lowering of groundwater levels in the manner required by Sustainable Groundwater Management Act (SGMA) and the GSP Regulations." DWR's findings specified the following:

1. *The GSPs do not define metrics for undesirable results and minimum thresholds based on avoiding a significant and unreasonable depletion of groundwater supply, informed by, and considering, the relevant and applicable beneficial uses and users in their Subbasin.*
2. *The GSPs do not describe specific potential effects from the chronic lowering of groundwater levels and depletion of supply that would be significant and unreasonable to beneficial uses and users of groundwater, on land uses and property interests, and other potential effects and, therefore, constitute an undesirable result.*
3. *The GSPs do not consider how minimum thresholds developed for one sustainability indicator will affect other related sustainability indicators."*

The GSAs are given up to 180 days from the receipt of DWR's staff report to address the deficiencies for chronic lowering of groundwater levels SMC. This report provides the technical support to fulfill that purpose.

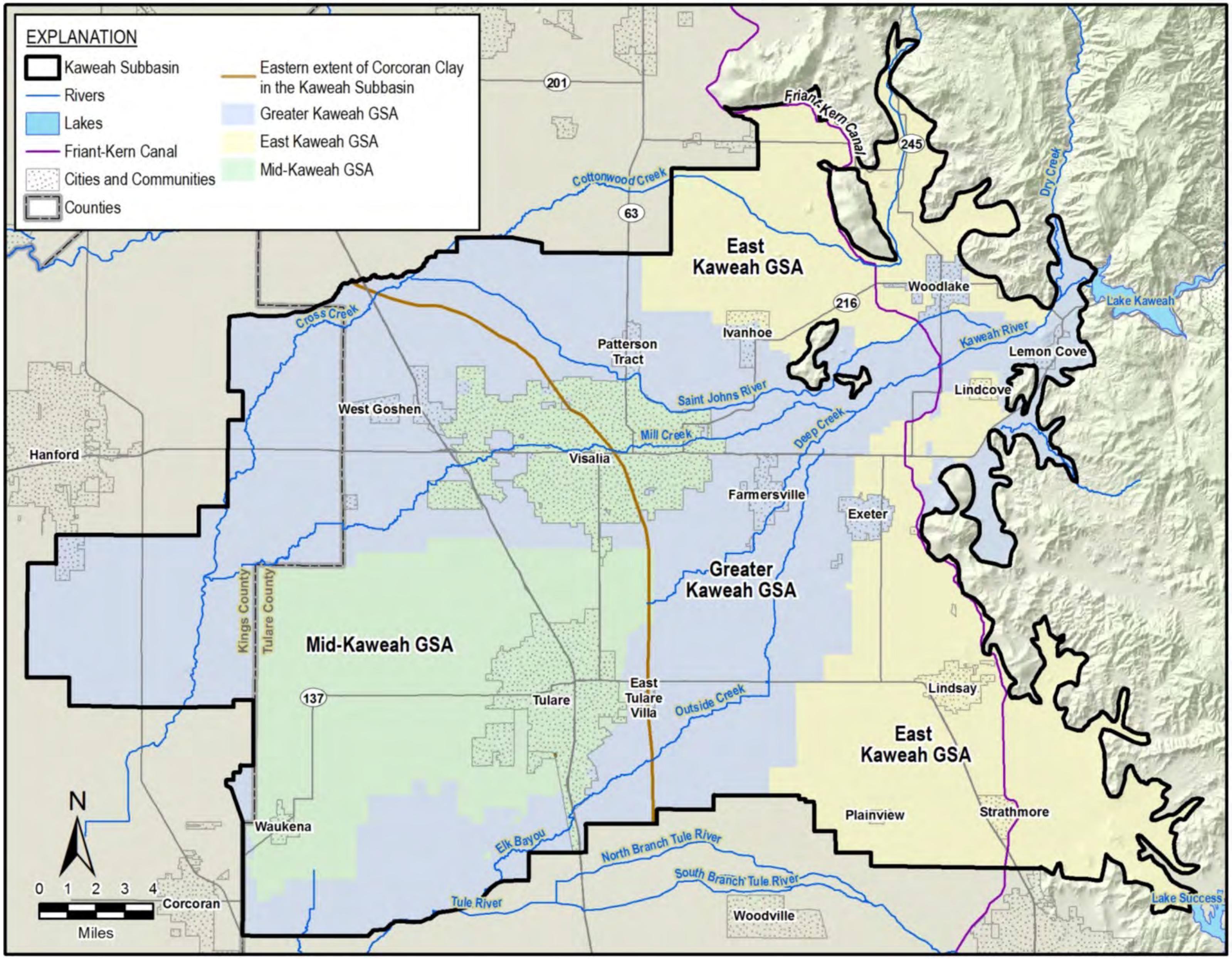



Figure 1. Groundwater Sustainability Agencies in the Kaweah Subbasin

## 1.1 General Approach Used to Develop Sustainable Management Criteria

Chronic lowering of groundwater levels SMC are developed to protect relevant and applicable beneficial uses and users of groundwater in the Subbasin. Beneficial users of groundwater are domestic pumpers, disadvantaged communities, small water systems (2 to 14 connections), municipal water systems (>14 connections), agricultural pumpers, California Native American Tribes, environmental users, and entities engaged in monitoring and reporting groundwater elevations. Understanding the types of users and their access to groundwater is the first step taken to inform what the GSAs and their stakeholder groups consider significant and unreasonable impacts to those users.

Since wells are how users access groundwater, the approach used to develop SMC is based on water supply well depths. The depth of wells across the Subbasin varies by depth to groundwater and beneficial user type. Because of well depth variability, the Subbasin is subdivided into analysis zones based on GSP management area boundaries, clusters of beneficial user types, aquifers, and completed well depths. Completed well depth statistics inform significant and unreasonable groundwater levels, with the SMC being based on protecting at least 90% of all water supply wells in the Subbasin.

## 1.2 Data Sources and Quality Control

Information used for establishing the chronic lowering of groundwater levels SMC include:

- Completed depths, screen depths, and locations of wells installed since January 1, 2002, and included in DWR's Well Completion Report (WCR) dataset (Figure 2). Only well records drilled since 2002 are used for analysis to filter out wells that may have been abandoned or no longer represent typical modern depths for active wells and current groundwater elevations. Data download date was March 1, 2022.
- Historical groundwater elevation data from DWR's California Statewide Groundwater Elevation Monitoring Program, SGMA Portal Monitoring Network Module, and individual water agencies.
- Maps of current and historical groundwater elevation contours.

The WCR dataset does not contain a complete accurate dataset, however, it is the best public source of data available. Approximately one-third of the wells drilled from 2002 on did not have well completion depths and could not be used in the analysis. For purposes of well depth analyses, we assumed the available wells with depth information are typical of depths in the Subbasin.

Well logs were reviewed for wells with completion depths less than 100 feet. This review generally found that either 1) the planned well use field was incorrectly classified as a water supply well when it was supposed to be a destroyed or remediation well, or 2) the completed well depth field was the depth of the conductor casing (often 50 feet) and not the bottom of the completed well. These inaccuracies were corrected. Furthermore, where coordinates of wells are unavailable, DWR locates the well in the middle of the Public Land Survey System section.

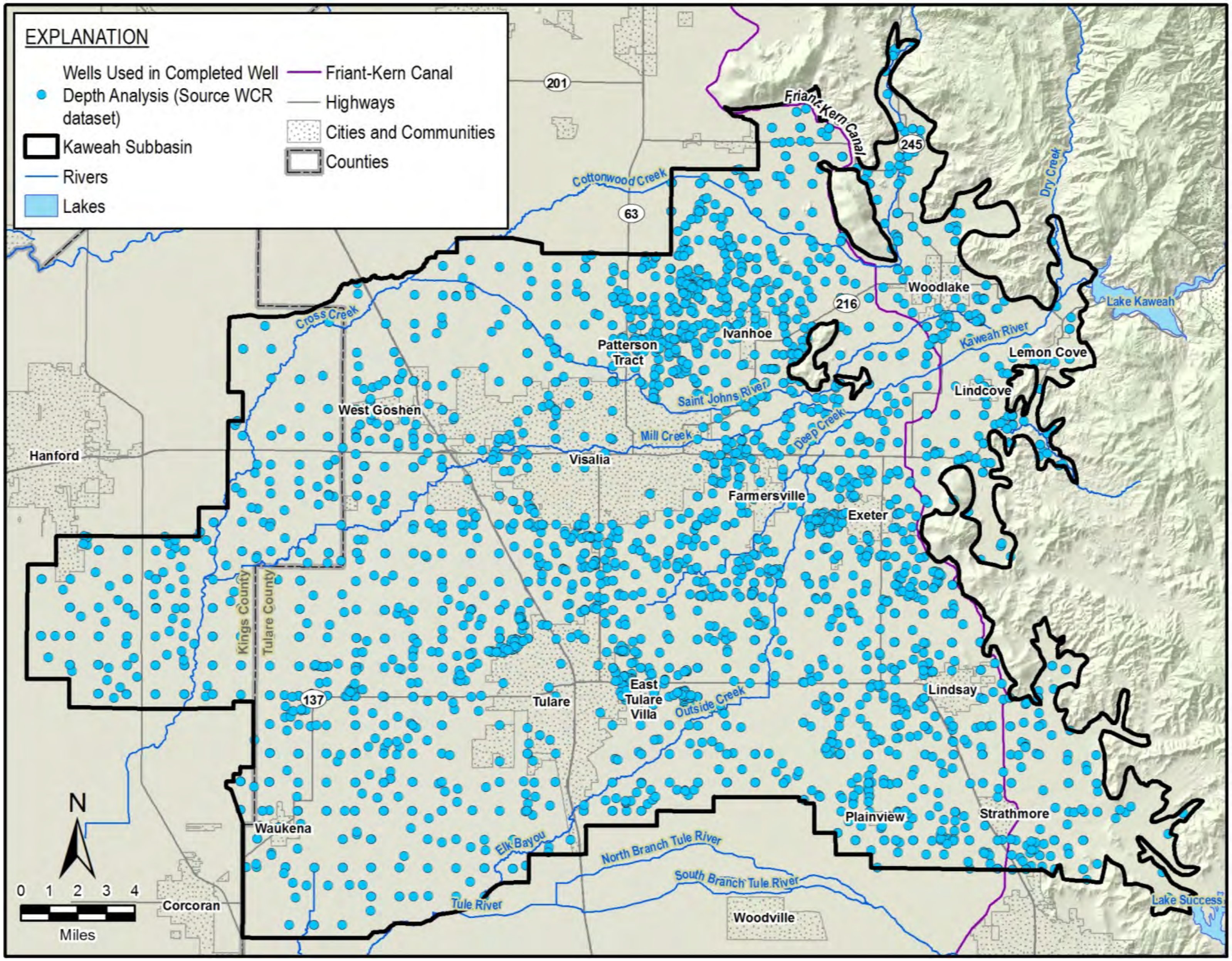



Figure 2. Location of WCR Water Supply Wells Used for Completed Well Depth Analysis

# 2 PROCESS USED TO ESTABLISH MINIMUM THRESHOLDS

Minimum thresholds (MTs) are derived from groundwater elevations that protect at least 90% of all water supply wells drilled since January 1, 2002, in each analysis zone, and that do not result in a greater rate of decline over water years 2020 to 2040 than experienced over a specific historical time period. Groundwater elevations representing MTs are set at representative monitoring sites identified in the Monitoring Network section of the GSPs.

The process for developing MTs is based on a comparison of three methodologies. The process is generally to:

1. Develop analysis zones based on GSP management areas, aquifer type, beneficial user types, and similar completed well depths (described in Section 2.1.1).
2. Identify water supply wells drilled since January 1, 2002, with well screen depth information or a completed well depth.
3. Designate water supply wells to either the Upper, Lower, or Single Aquifer System based on a set of assumptions (described in Section 2.1.2).
4. Designate representative monitoring sites to either the Upper, Lower, or Single Aquifer System (described in Section 2.1.2).
5. Estimate MT depths through Methodology 1 by calculating the 90th percentile well completion depth for water supply wells in each analysis zone and aquifer (described in Section 2.1.3).
6. Apply the 90th percentile protective depth corresponding to the representative monitoring sites' aquifer designation and analysis zone (described in Section 2.1.4).
7. Estimate MT depths through Methodology 2 by projecting relevant base period groundwater level trends to 2040 for each representative monitoring site (described in Section 2.1).
8. Compare elevations resultant from protective depths (Step 6) and projecting a groundwater levels trend out to 2040 (Step 7). The initial MT for the representative monitoring site is the higher elevation of the two methods (Figure 3).
9. Contour the representative monitoring site MTs obtained in Step 8 for the unconfined aquifers (Single and Upper Aquifer Systems) to determine if the MT surface is relatively smooth. If there are anomalous MTs, remove the anomalous points and interpolate the final MT elevations at these points from MT contours generated by excluding the anomalous sites. This is shown as Method 3 in Figure 3.

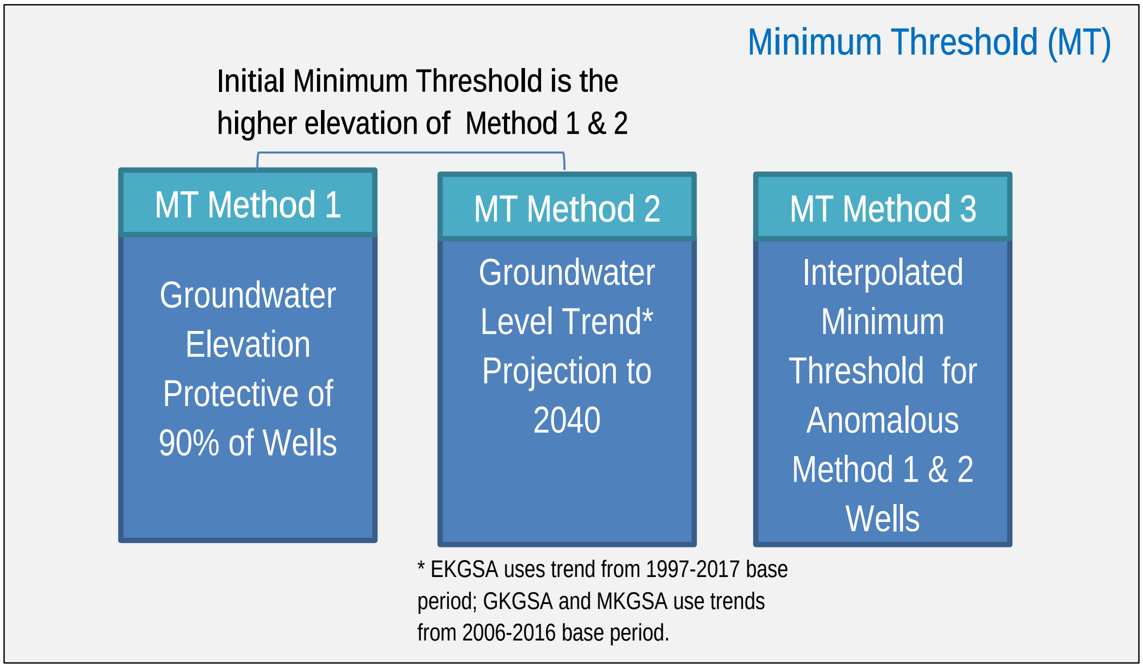



Figure 3. Minimum Threshold Methodologies

## 2.1 Methodology 1, Protective Elevations

The primary methodology for establishing MTs is designed to protect at least 90% of all wells in the Subbasin. This approach is protective of most beneficial uses and users of groundwater. The 90% threshold was chosen in acknowledgment that it is impractical to manage groundwater to protect the shallowest wells. More importantly, the GSAs wanted to set elevations based on well records of active wells, and not wells that may be destroyed or replaced. Because there is no active well registry to provide more accurate records, there is uncertainty regarding which wells are active. For example, the 2012-2016 drought was a period when approximately 480 wells in the Subbasin were reported dry according to the DWR's Dry Well Reporting System and a record number of wells were drilled in the Subbasin (Figure 4). Wells replaced by new deeper wells during this time are those that are presumed part of the shallowest 10% of wells in the dataset used to determine protective elevations. In consideration of the abovementioned factors, the GSA Managers selected 90% so that the dataset used to establish minimum thresholds contained well records reflective of current active wells.

Given approximately 10% of wells are shallower than the protected elevations, the GSAs in the Subbasin are in the process of establishing a Well Mitigation Program to assist impacted well owners.

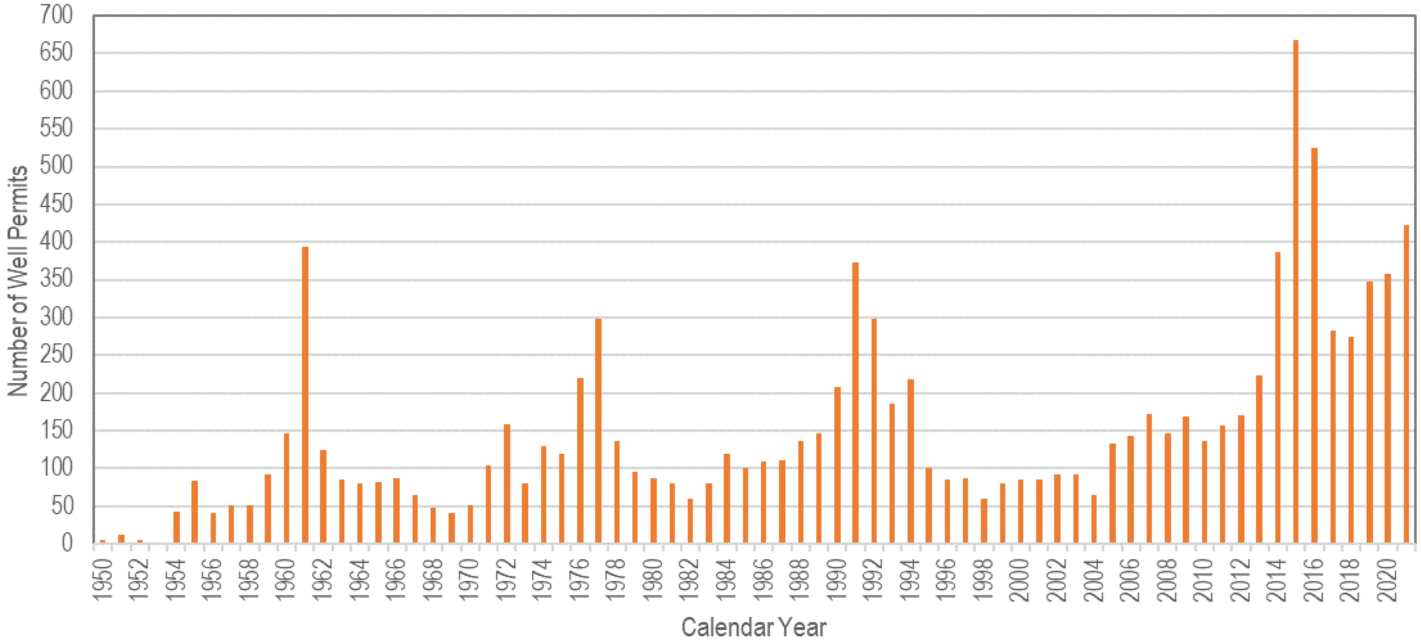



Figure 4. Annual Number of Water Supply Wells Drilled in the Kaweah Subbasin from 1950 to 2021

A total of 3,353 water supply well records from the WCR dataset are used for identifying significant and unreasonable groundwater elevations for beneficial groundwater users and uses. Criteria used to select well records from the WCR dataset include:

- The wells are drilled after January 1, 2002
- The wells are water supply wells with a planned purpose of domestic supply (includes DACs and private domestic wells), agricultural use, industrial use, or public supply (includes small water systems and municipal wells), and
- The wells have completed well depth data.

### 2.1.1 Analysis Zones

Because well depths vary with location, unique protective elevations are set for analysis zones that divide the Subbasin. The analysis zones are intended to group wells that would experience similar impacts by accounting for GSP management areas, groundwater elevations, base of aquifer, aquifer type, beneficial user type, land use, and similar completed well depths. A total of 39 spatial analysis zones are delineated (Figure 5). Twenty-three zones (analysis zones 1-23) cover the Single Aquifer System east of the limit of the Corcoran Clay shown on Figure 5. Sixteen zones (analysis zones 24-39) underlain by Corcoran Clay are split into an Upper and Lower Aquifer System based on the depth of the Corcoran Clay (described in Section 2.1.2). The Corcoran Clay is delineated vertically and spatially from recent airborne electromagnetic data acquired in the Subbasin by Stanford University (Kang *et al*., 2022).

### 2.1.2 Aquifer Designations

Aquifer designations are assigned to wells in the WCR dataset and the GSAs' representative monitoring sites based on available construction information and Corcoran Clay extent, depth, and thickness. As shown on Figure 6, the Corcoran Clay is a prominent confining geologic unit that underlies the western portion of the Subbasin and pinches out below the eastern portion of the Subbasin. The clay surface dips slightly with shallower occurrence to the east than the west. The Corcoran Clay is between 290 and 490 feet deep and up to 80 feet thick in the Subbasin.

All wells located east of the Corcoran Clay extent are designated as in the Single Aquifer System (Figure 6). Where the Corcoran Clay is present, wells are designated as Upper Aquifer System if the bottom of the well is above the bottom of the Corcoran Clay, and Likely Upper if the bottom of the well is within 50 feet of the bottom of the Corcoran Clay. Wells are designated as Lower Aquifer System if the top of its screen is within or below the Corcoran Clay. Wells are designated as Likely Lower if the total depth of the well with unknown screen depth is more than

50 feet below the bottom of the Corcoran Clay, or it is screened from less than 50 feet below the Corcoran Clay to more than 50 feet below the Corcoran Clay.

For wells without construction information that are underlain by the Corcoran Clay, groundwater level hydrographs are compared with hydrographs of other wells with construction information in the same analysis zone to determine in which aquifer the well is likely screened. Wells are designated as assumed Upper or assumed Lower Aquifer System based on similarities in seasonal and long-term groundwater level trends. Groundwater level hydrographs for representative monitoring sites are grouped by analysis zone and aquifer in Appendix A.

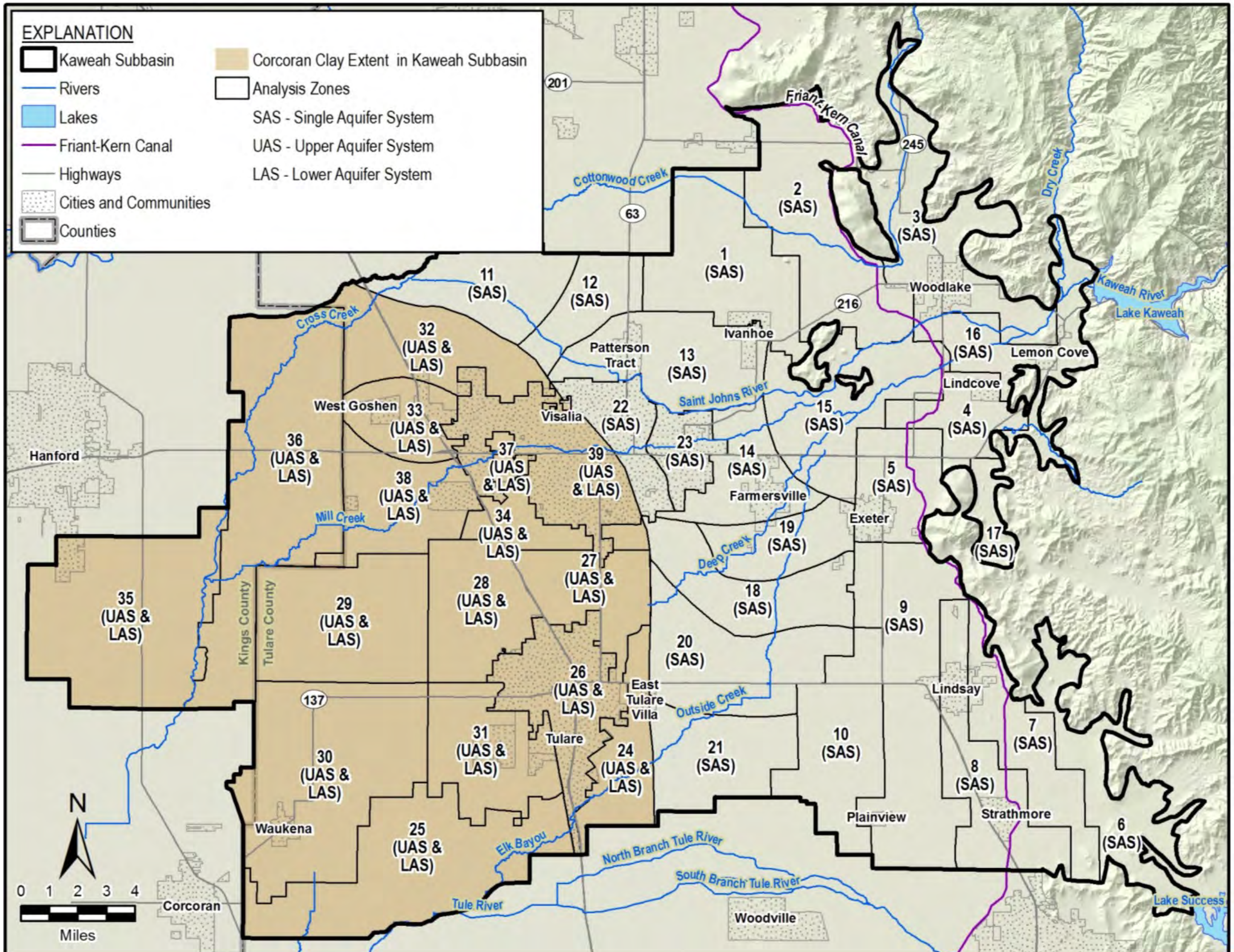



Figure 5. Kaweah Subbasin Analysis Zones

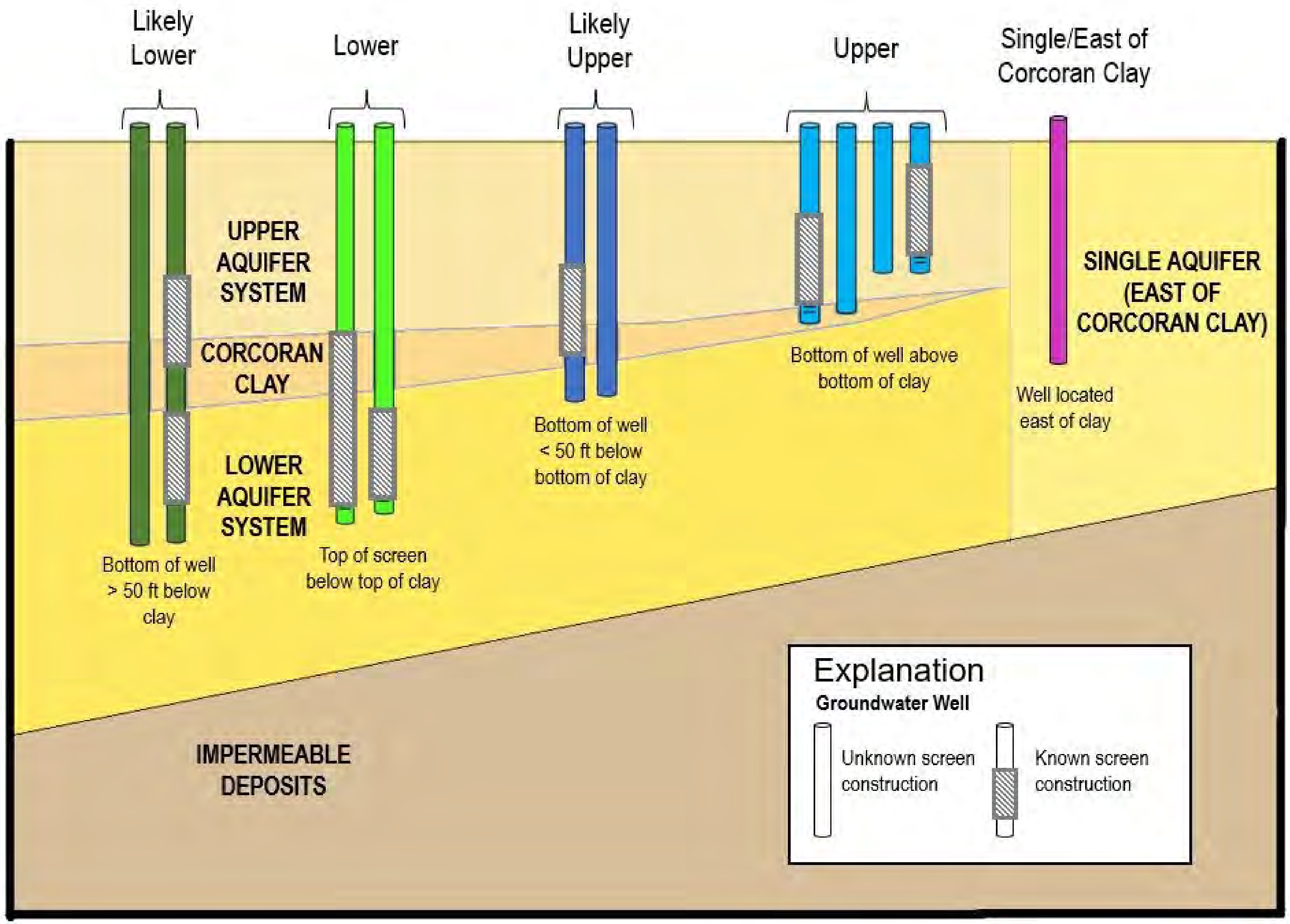



Figure 6. Kaweah Subbasin Aquifer Designation Assumptions

### 2.1.3 Completed Well Depth Analysis

Completed well depth is analyzed rather than total depth or depth of screens for the following reasons.

- Total depth drilled is typically deeper than the completed depth. Sometimes the difference can be quite large if the bottom portion of the well is not considered water bearing enough by the driller and is backfilled up to where the well is to be screened.
- More wells in the WCR dataset have completed depth information than well screen information. Of the wells with completed well depth information, 80% of those wells have screen depths. Since it is typical that wells are screened near the bottom of the completed well, more wells could be used in the analysis if completed well depth is used rather than screen depth.

Completed well depths vary by well use type, depth to groundwater, and aquifer. Figure 7 though Figure 13 depict the distribution of well use type and completed well depths across the Subbasin. Figure 7 shows a histogram of completed well depths across the entire Subbasin. Wells used in analysis are designated an aquifer system according to the assumptions outlined in Section 2.1.2.

Most wells in the Subbasin are completed to depths between 100 and 700 feet. The most common completed well depth is 350 to 400 feet, with about 700 total wells drilled to this depth. Well depth by type and aquifer is reviewed to assess which beneficial users would be impacted by lower groundwater levels. Figure 8 through  Figure 10 are aquifer-specific histograms of completed well depth by well use type. Most supply wells in the Subbasin are either used for agricultural or domestic water supply. Agricultural wells are more numerous than other types of water supply wells and also cover the widest range of depths, including the deepest depths of all wells. Overall, the shallowest wells tend to be domestic supply wells with few domestic wells installed deeper than 450 feet. There are relatively fewer public supply wells, with the majority less than 450 feet deep, although there are some that are deeper than 800 feet.

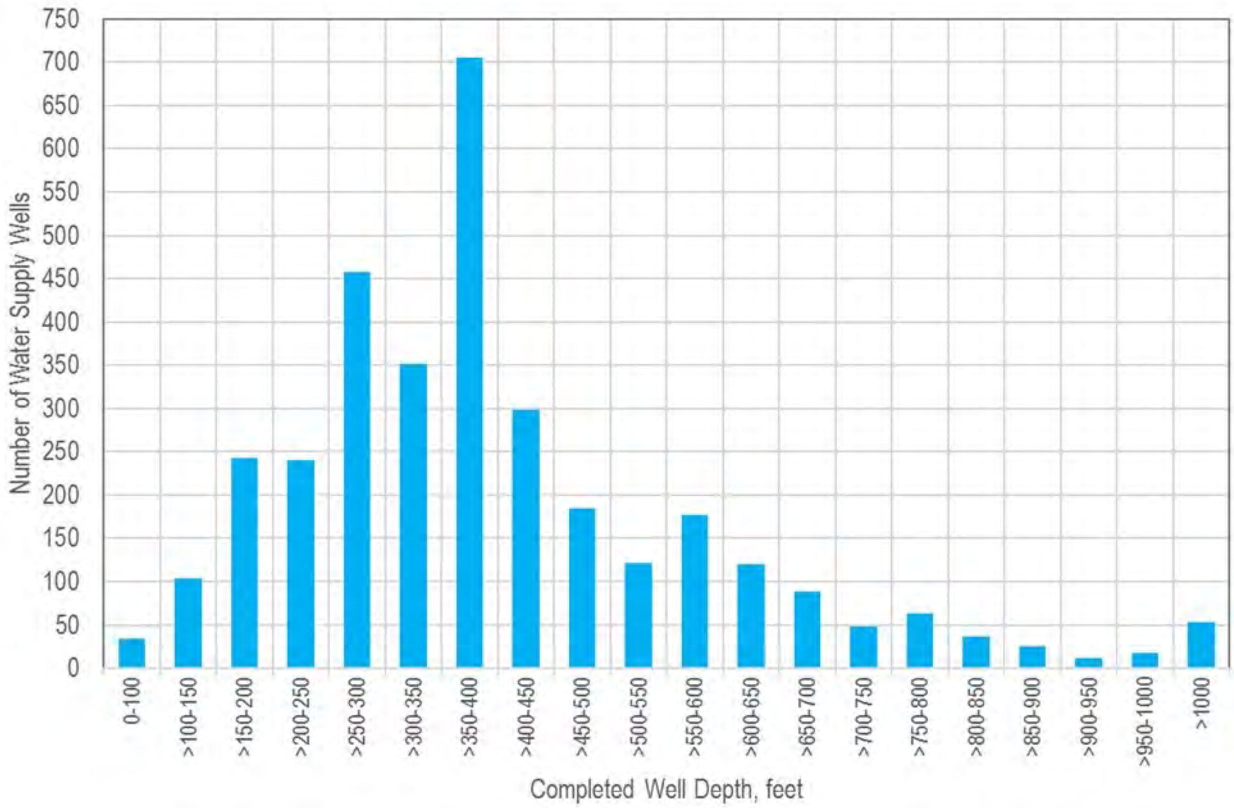



Figure 7. Histogram of Completed Wells Depths for Water Supply Wells in the Kaweah Subabsin

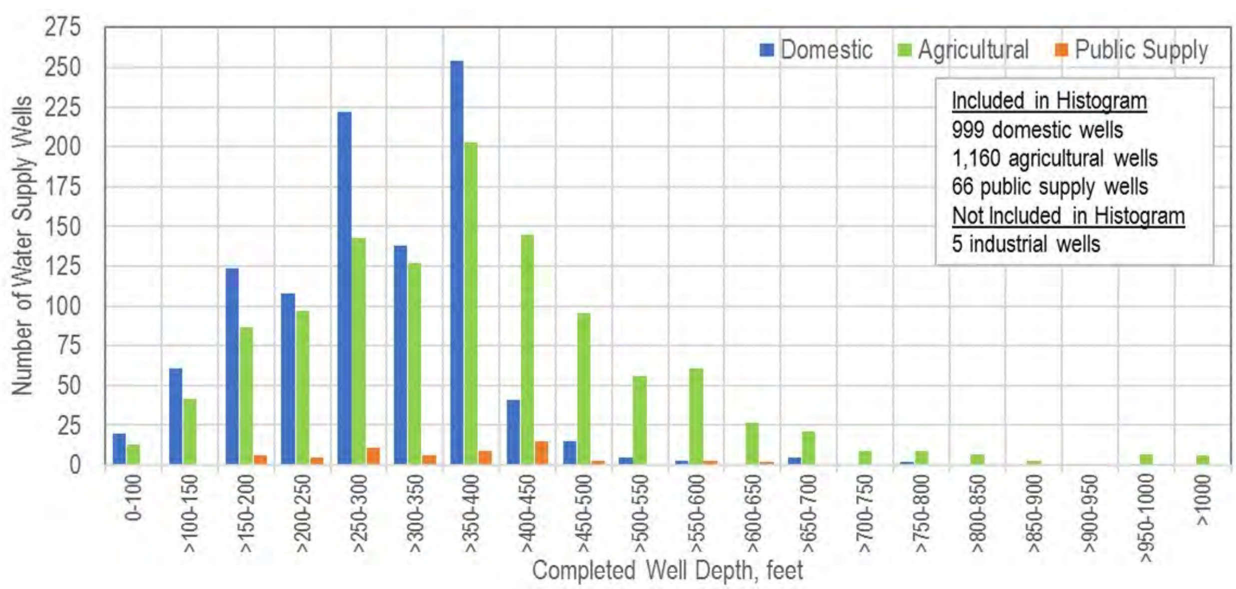



Figure 8. Histogram of Completed Well Depths for Single Aquifer System Water Supply Wells

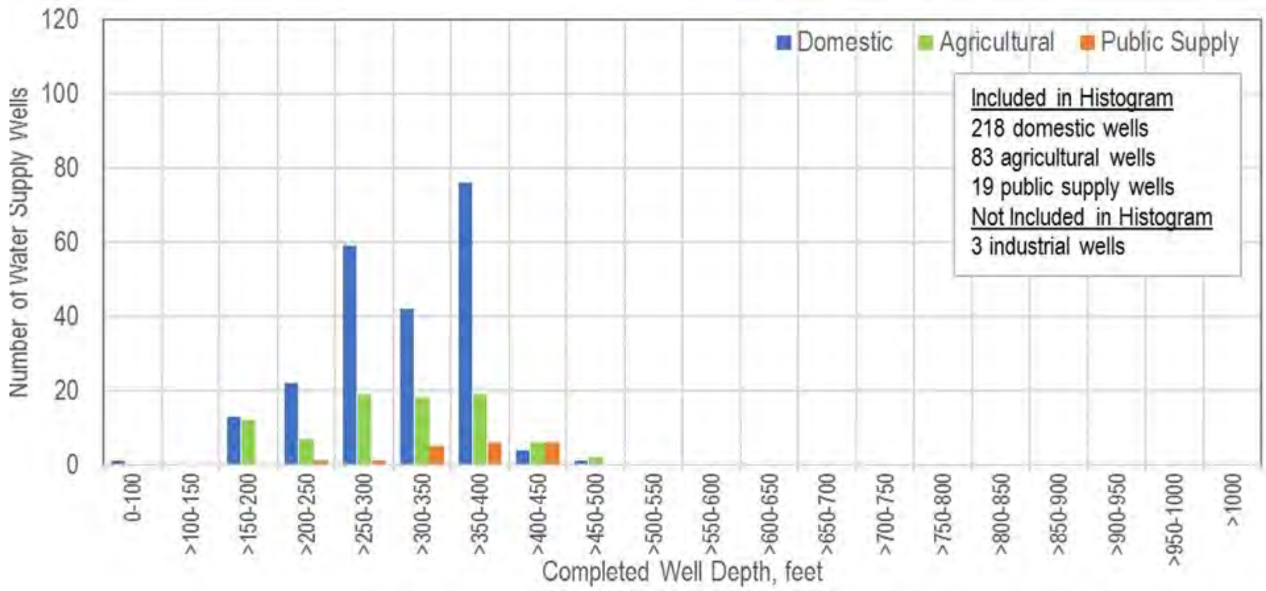



Figure 9. Histogram of Completed Well Depths for Upper Aquifer System Water Supply Wells

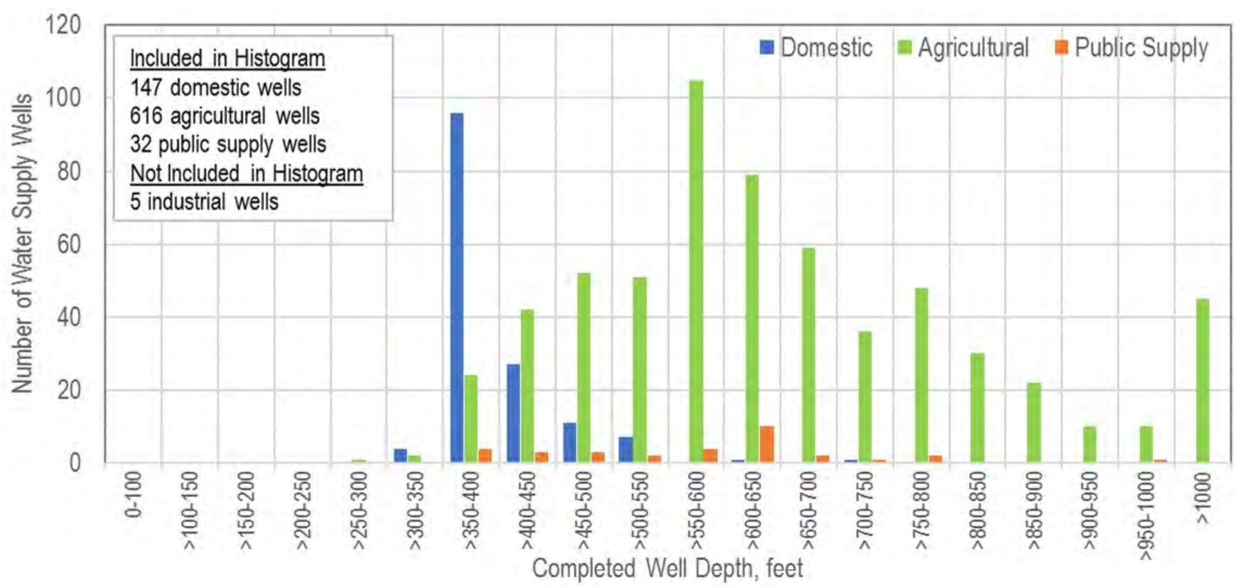



Figure 10. Histogram of Completed Well Depths for Lower Aquifer System Water Supply Wells

The number, depth, and type of water supply wells completed in each of the three aquifer systems are summarized below:

- The Single Aquifer System contains the most wells (2,232) and greatest well density (6.1 wells per square mile) of the three aquifer systems. It also has some of the shallowest wells in the Subbasin, with depths less than 100 feet (Figure 8). It has similar numbers of domestic (999) and agricultural wells (1,160), though overall domestic wells are shallower. About 60% of wells shallower than 200 feet in the Single Aquifer System are domestic wells and about 40% are agricultural wells.
- The Upper Aquifer System has the fewest total wells of the three aquifers (323) and has a well density of about 1 well per square mile. About 2.5 times as many domestic wells (218) as agriculture supply wells (83) are completed in the Upper Aquifer System, as shown on Figure 9. The shallowest wells in the Upper Aquifer System are between 150 and 200 feet, which is slightly deeper than the Single Aquifer System. This is because groundwater levels are deeper in the western portion of the Subbasin underlain by the Corcoran Clay. About 60% of wells in the top 100 feet of the saturated Upper Aquifer System (from 150 to 250 feet) are domestic wells and 40% are agricultural wells.
- The Lower Aquifer System wells are screened mostly below the Corcoran Clay and are generally deeper than 300 feet ( Figure 10). The dataset analyzed has 803 wells and a well density of about 2.5 wells per square mile. About 77% of wells screened in the Upper Aquifer System are agricultural wells (616). However, since most domestic wells are installed shallower than 450 feet and most agricultural wells are installed deeper than 450 feet, there are more domestic wells than agricultural wells in the shallower portions of the Lower Aquifer System. In total, about 65% of wells that are less than 450 feet deep are domestic wells and 35% are agricultural wells.

Completion well depths are evaluated by analysis zone because their depths vary spatially due to different groundwater depths across the Subbasin. Appendix B contains histograms of completed well depth by water use type and analysis zone. Figure 11 through Figure 13 show the proportions of well use types distributed across the Subbasin by analysis zone. By grouping wells in analysis zones, the predominant well use depths in the zone influence statistics used to determine protective groundwater elevations. For example, analysis zone 19 on Figure 11 has more domestic wells than other well use types which means the completed depth statistics derived from wells in the zone are influenced more by domestic wells than other use types.

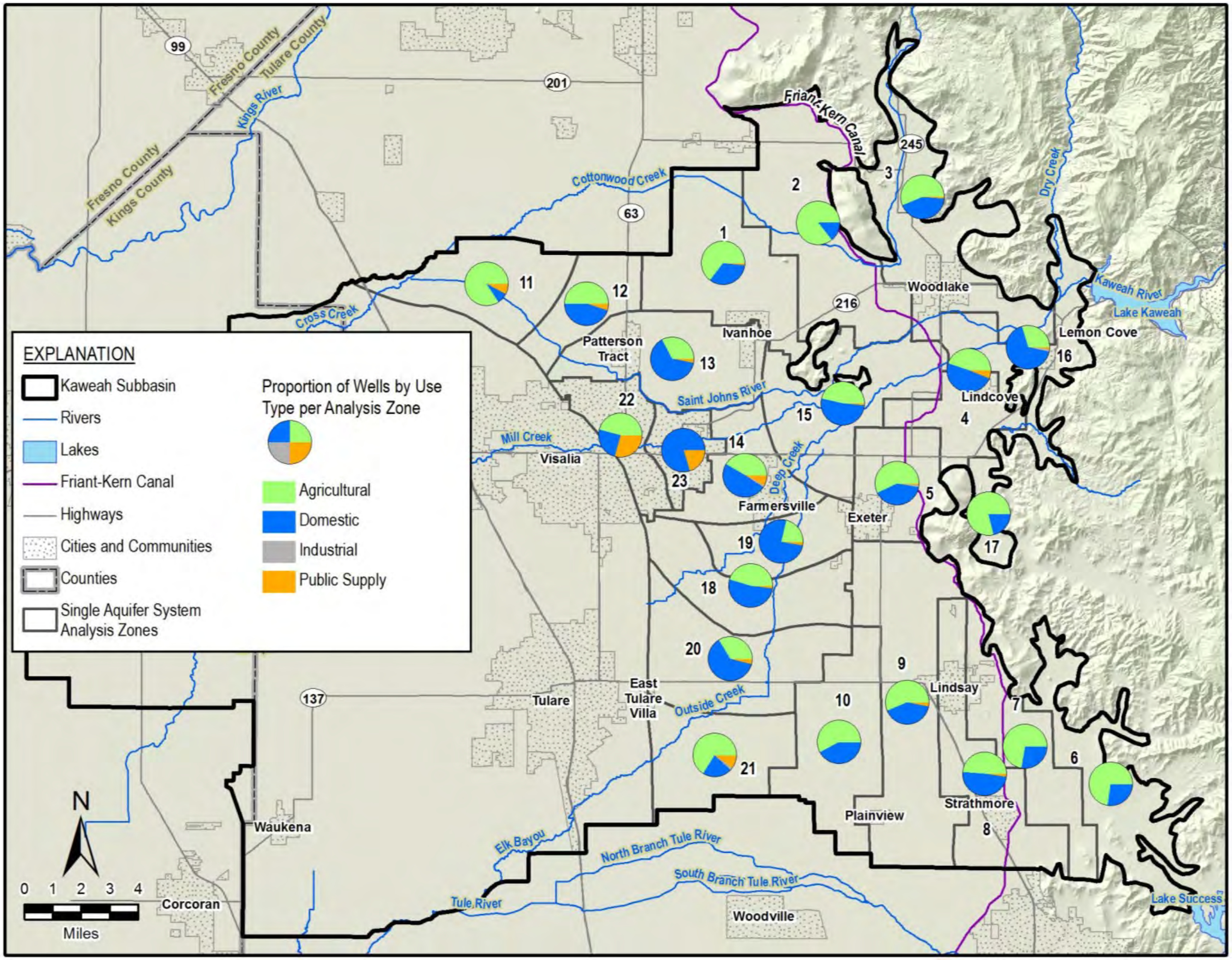



Figure 11. Single Aquifer System Well Use Types by Analysis Zone

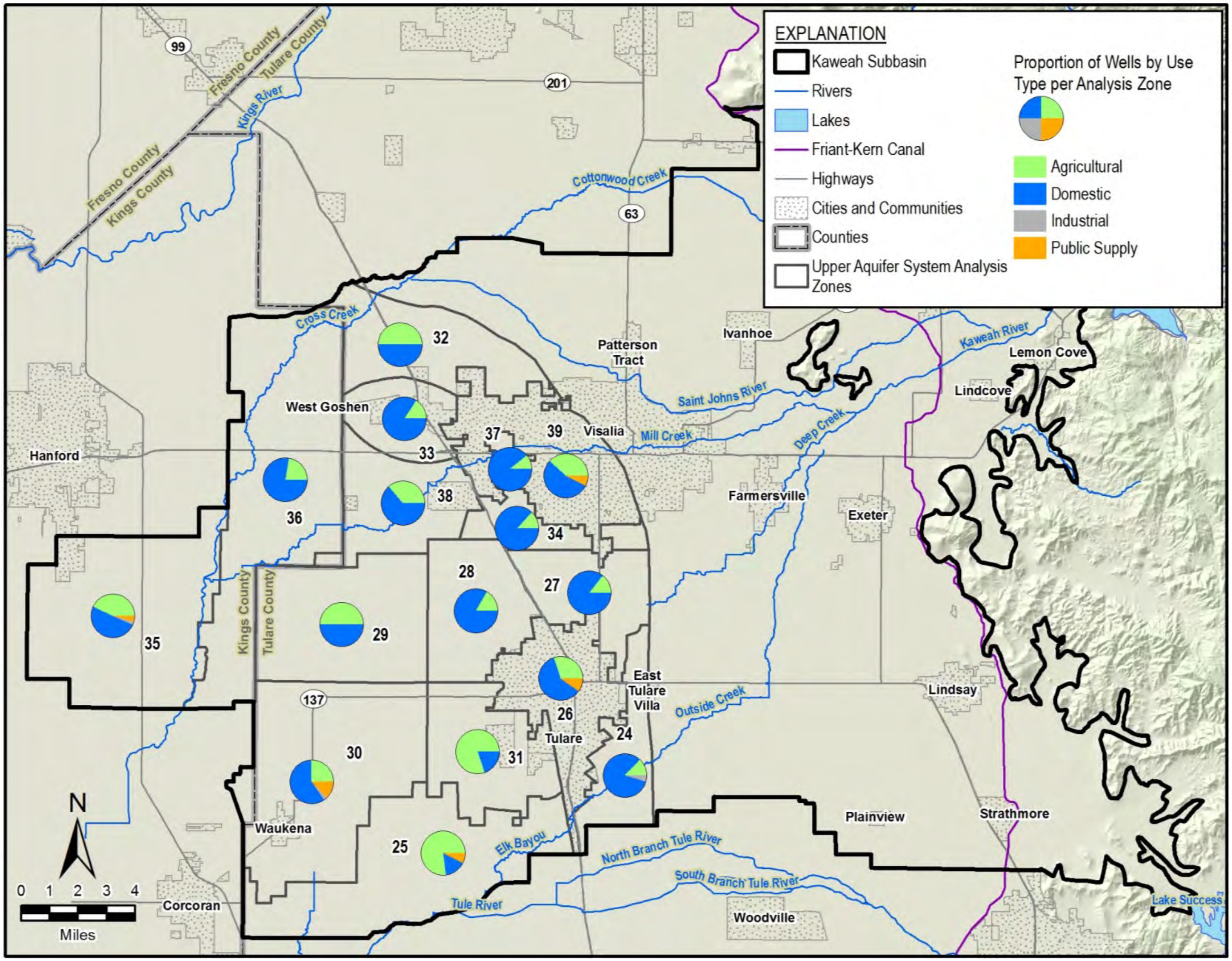



Figure 12. Upper Aquifer System Well Use Types by Analysis Zone

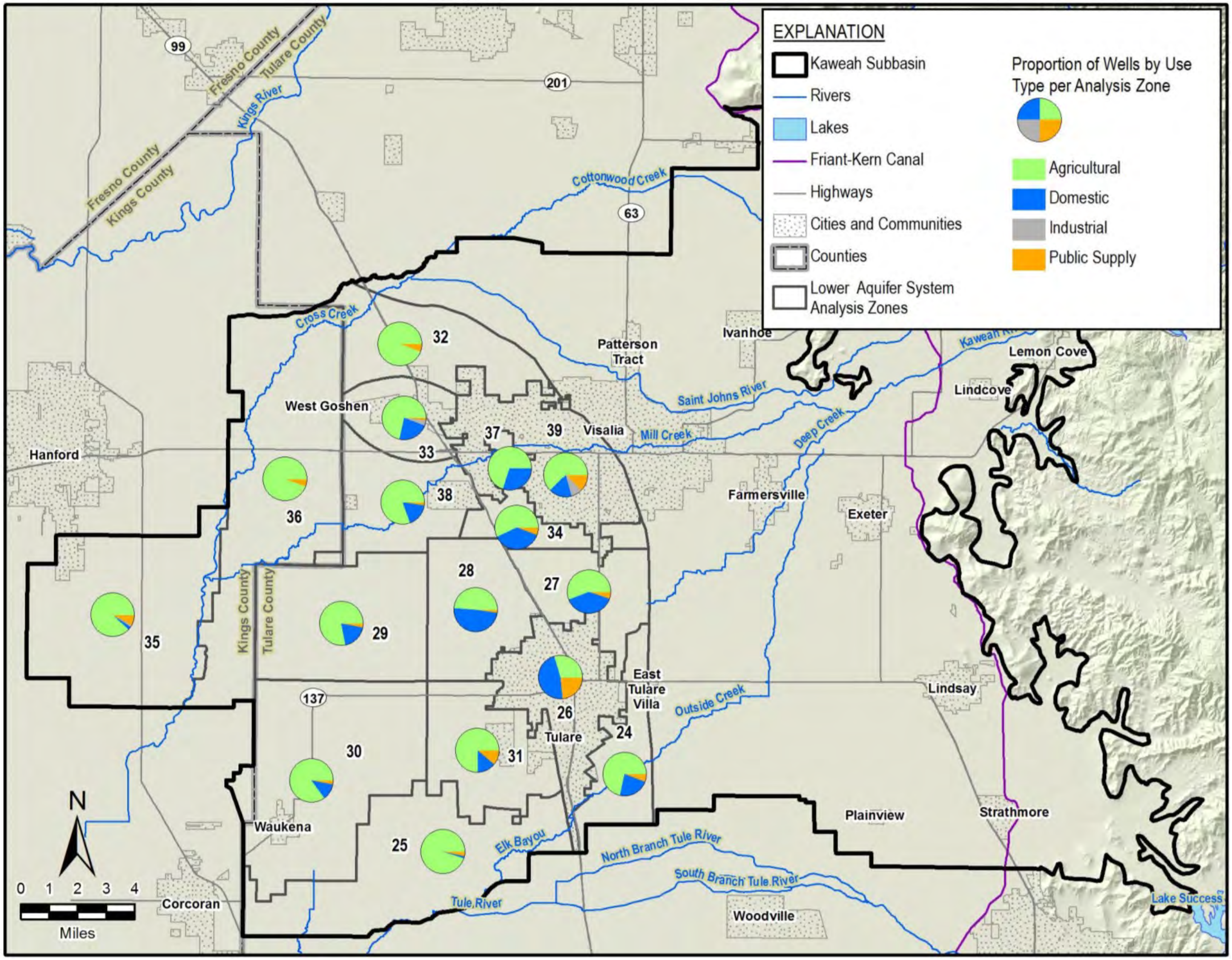


Figure 13. Lower Aquifer System Well Use Types by Analysis Zone

Well type spatial variability within the various aquifer systems is described below:

- The Single Aquifer System wells are relatively evenly split between domestic and agricultural use as shown on Figure 11. Wells around the margins of the Subbasin, including analysis zones 1, 2, 3, 11, and 17 are predominantly used for agriculture, while wells near the Kaweah River distributaries in the middle of the Subbasin such as zones 16, 19, 20, and 23 are predominantly used for domestic purposes. Visalia is the only area with greater than 20% public supply wells (analysis zones 22 and 23).

- The Upper Aquifer System is predominantly pumped by domestic wells as shown on Figure 12. However, there are parts of the Subbasin that are not heavily populated and nearly all wells are used for agriculture (analysis zones 25 and 31). Other areas with a relatively even number of domestic and agricultural supply wells include analysis zones 29 and 35 to the west and 32 to the north. Public supply wells make up less than 20% of all wells in each analysis zone, with the most concentrated distribution near Waukena (analysis zone 30).

- The Lower Aquifer System is primarily pumped by agricultural wells but there are a few areas near Tulare and Visalia where domestic wells make up between 25% to 50% of all wells (Zones 26, 27, 28, 34, and 37). Areas with the greatest number of public supply or industrial wells are in Tulare (analysis zone 26) and Visalia (analysis zone 39).

### 2.1.4 Protective Elevations

To calculate a groundwater elevation minimum threshold based on protection of active water supply wells, a statistical approach using percentiles was taken to develop a realistic view of active wells given well status uncertainties. A percentile well depth, or percentage of wells that would be deeper than a particular depth, was calculated for each analysis zone and aquifer. For example, the 90th percentile well depth (for wells ranked from deepest to shallowest), is the depth that 90% of wells are deeper than or equal to. This means 10% of wells are shallower than the 90th percentile depth. The 10% shallowest completed well depth are not used in the analysis as it is likely they are no longer active.

Selecting the 90th percentile recognizes the uncertainty in the accuracy and completeness of the DWR WCR dataset and accounts for destroyed or replaced shallower wells. The impracticability of managing the Subbasin to the shallowest wells is an additional factor leading to consensus amongst the three GSAs to, at a minimum, protect 90% of all water supply wells.

The 90th percentile completed well depths are calculated for each of the analysis zones by aquifers using the data described in Section 1.2. The analysis was not performed on a particular well use type but for all water supply wells within each analysis zone. Figure 14 shows the protective elevation depths for the three aquifer systems by analysis zone.

Protective well depths follow similar trends as the well completion statistics. The protective well depths are generally shallowest for the Single Aquifer System (Table 1), followed by the Upper Aquifer System, with the deepest protective depths in the Lower Aquifer System. The median protective well depth is 200 feet for the Single Aquifer System, 241 feet for the Upper Aquifer System, and 400 feet for the Lower Aquifer System. The range of protective depths are 100 to 378 feet for the Single Aquifer System, 168 to 300 feet for the Upper Aquifer System, and 380 to 606 feet for the Lower Aquifer System.

Table 1. Summary of Protective Elevations Statistics by Aquifer

| Aquifer | 90th Percentile Protective Depth (feet below ground surface) | | |
|---|---|---|---|
| | Minimum | Median | Maximum |
| Single Aquifer System | 100 | 200 | 378 |
| Upper Aquifer System | 168 | 241 | 300 |
| Lower Aquifer System | 380 | 400 | 606 |

The number of well records in the WCR dataset with construction information, above or below the protective elevation are summarized in Table 2. As mentioned previously, some of these shallow wells are likely destroyed and replaced with deeper wells, Domestic well depths tend to be shallower than wells used for other purposes, so a slightly higher number and percentage of domestic wells are potentially impacted by groundwater declines compared to other wells. Of the 297 wells shallower than the 90$^{th}$ percentile well depth, 58% are domestic wells, 39% are agricultural wells, and 3% are public supply wells. However, in total, 90% of all well types installed since January 2002 are deeper than protective well depths, including 88% of domestic wells, 94% of agricultural wells, and 92% of public supply wells. Although the full set of WCR wells lacks construction information for many wells, if it is assumed the percentages of well use type and depth are the same for the full set of WCR wells as the subset of wells with construction information, the subset percentages may be used to scale up the number of potentially impacted wells to the full set of WCR wells.

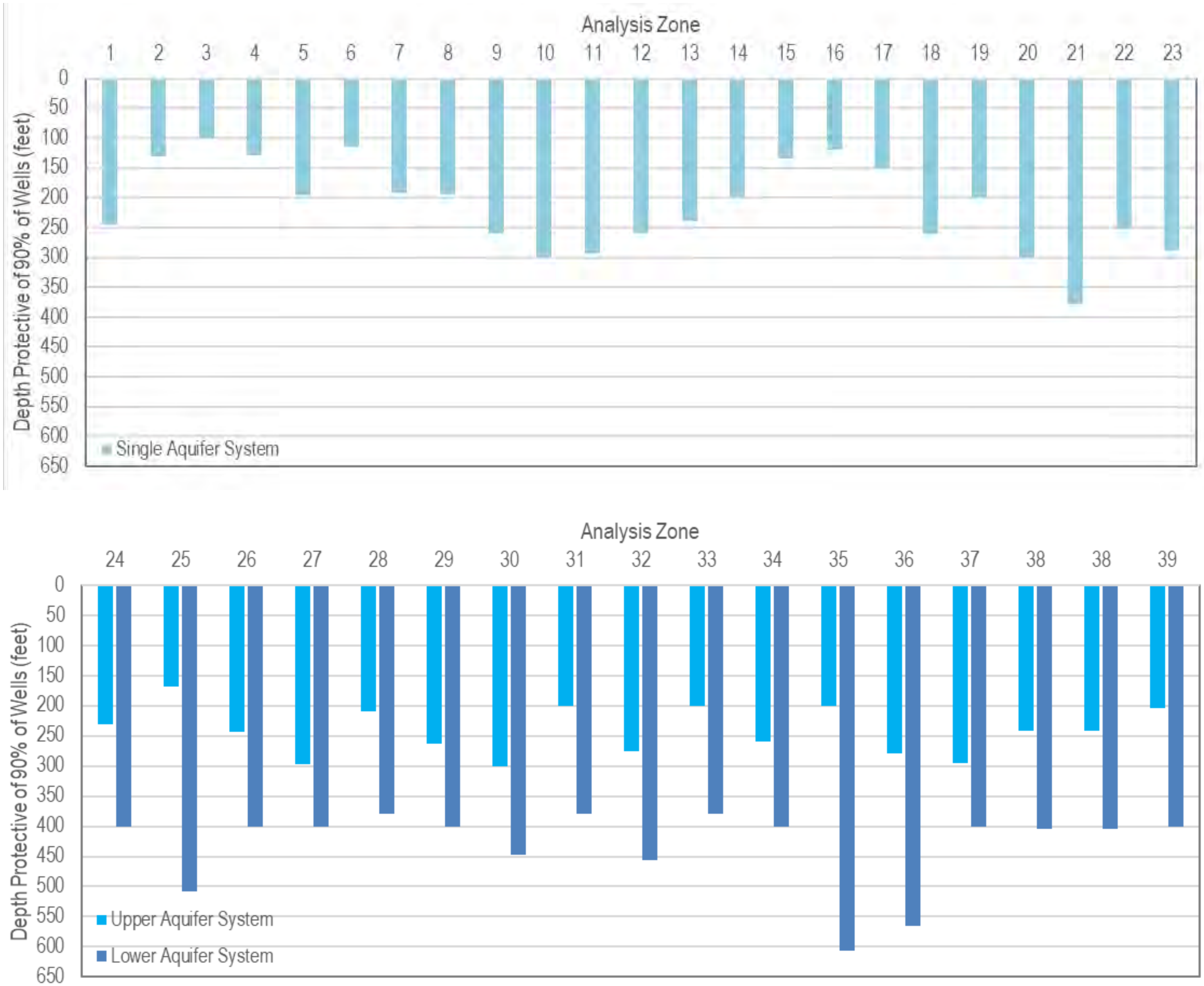



Figure 14. Analysis Zone Depths Protective of 90% of Water Supply Wells in the Kaweah Subbasin

Table 2. Summary of Basinwide Potential Well Impacts of Groundwater Levels at 90% Protective Depths Using WCR Well Records with Construction Information

| Well Use Type | Deeper than 90% Protective Depth | | Shallower than 90% Protective Depth | | Total Number |
|---|---|---|---|---|---|
| | Number of Wells Deeper than the Protective Depth | Well Use Type Percentage | Number of Potentially Impacted Wells | Well Use Type Percentage | |
| Domestic | 1,193 | 39% | 171 | 58% | 1,364 |
| Agricultural | 1,742 | 57% | 117 | 39% | 1,859 |
| Public Supply | 108 | 4% | 9 | 3% | 117 |
| Industrial | 13 | 0% | 0 | 0% | 13 |
| Total | 3,056 | | 297 | | 3,353 |

The number of well records in the WCR dataset of wells with construction information, potentially impacted at the 90% protective depth for each of the three aquifer systems are summarized in Table 4. Domestic wells in the Single Aquifer System will be the most impacted if groundwater levels fall to the protective elevation, followed by agricultural wells. Lower Aquifer System agricultural wells will be impacted more than domestic wells because of the greater number of agricultural wells in the Lower Aquifer System ( Figure 10). The Upper Aquifer System has the least potentially impacted wells, with more domestic wells than agricultural wells potentially impacted.

Table 3. Summary of Potential Well Impacts of Groundwater Levels at 90% Protective Depths by Aquifer Using WCR Well Records with Construction Information

| Well Use Type | Single Aquifer System | | Upper Aquifer System | | Lower Aquifer System | | Total |
|---|---|---|---|---|---|---|---|
| | Number of Potentially Impacted Wells | Well Use Type Percentage | Number of Potentially Impacted Wells | Well Use Type Percentage | Number of Potentially Impacted Wells | Well Use Type Percentage | |
| Domestic | 135 | 63% | 19 | 68% | 17 | 30% | 171 |
| Agricultural | 74 | 35% | 9 | 32% | 34 | 61% | 117 |
| Public Supply | 4 | 2% | 0 | 0% | 5 | 9% | 9 |
| Industrial | 0 | 0% | 0 | 0% | 0 | 0% | 0 |
| Total | 213 | | 28 | | 56 | | 297 |

The East Kaweah Groundwater Sustainability Agency (EKGSA) and Greater Kaweah Groundwater Sustainability Agency (GKGSA) areas are those with the greatest number of wells shallower than the 90% protective depth (Table 4). This is because the Single Aquifer System underlies all of the EKGSA and a portion of the GKGSA, and it is the aquifer with the largest number of potentially impacted wells above the 90% protective depth. The GKGSA has the greatest total number of potentially impacted wells and the Mid-Kaweah Groundwater Sustainability Agency (MKGSA) has the fewest. The GSA areas are shown on Figure 1. Table 4 also summarizes the density of potentially unprotected wells within each GSA area. The EKGSA has the greatest overall density at 0.63 wells per square mile, GKGSA has 0.42 wells per square mile, and MKGSA the lowest density at 0.22 wells per square mile.

The protective elevation for each representative monitoring site is calculated by subtracting the analysis zone-specific 90th percentile protective depth from the representative monitoring site's surface elevation. Appendix C lists the 90% protective elevations for all the representative monitoring sites.

Table 4. Summary of Potential Well Impacts with Groundwater Levels at 90% Protective Depths by GSA Using WCR Well Records with Construction Information

| Well Use Type | East Kaweah GSA | | | Greater Kaweah GSA | | | Mid-Kaweah GSA | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | Potentially Impacted Wells | | Well Use Type Percentage in GSA | Potentially Impacted Wells | | Well Use Type Percentage in GSA | Potentially Impacted Wells | | Well Use Type Percentage in GSA | |
| | Number | Wells per Square Mile | | Number | Wells per Square Mile | | Number | Wells per Square Mile | | |
| Domestic | 58 | 0.32 | 52% | 93 | 0.27 | 64% | 17 | 0.10 | 49% | 171 |
| Agricultural | 50 | 0.27 | 45% | 47 | 0.14 | 32% | 18 | 0.11 | 51% | 117 |
| Public Supply | 3 | 0.02 | 3% | 6 | 0.02 | 4% | 0 | 0 | 0% | 9 |
| Industrial | 0 | 0 | 0% | 0 | 0 | 0% | 0 | 0 | 0% | 0 |
| Total | 111 | 0.61 | | 151 | 0.43 | | 35 | 0.22 | | 297 |

## 2.2 Methodology 2, Groundwater Level Trend

This method extrapolates groundwater level trends for individual representative monitoring sites over a selected base period out to 2040. In all cases the trend is a decline with a rate that varies across the Subbasin. The EKGSA used a different base period than the GKGSA and MKGSA base period as described below. If the MT is derived from this method, it means groundwater levels are set to protect more than 90% of wells in the analysis zone while not allowing groundwater levels to decline at a greater rate than the base period.

In the EKGSA, groundwater level trends over a historical 21-year base period (1997-2017) are projected to 2040. EKGSA critically analyzed the projected 2040 groundwater levels and determined the magnitude of potential impacts likely to occur due to the current pumping and recharge regime. In cases where projected groundwater levels mirror the condition of the basin before the 1950s, when Central Valley Project brought in surface water supplies, or were not sufficiently protective of aquifer storage capacity it was determined that returning groundwater conditions similar to pre-1950 is undesirable. In EKGSA's eastern analysis zones (also called threshold regions), some initial MT elevations were increased due to the shallow depth to the bottom of the aquifer. Groundwater level MTs are established for each of the EKGSA's 10 analysis zones based on available groundwater level trend data for wells within each analysis zone. EKGSA representative monitoring sites within an analysis zone are therefore assigned the same MT groundwater elevations.

For representative monitoring sites in the GKGSA and MKGSA, the groundwater level trend base period projected to 2040 is the 11-year period from 2006 to 2016. The 2006-2016 base period represents a more recent period that reflects recent pumping patterns and includes the effects of the 2012-2016 drought. Unlike EKGSA which assigns a single MT to all representative monitoring sites within an analysis zone, GKGSA and MKGSA representative monitoring sites all have unique MTs based upon the 11-year groundwater level trend.

## 2.3 Methodology 3, Interpolated Minimum Threshold

After estimating MTs using methodologies 1 and 2, some GKGSA and MKGSA representative monitoring site MTs were determined to be anomalously low compared to neighboring monitoring sites because the wells' 2006-2016 groundwater level trend are much steeper than adjacent representative monitoring sites. There are four sites in the Single Aquifer System and three sites in the Upper Aquifer System where this occurs.

For representative monitoring sites with anomalously low MTs derived from the higher of Methodology 1 and 2 elevations, MTs were raised to an elevation determined by interpolating from MT contours. The contours are generated from the representative monitoring site MTs without the seven sites as control points. Figure 15 identifies the resultant MT contours and identifies the seven sites with pre-adjusted and adjusted MTs labeled. The result of using Methodology 3 is that MTs were interpolated into a smooth surface of MTs without any significant level change (“cliffs”) between representative monitoring sites.

## 2.4 Selection of Method to Use for Minimum Threshold

For each representative monitoring site, the elevations based on the 90% protective depth (Method 1) and groundwater levels trend (Method 2) are compared. The higher of the two elevations is selected as the MT. If the groundwater level trend elevation is higher than the protective elevation, more than 90% of wells in the analysis zone are protected. Appendix C includes the elevations for both methods and highlights the elevation of the method used for MTs.

Even though multiple methods are used by the GSAs to establish MTs, contours of MTs for the Single and Upper Aquifer Systems (unconfined) and the Lower Aquifer System (confined) onFigure 15 and Figure 16, respectively, demonstrate MTs across the Subbasin do not show abnormal differences between RMS and MTs decrease in elevation from east to west similar to groundwater elevations.

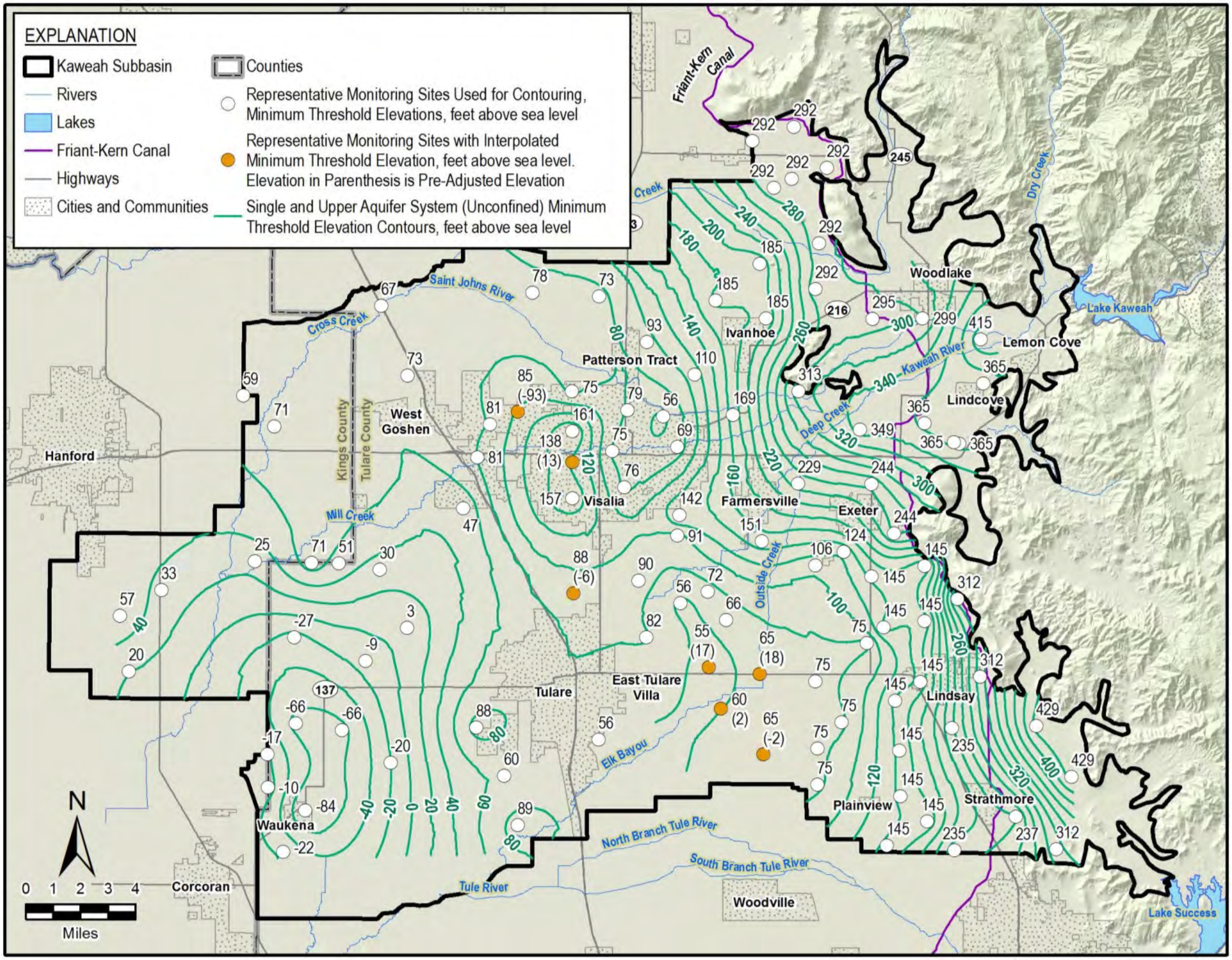


Figure 15. Single and Upper (Unconfined) Aquifer System Minimum Threshold Contours Across the Kaweah Subbasin

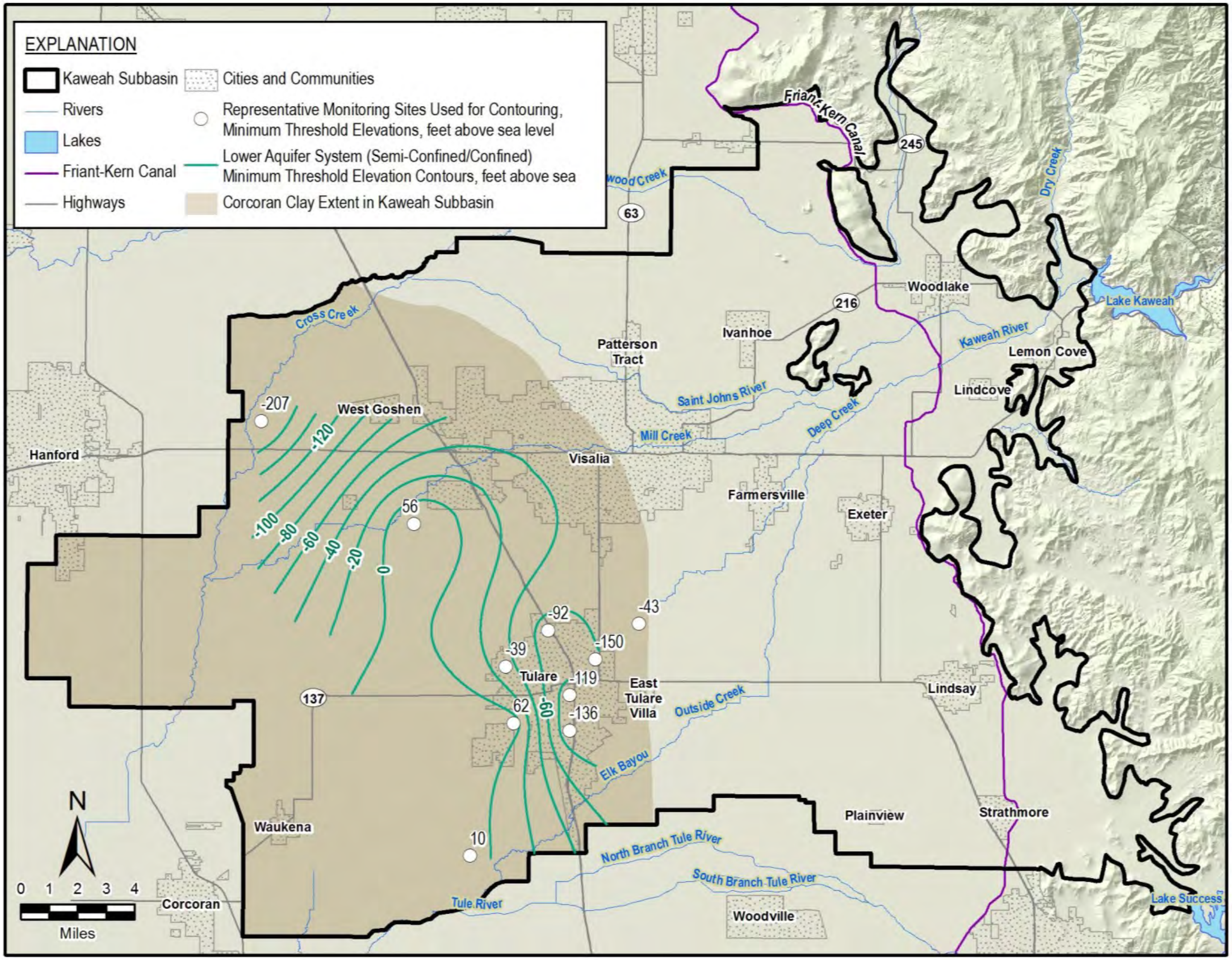



Figure 16. Lower Aquifer (Semi-Confined/Confined) System Minimum Threshold Contours Across the Kaweah Subbasin

# 3 PROCESS USED TO ESTABLISH MEASURABLE OBJECTIVES AND INTERIM MILESTONES

## 3.1 Measurable Objective Methodologies

Measurable objectives (MOs) are established at groundwater elevations higher than MTs to provide operational flexibility and reflect the GSAs' desired groundwater conditions in 2040. The margin of operational flexibility accounts for droughts, climate change, conjunctive use operations, other groundwater management activities, and data uncertainty. The GSAs in the Kaweah Subbasin are managing their groundwater sustainability to meet the MO in 2040.

The EKGSA MOs are based on Spring 2017 groundwater levels. Spring 2017 was a wet year that followed the 2012-2016 drought. This approach applies to wells where the MT is based on the 1997-2017 groundwater level trend projection described in Section 1.1 and shown on Figure 17.

The GKGSA and MKGSA MOs are based on one of two methods, depending on which methodology was used to set MTs. Figure 17 graphically shows the relationship between the different MT and MO methodologies.

MO Method 1, Groundwater Level Trend Projection to 2030:

- For GKGSA and MKGSA representative monitoring sites with MTs derived from the groundwater level trend projection, the MO is the 2006-2016 groundwater elevation projected to 2030 (Figure 18).
- For representative monitoring sites where the MT is set using the protective elevation, and the difference between the MT and groundwater elevation trend projected to 2030 is 20 feet or more, the MO is the 2006-2016 groundwater elevation projected to 2030 (Figure 18).

MO Method 2: 5-Year Drought Storage Based on 2006-2016 Trend

- For representative monitoring sites where the MT is set using the protective elevation, and the difference between the MT and groundwater elevation trend projected to 2030 is less than 20 feet, the MO is set at an elevation that provides for 5 years of drought storage above the MT. Five years of drought storage is determined as the groundwater level change occurring over 5 years using the 2006-2016 groundwater level trend (Figure 19). The groundwater level change is added to the MT elevation to establish the MO elevation (Figure 19).

- For representative monitoring sites where anomalously low MTs are adjusted by interpolating from MT contours, the MO is set at an elevation that provides for 5 years of drought storage above the adjusted MT.

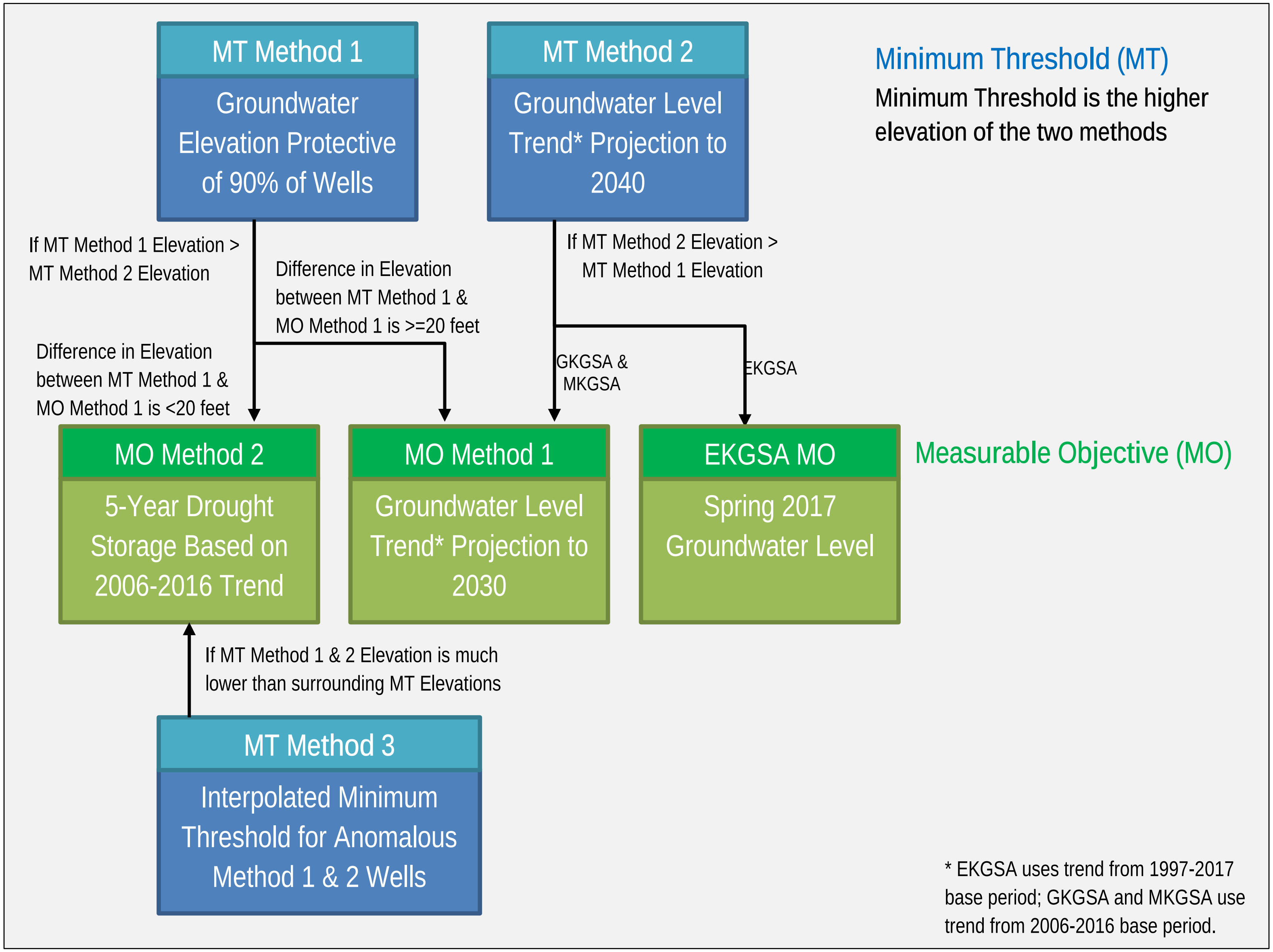



Figure 17. Relationship Between Minimum Threshold and Measurable Objective Methodologies

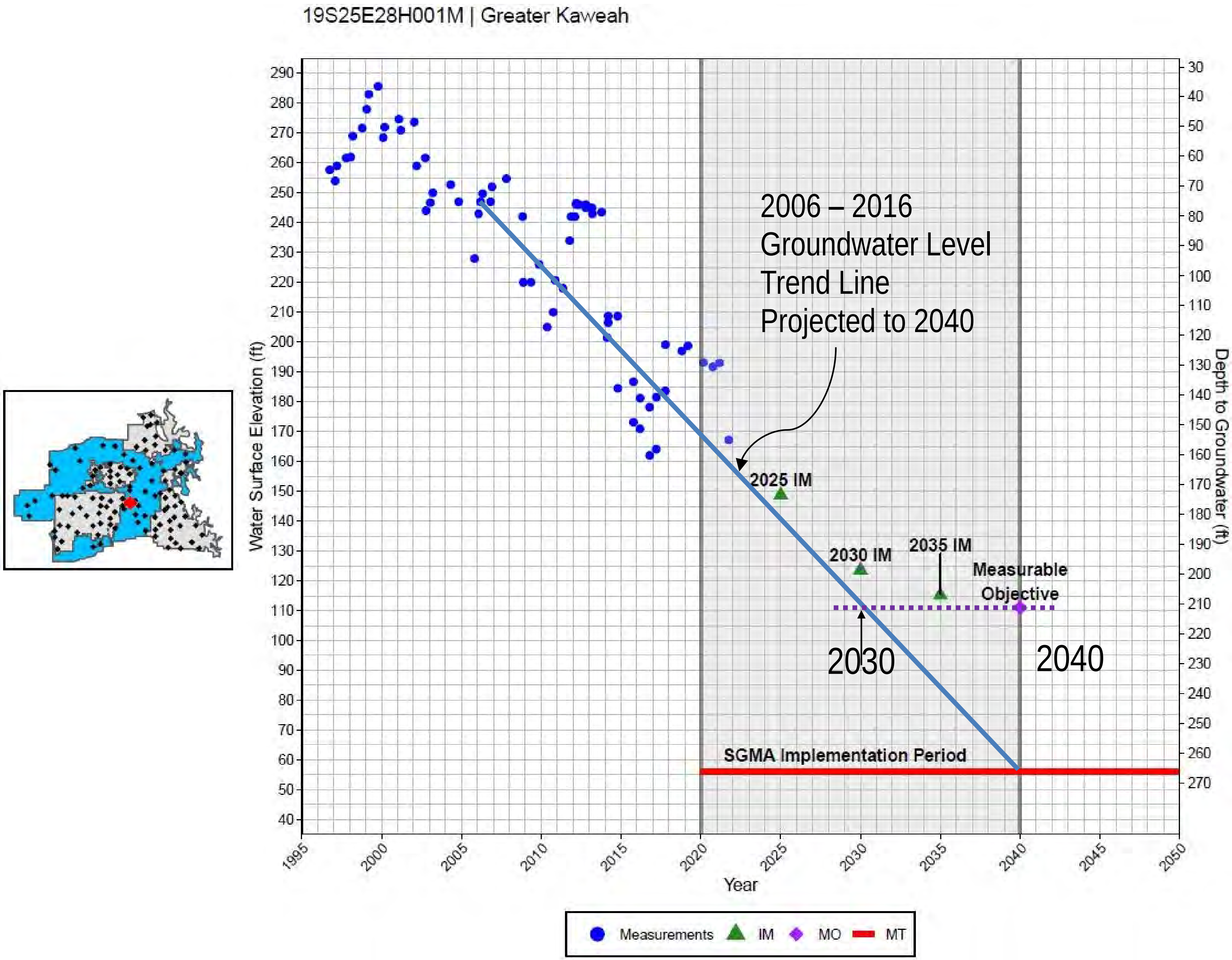



Figure 18. Example Hydrograph Showing Projection of 2006 – 2016 Trend Line

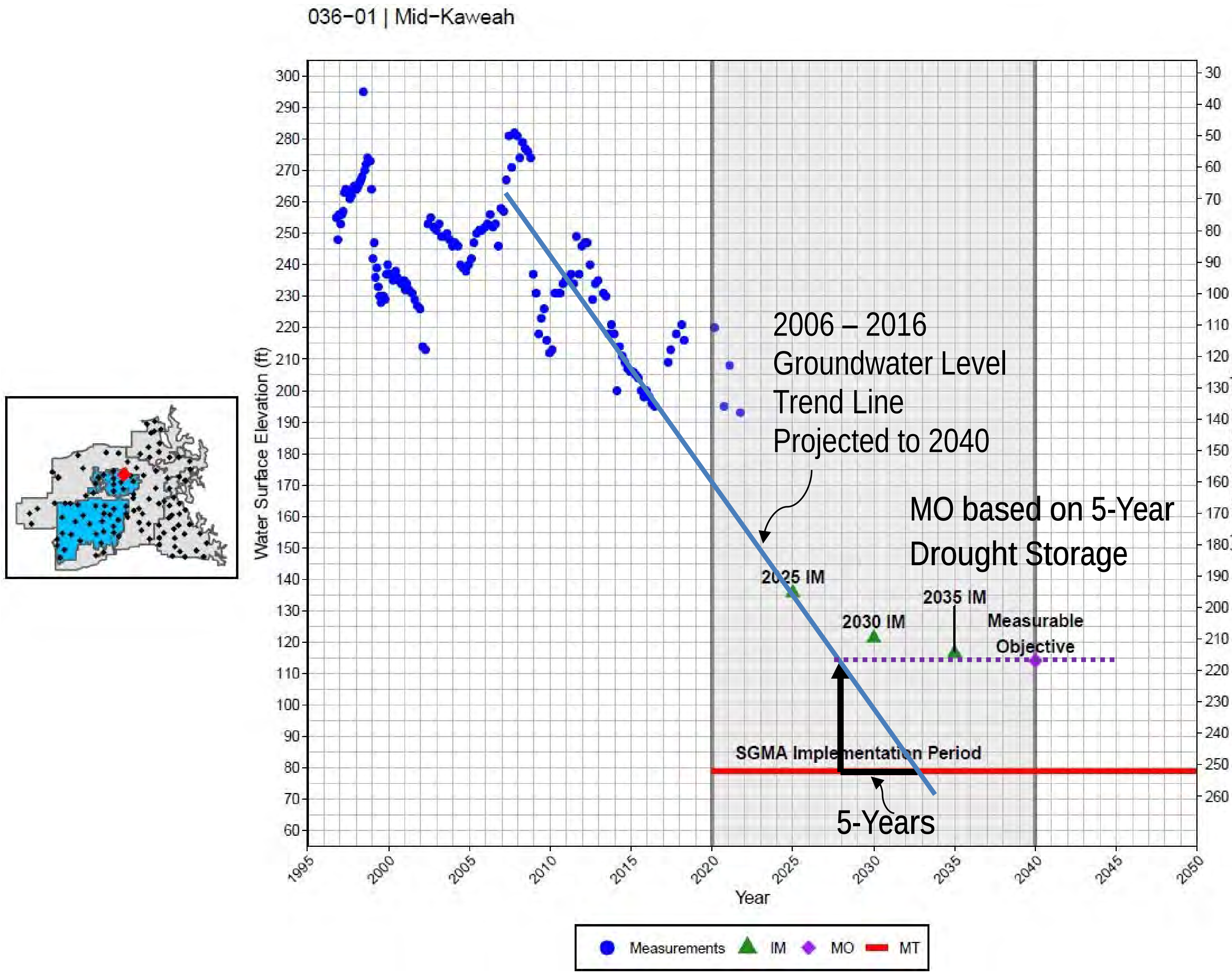



Figure 19. Example Hydrograph Showing Measurable Objective Based on 5-Year Drought Storage

## 3.2 Interim Milestone Methodology

Interim milestones for all representative monitoring sites take the form of a curve that flattens out toward 2040 when the MO is reached. The curve shape is determined based on implementation of projects and management actions over the next 18 years.

For the EKGSA, interim milestones are proportional to percent of overdraft to be corrected in 5-year intervals through implementation period. The interim milestones leading to groundwater level stabilization are unique to each analysis zone but follow the same incremental mitigation rate for correction of 5%, 25%, 55%, and 100% by 2025, 2030, 2035, and 2040, respectively.

Interim milestones for GKGSA and MKGSA representative monitoring sites are based on incrementally decreasing groundwater level change over time based on the following:

- 2025 interim milestone– extend the 2006-2016 groundwater level trend to 2025
- 2030 interim milestone –elevation at two-thirds of the elevation difference between the 2025 interim milestone and the MO
- 2035 interim milestone - elevation at two-thirds of the elevation difference between the 2030 interim milestone and the MO

The method for setting GKGSA and MKGSA interim milestones is illustrated on Figure 20.

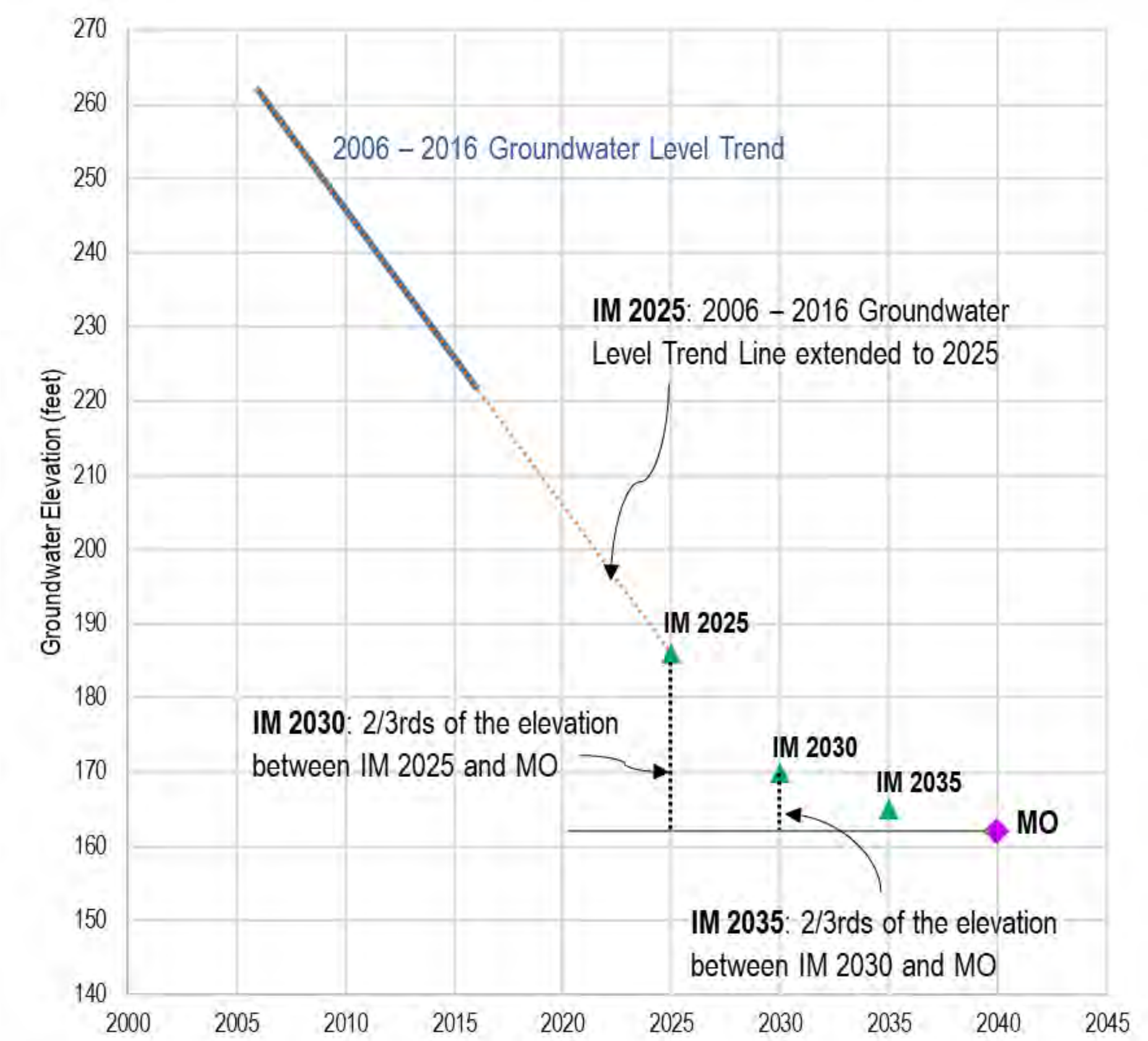


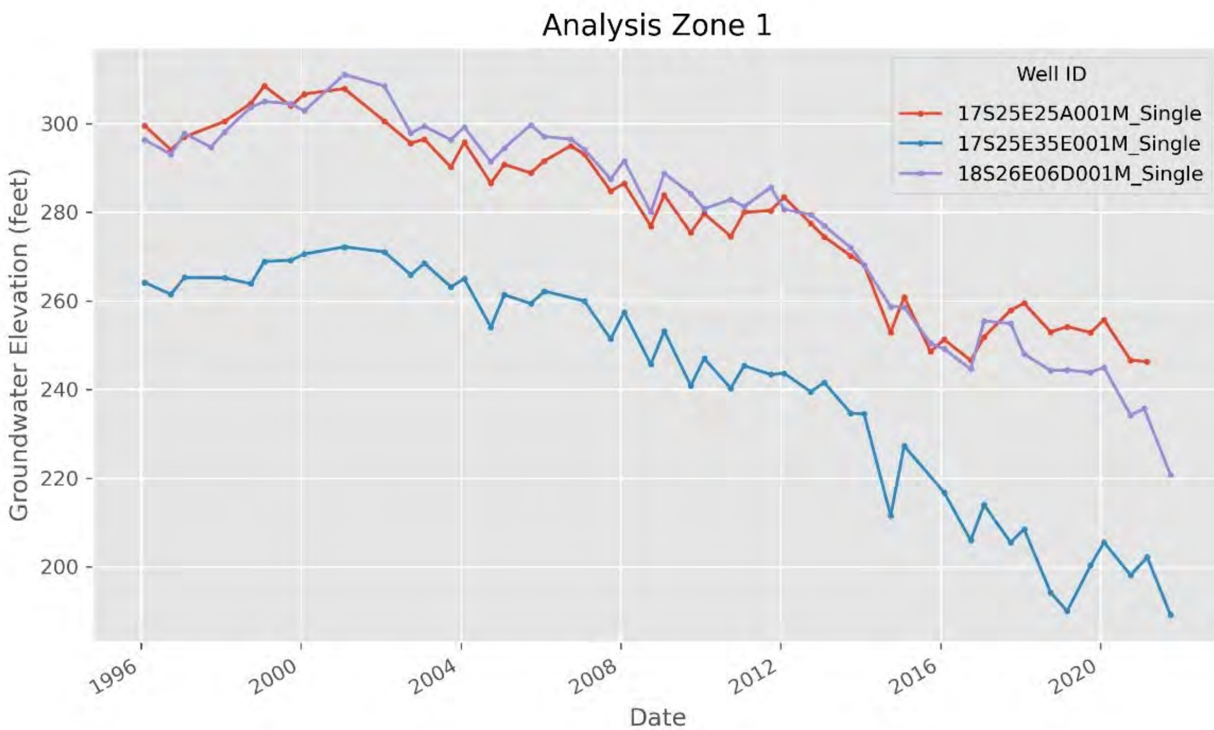

Figure 20. Example of Interim Milestone Method for GKGSA and MKGSA Represenative Monitoring Sites

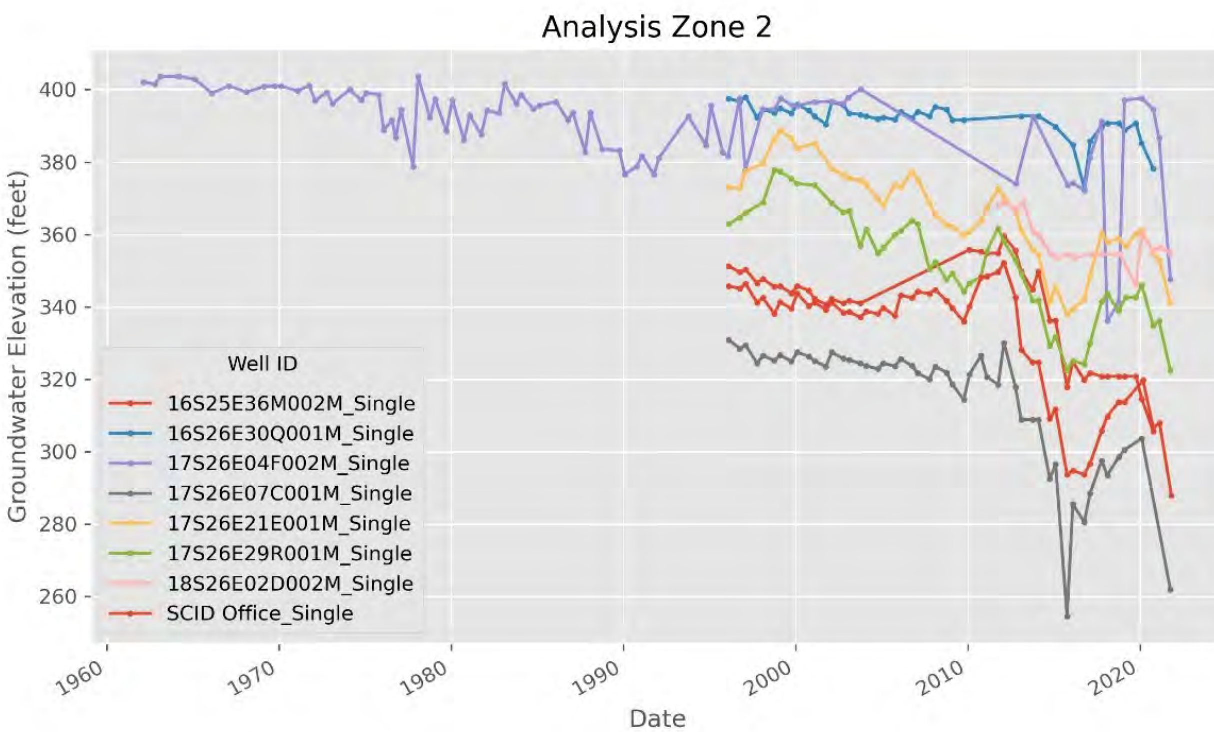
# 4 REFERENCES

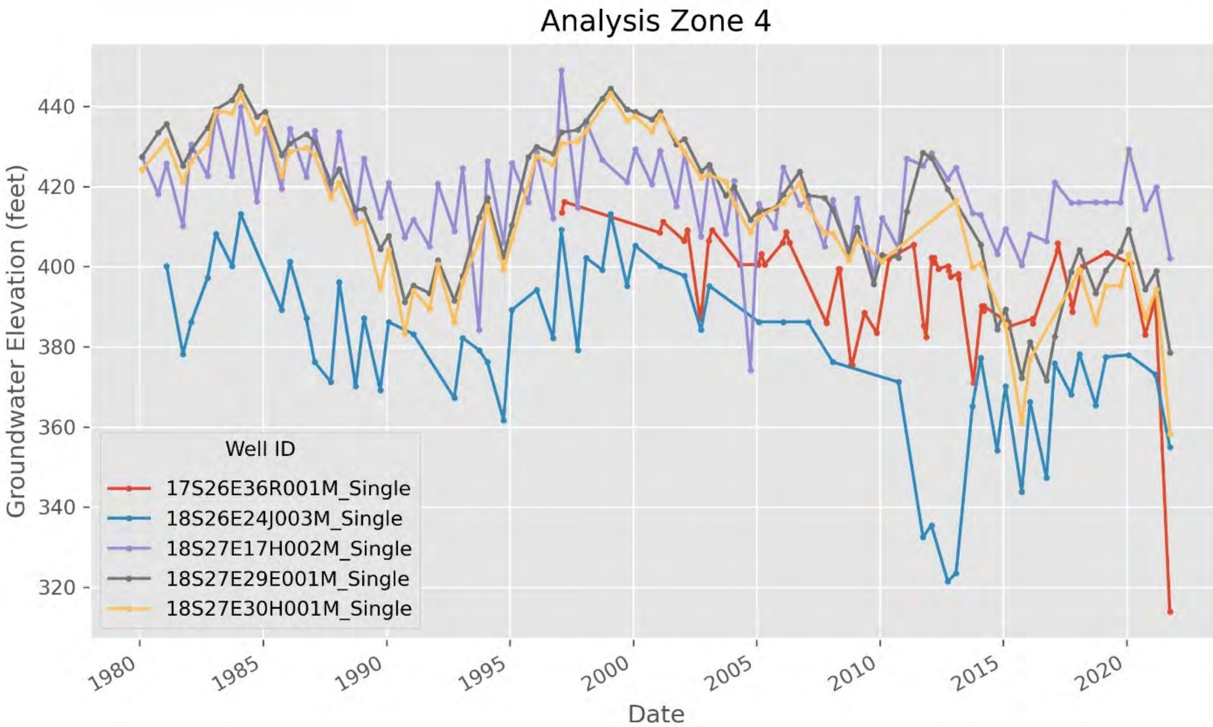
Kang, S., Knight, R., & Goebel, M. (2022). Improved imaging of the large-scale structure of a groundwater system with airborne electromagnetic data. *Water Resources Research*, 58, e2021WR031439. https://doi.org/10.1029/2021WR031439

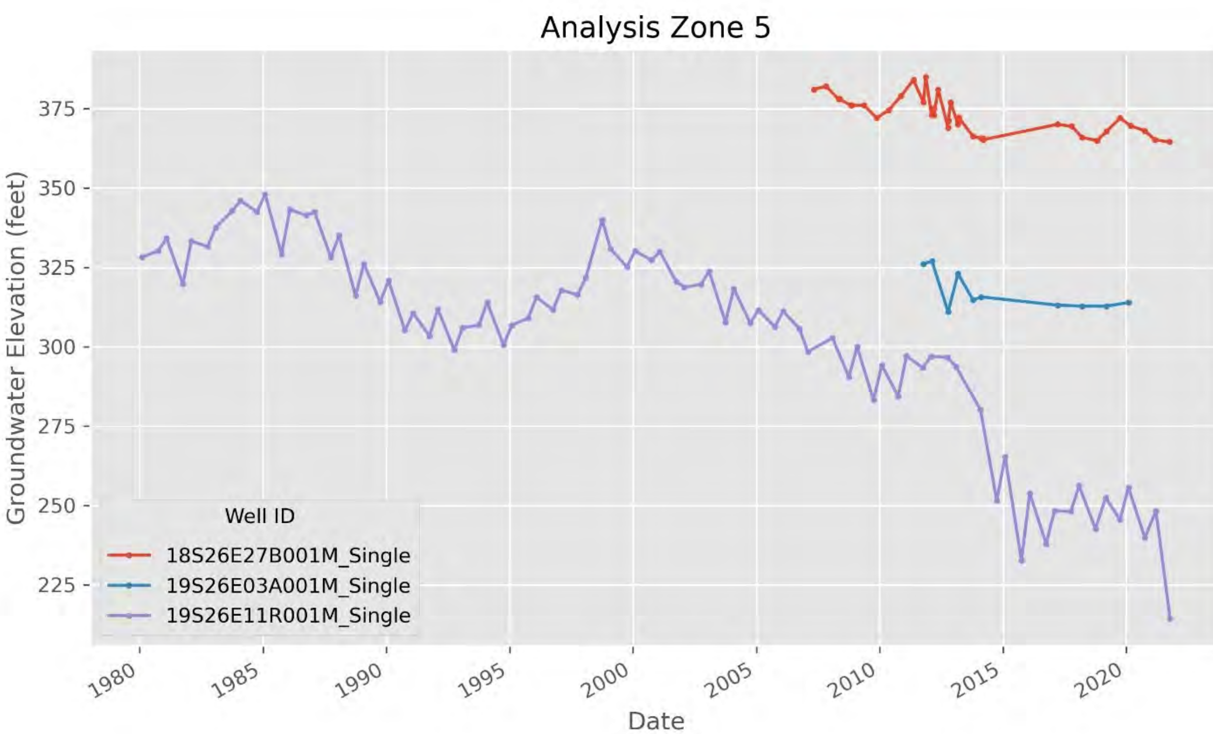
# Appendix A

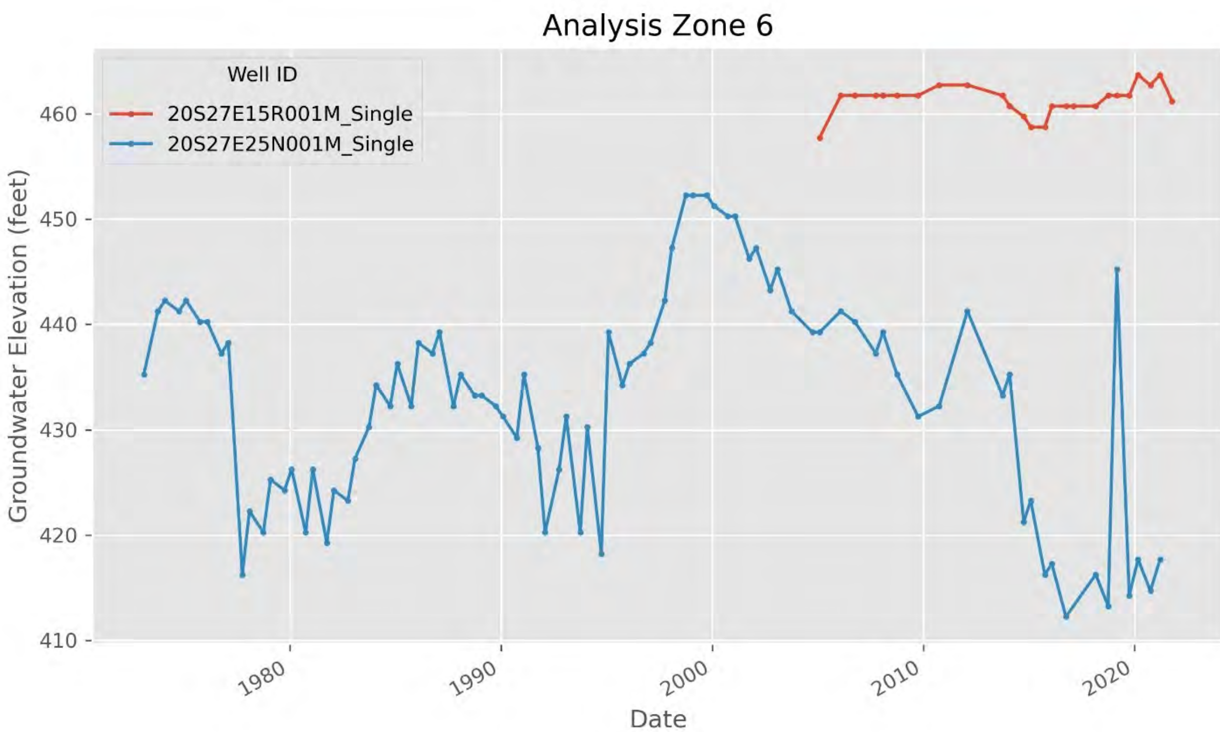
## Representative Monitoring Site Hydrographs by Aquifer and Analysis Zone

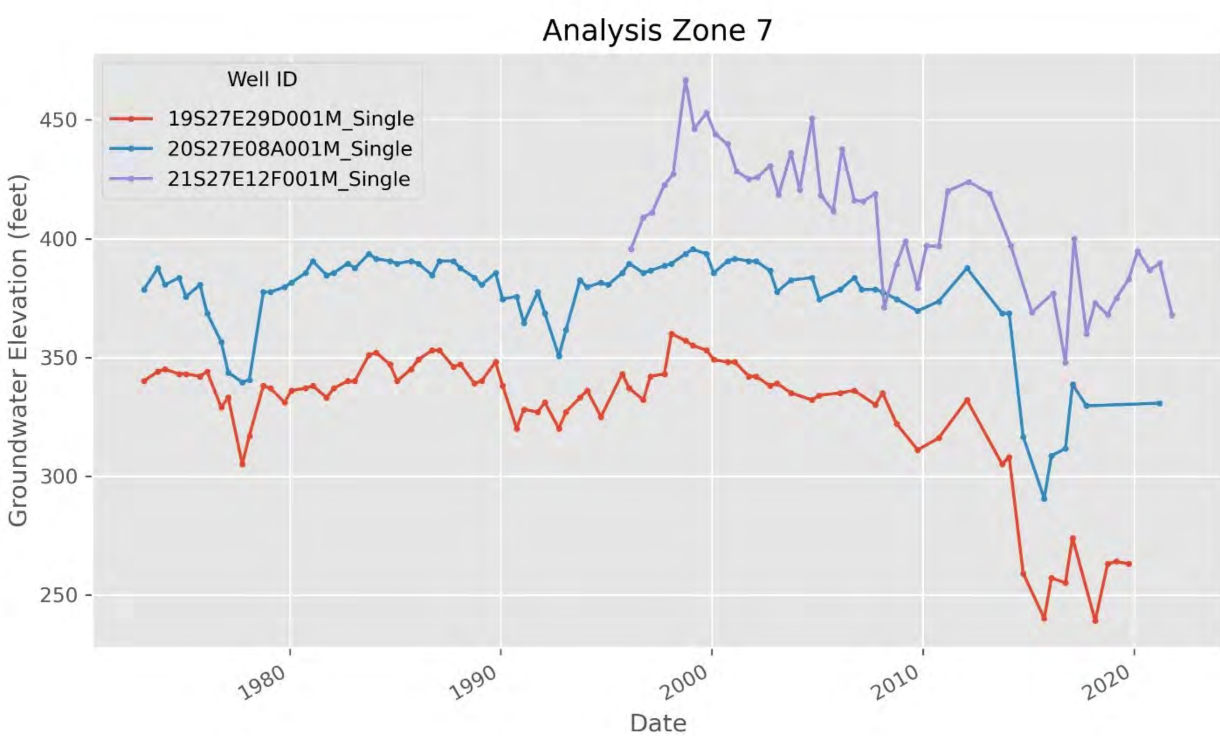

Analysis Zone 1
Well ID
17S25E25A001M_Single
17S25E35E001M_Single
18S26E06D001M_Single
Groundwater Elevation (feet)
300
280
260
240
220
200
1996
2000
2004
2008
2012
2016
2020
Date

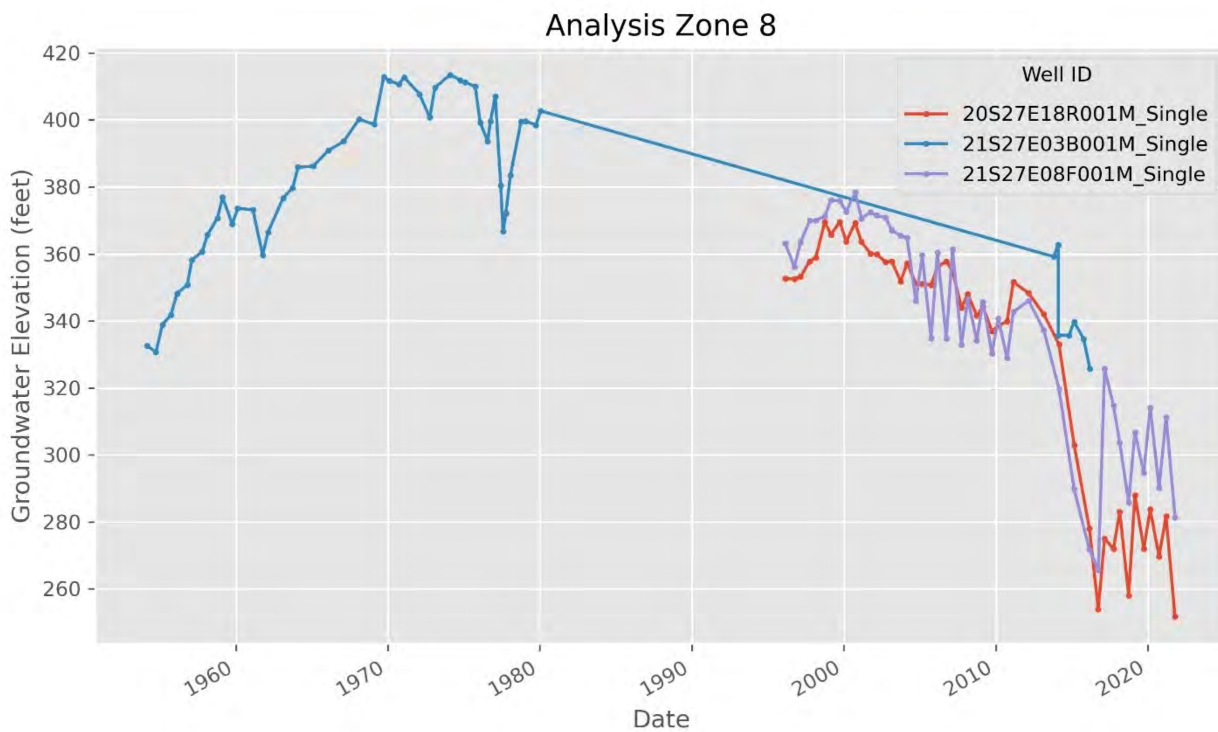

Analysis Zone 2
Well ID
16S25E36M002M_Single
16S26E30Q001M_Single
17S26E04F002M_Single
17S26E07C001M_Single
17S26E21E001M_Single
17S26E29R001M_Single
18S26E02D002M_Single
SCID Office_Single
Groundwater Elevation (feet)
400
380
360
340
320
300
280
260
1960
1970
1980
1990
2000
2010
2020
Date

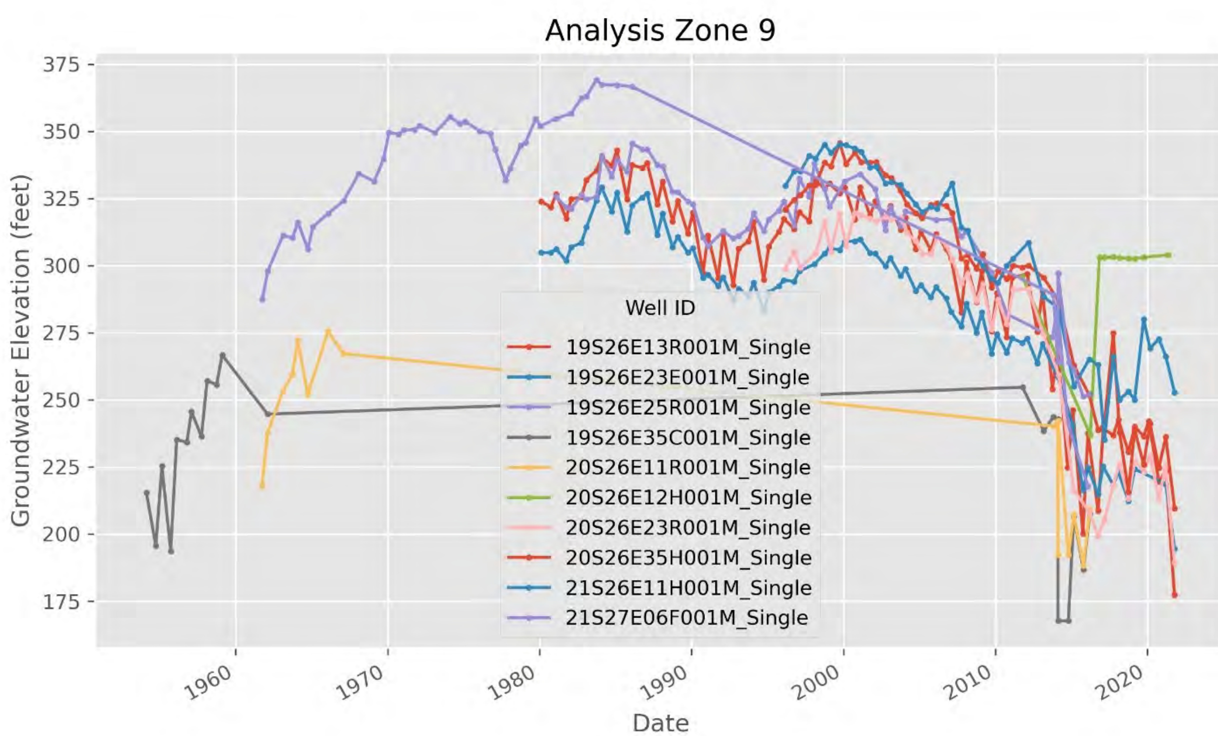

Analysis Zone 4
Groundwater Elevation (feet)
440
420
400
380
360
340
320
Well ID
17S26E36R001M_Single
18S26E24J003M_Single
18S27E17H002M_Single
18S27E29E001M_Single
18S27E30H001M_Single
1980
1985
1990
1995
2000
2005
2010
2015
2020
Date

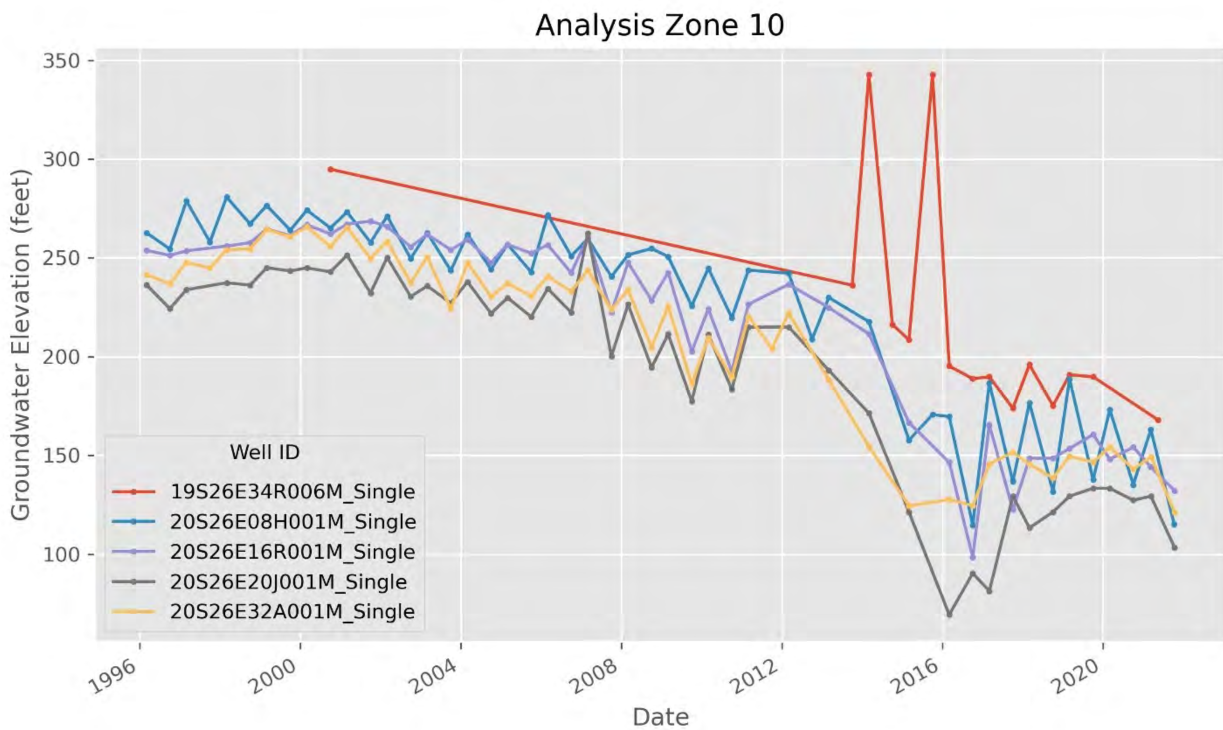

Analysis Zone 5
Groundwater Elevation (feet)
375
350
325
300
275
250
225
Well ID
18S26E27B001M_Single
19S26E03A001M_Single
19S26E11R001M_Single
1980
1985
1990
1995
2000
2005
2010
2015
2020
Date

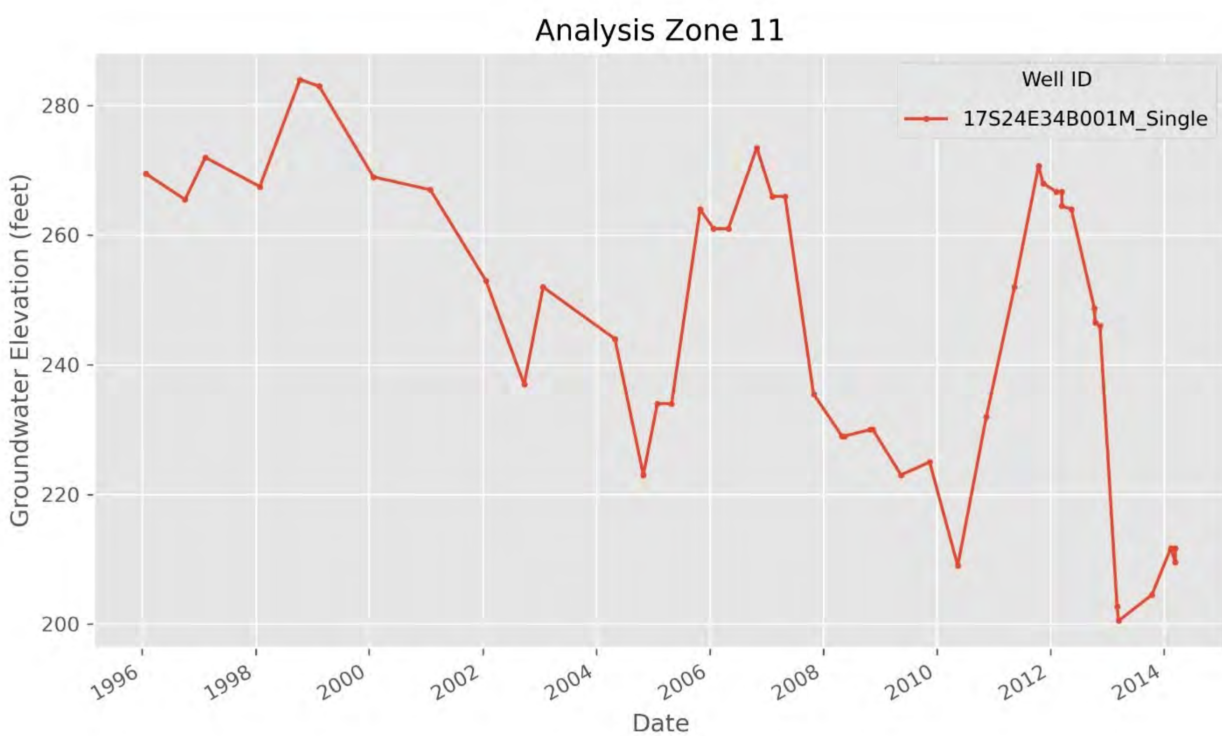

Analysis Zone 6
Well ID
20S27E15R001M_Single
20S27E25N001M_Single
Groundwater Elevation (feet)
460
450
440
430
420
410
1980
1990
2000
2010
2020
Date

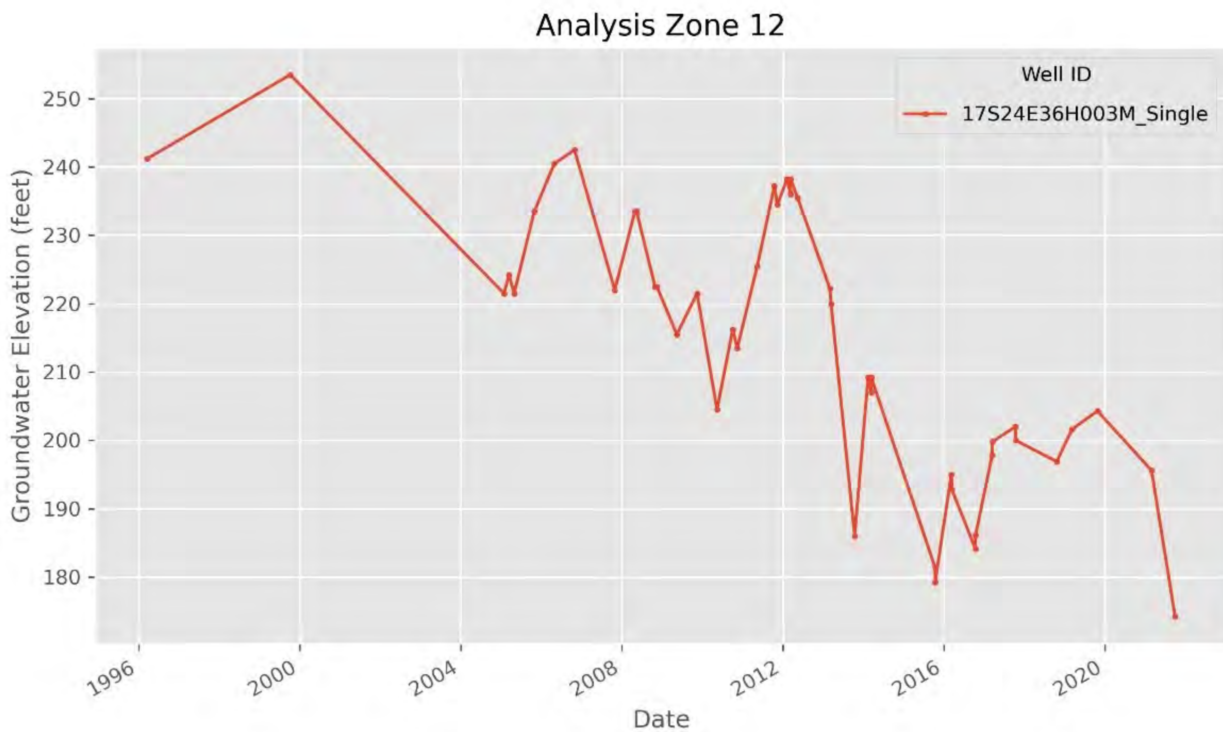

Analysis Zone 7
Well ID
19S27E29D001M_Single
20S27E08A001M_Single
21S27E12F001M_Single
Groundwater Elevation (feet)
450
400
350
300
250
1980
1990
2000
2010
2020
Date

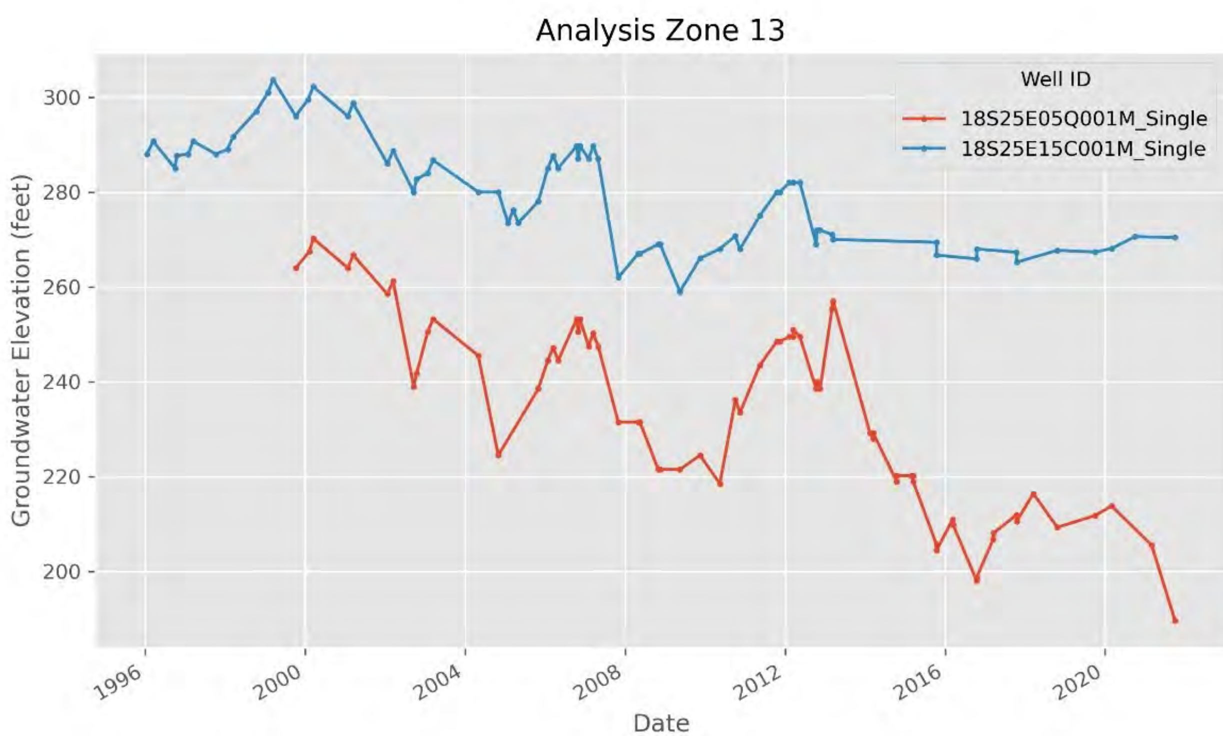

Analysis Zone 8
Groundwater Elevation (feet)
420
400
380
360
340
320
300
280
260
1960
1970
1980
1990
2000
2010
2020
Date
Well ID
20S27E18R001M_Single
21S27E03B001M_Single
21S27E08F001M_Single

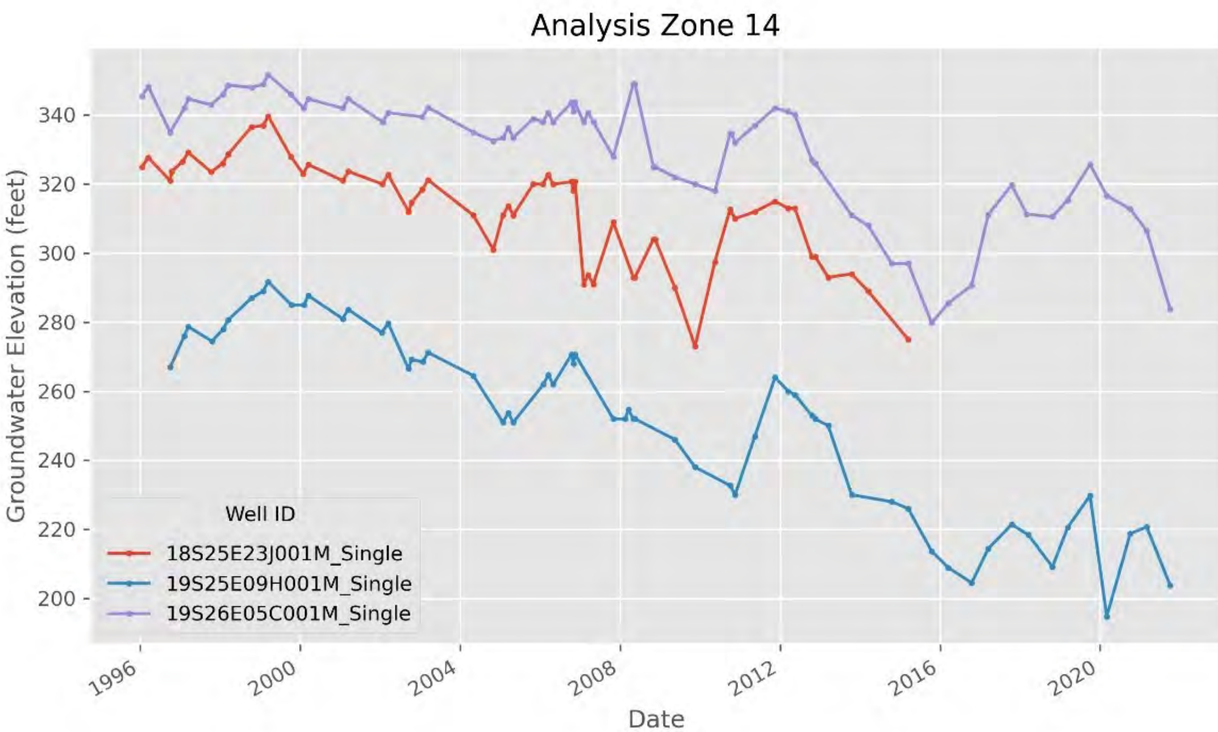

Analysis Zone 9
Groundwater Elevation (feet)
375
350
325
300
275
250
225
200
175
1960
1970
1980
1990
2000
2010
2020
Date
Well ID
19S26E13R001M_Single
19S26E23E001M_Single
19S26E25R001M_Single
19S26E35C001M_Single
20S26E11R001M_Single
20S26E12H001M_Single
20S26E23R001M_Single
20S26E35H001M_Single
21S26E11H001M_Single
21S27E06F001M_Single

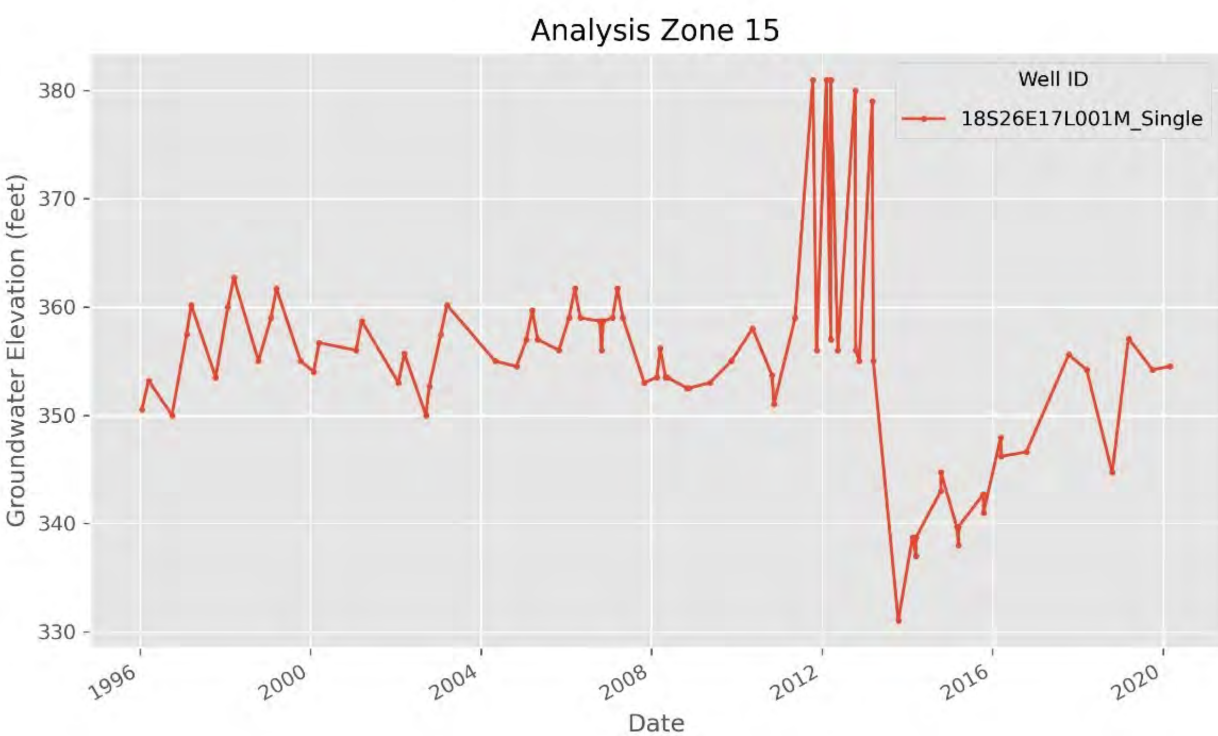

Analysis Zone 10
Groundwater Elevation (feet)
350
300
250
200
150
100
Well ID
19S26E34R006M_Single
20S26E08H001M_Single
20S26E16R001M_Single
20S26E20J001M_Single
20S26E32A001M_Single
1996
2000
2004
2008
2012
2016
2020
Date

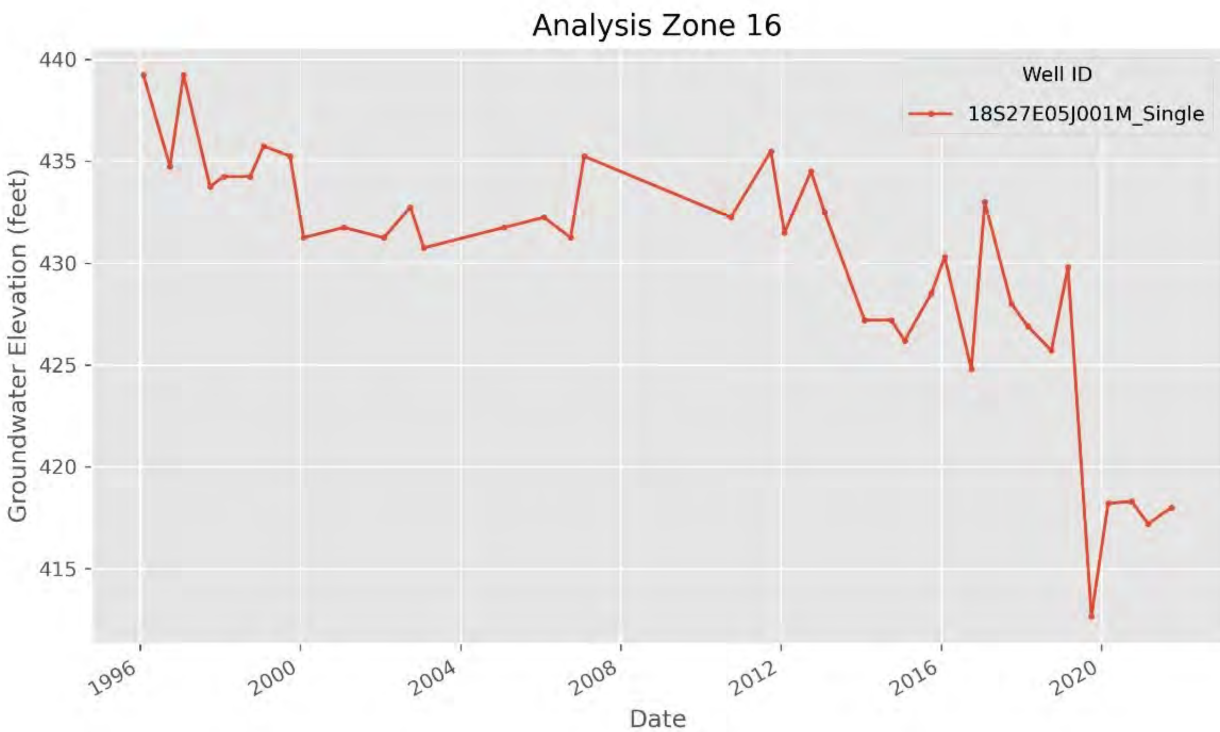

Analysis Zone 11
Groundwater Elevation (feet)
280
260
240
220
200
Well ID
17S24E34B001M_Single
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
Date

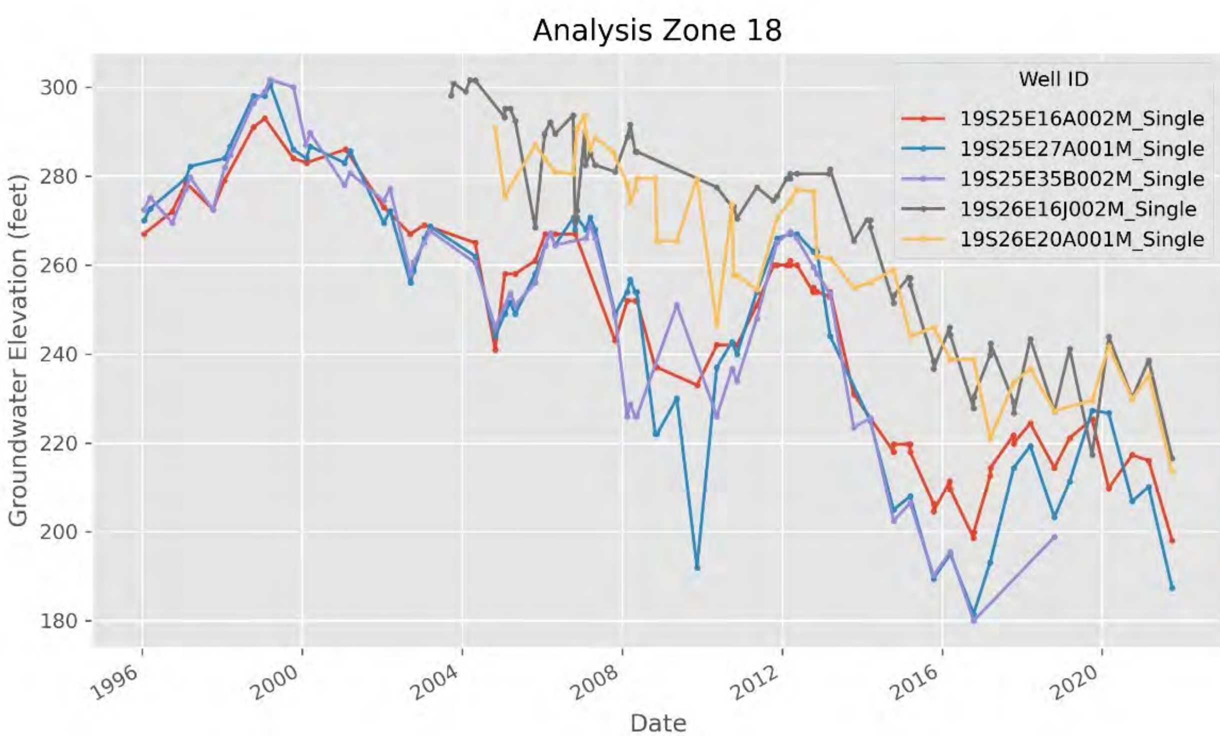

Analysis Zone 12
Well ID
17S24E36H003M_Single
Groundwater Elevation (feet)
250
240
230
220
210
200
190
180
1996
2000
2004
2008
2012
2016
2020
Date

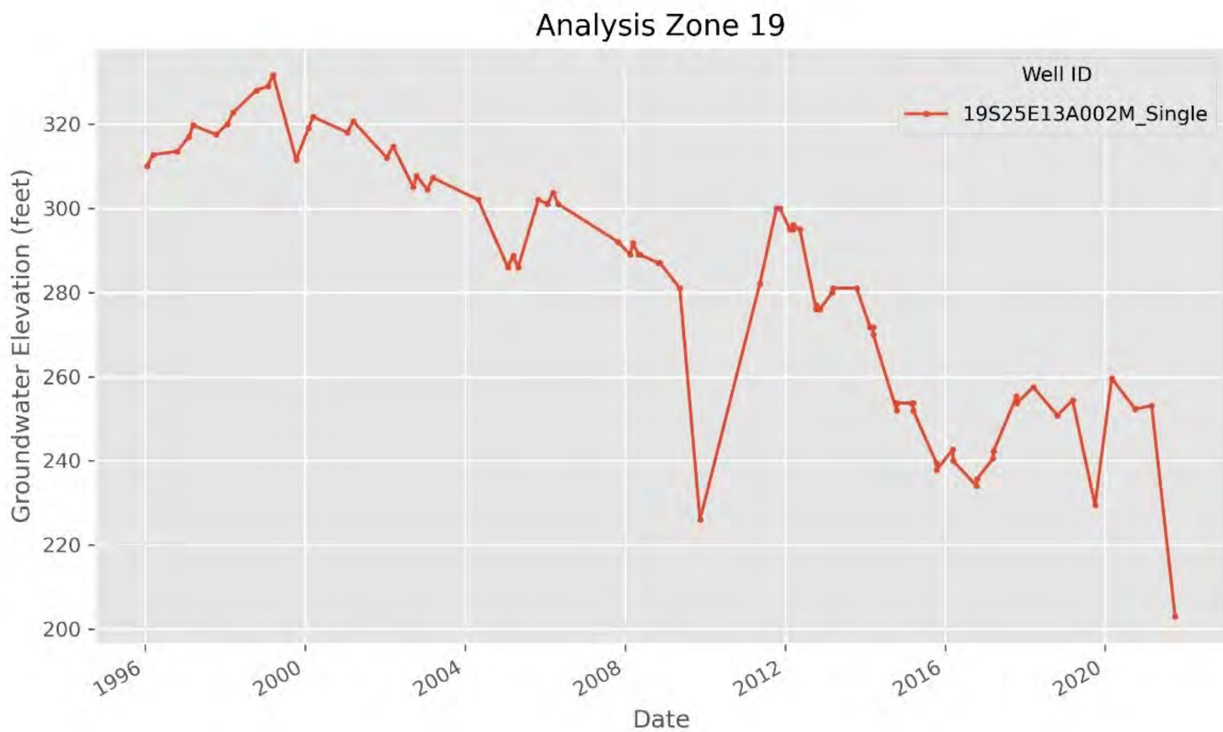

Analysis Zone 13
Well ID
18S25E05Q001M_Single
18S25E15C001M_Single
Groundwater Elevation (feet)
300
280
260
240
220
200
1996
2000
2004
2008
2012
2016
2020
Date

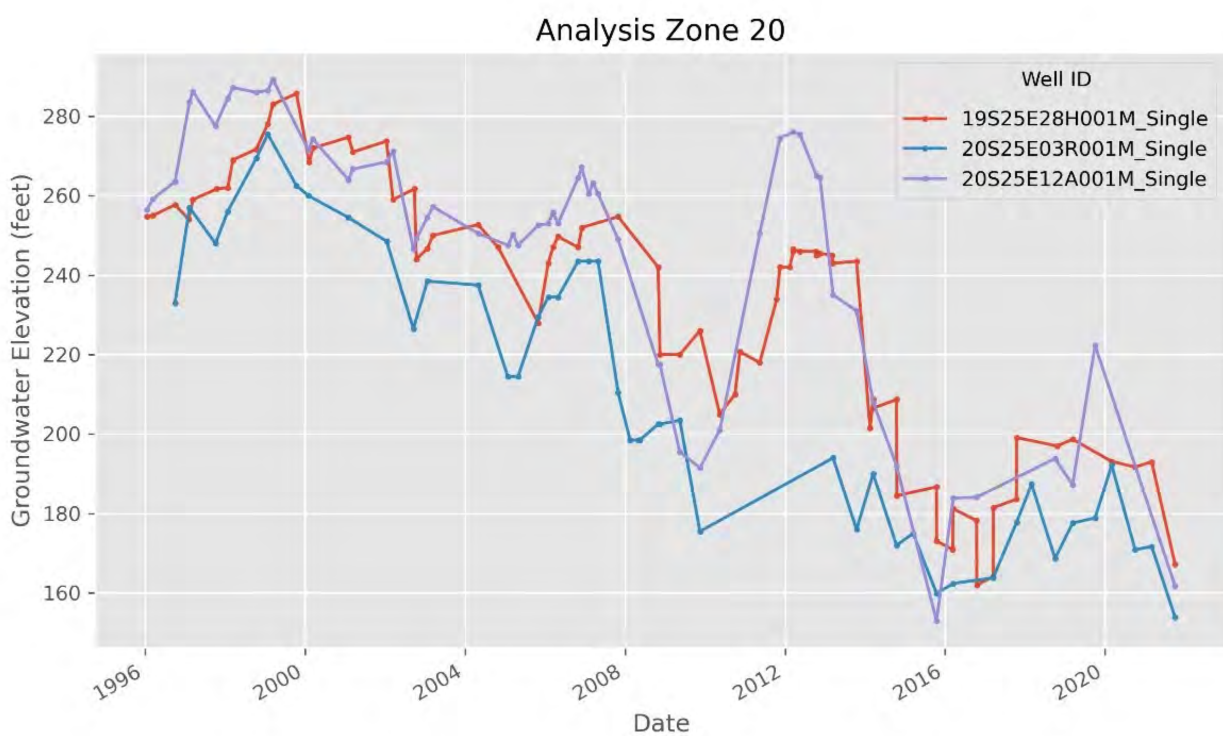

Analysis Zone 14
Groundwater Elevation (feet)
340
320
300
280
260
240
220
200
Well ID
18S25E23J001M_Single
19S25E09H001M_Single
19S26E05C001M_Single
1996
2000
2004
2008
2012
2016
2020
Date

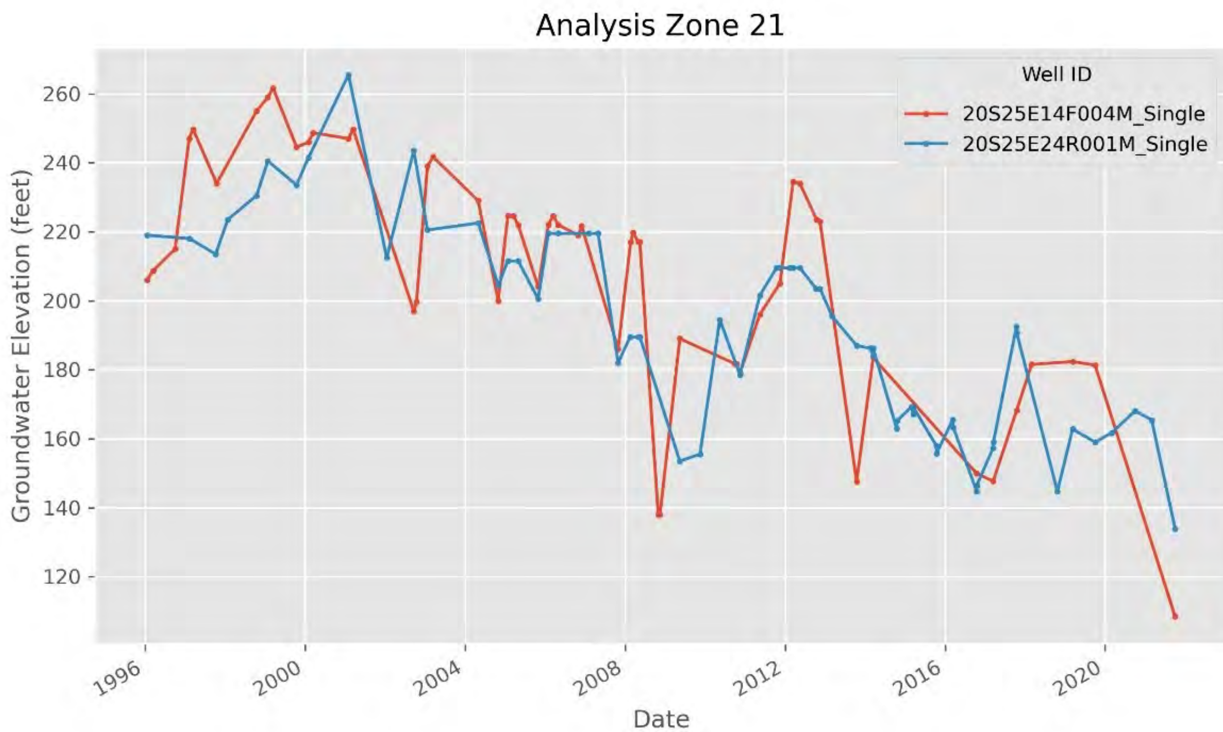

Analysis Zone 15
Groundwater Elevation (feet)
380
370
360
350
340
330
Well ID
18S26E17L001M_Single
1996
2000
2004
2008
2012
2016
2020
Date

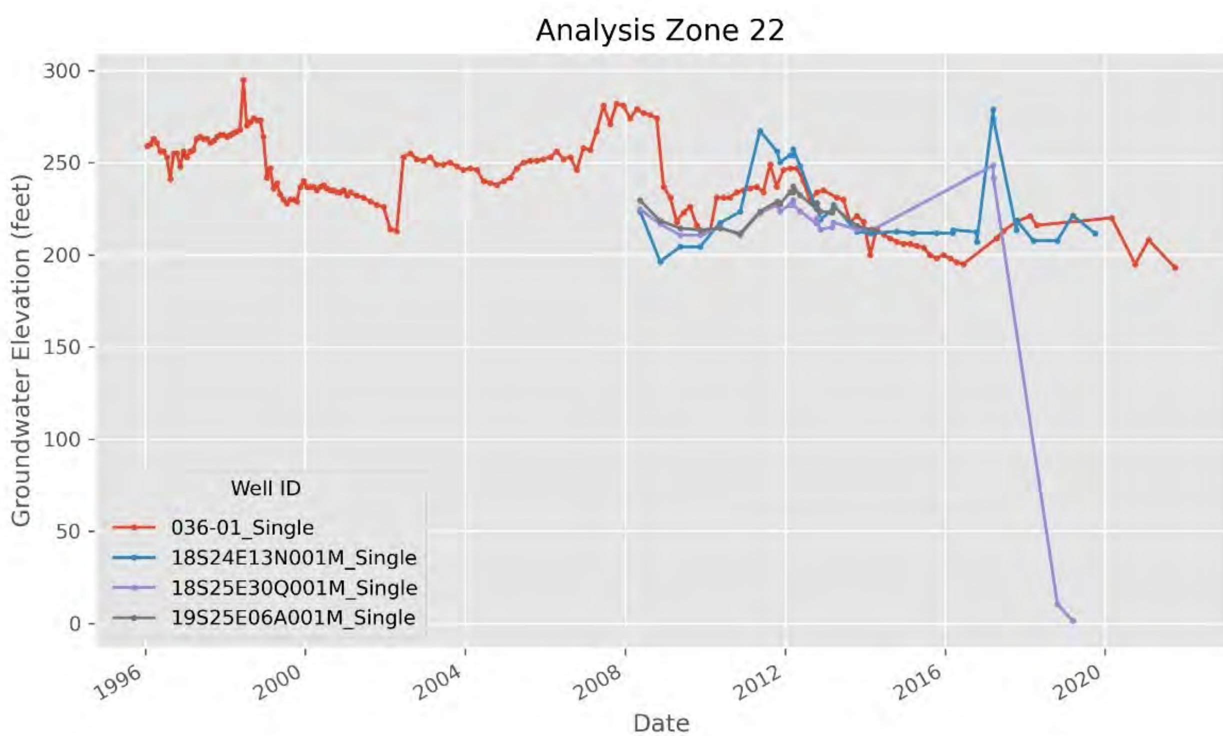

Analysis Zone 16
Well ID
18S27E05J001M_Single
Groundwater Elevation (feet)
440
435
430
425
420
415
1996
2000
2004
2008
2012
2016
2020
Date

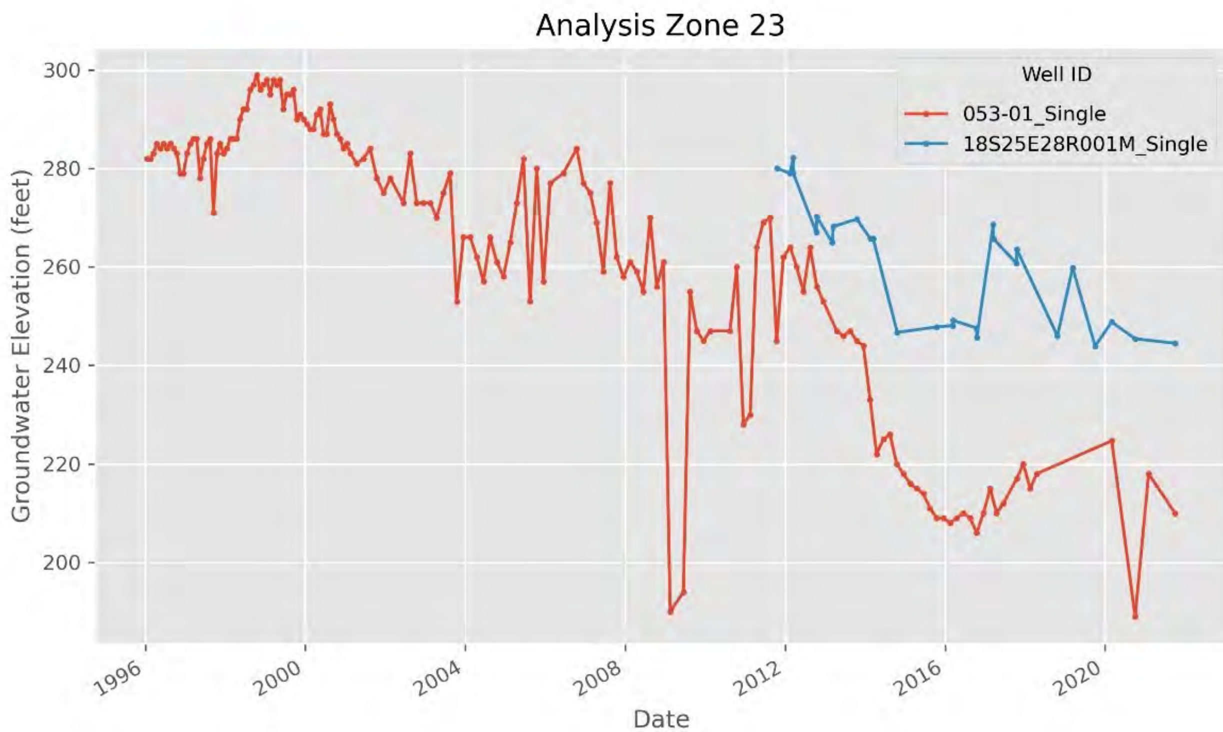

Analysis Zone 18
Well ID
19S25E16A002M_Single
19S25E27A001M_Single
19S25E35B002M_Single
19S26E16J002M_Single
19S26E20A001M_Single
Groundwater Elevation (feet)
300
280
260
240
220
200
180
1996
2000
2004
2008
2012
2016
2020
Date

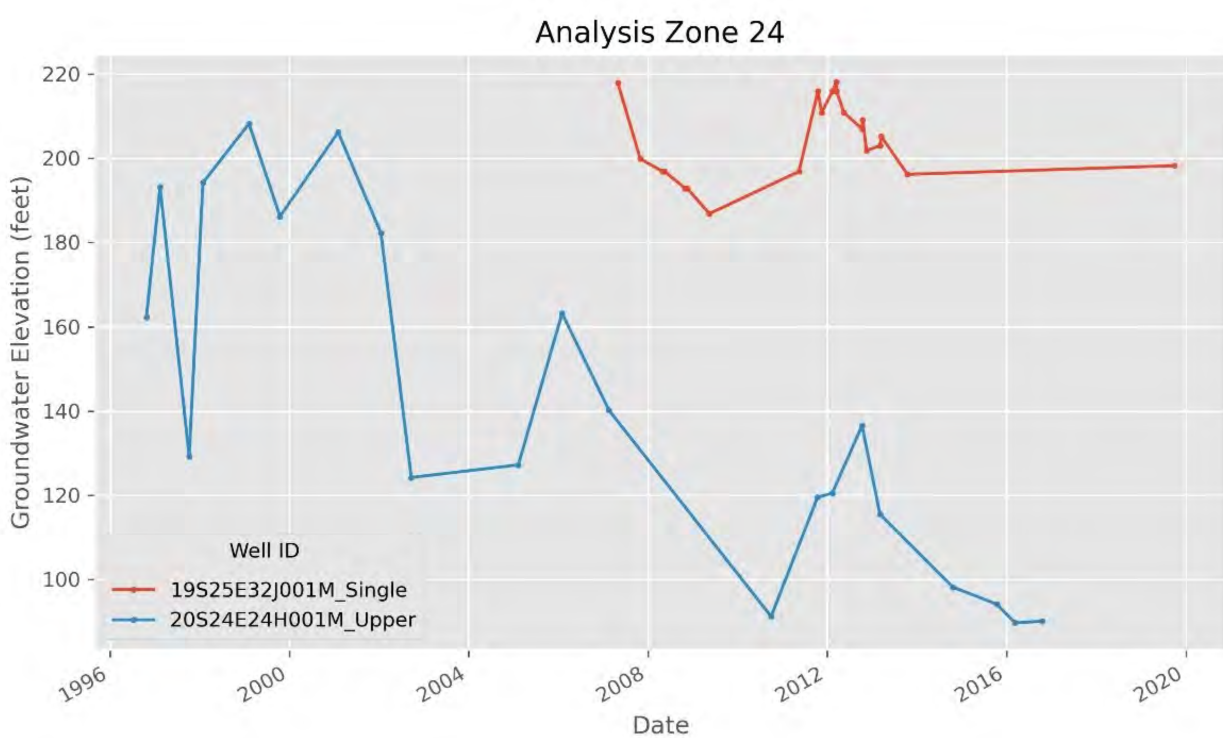

Analysis Zone 19
Well ID
19S25E13A002M_Single
Groundwater Elevation (feet)
320
300
280
260
240
220
200
1996
2000
2004
2008
2012
2016
2020
Date

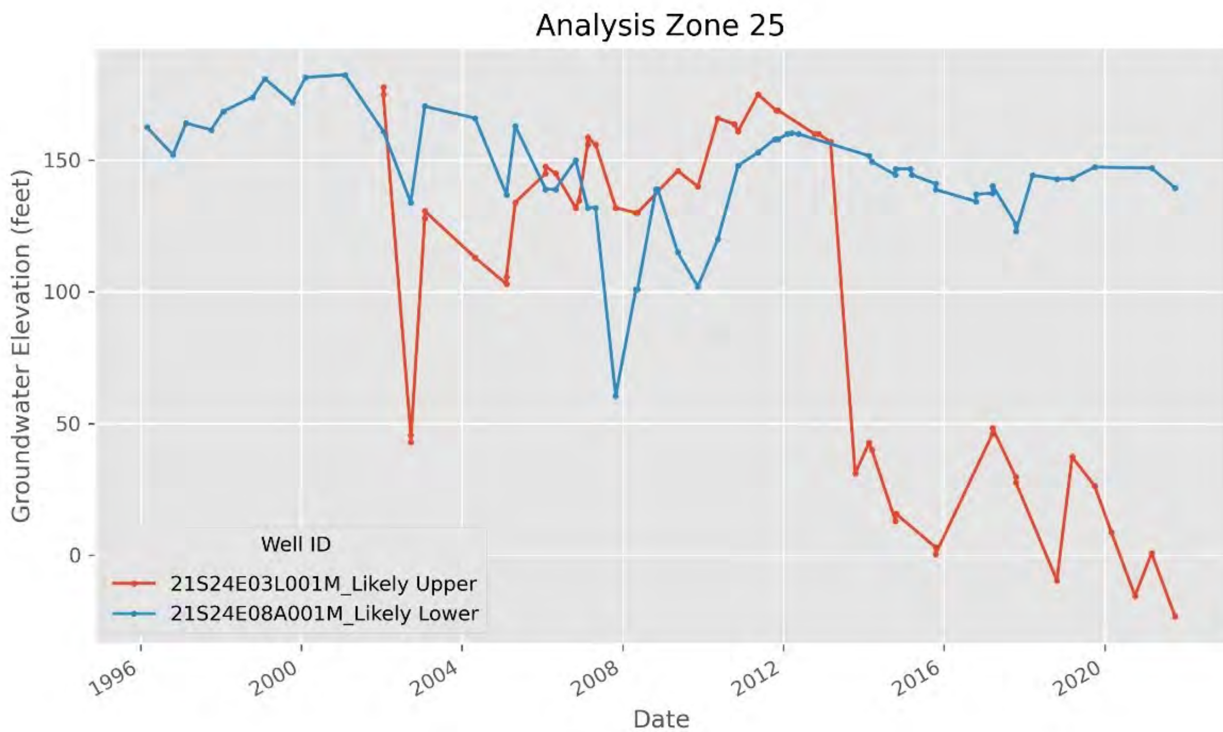

Analysis Zone 20
Well ID
19S25E28H001M_Single
20S25E03R001M_Single
20S25E12A001M_Single
Groundwater Elevation (feet)
280
260
240
220
200
180
160
1996
2000
2004
2008
2012
2016
2020
Date

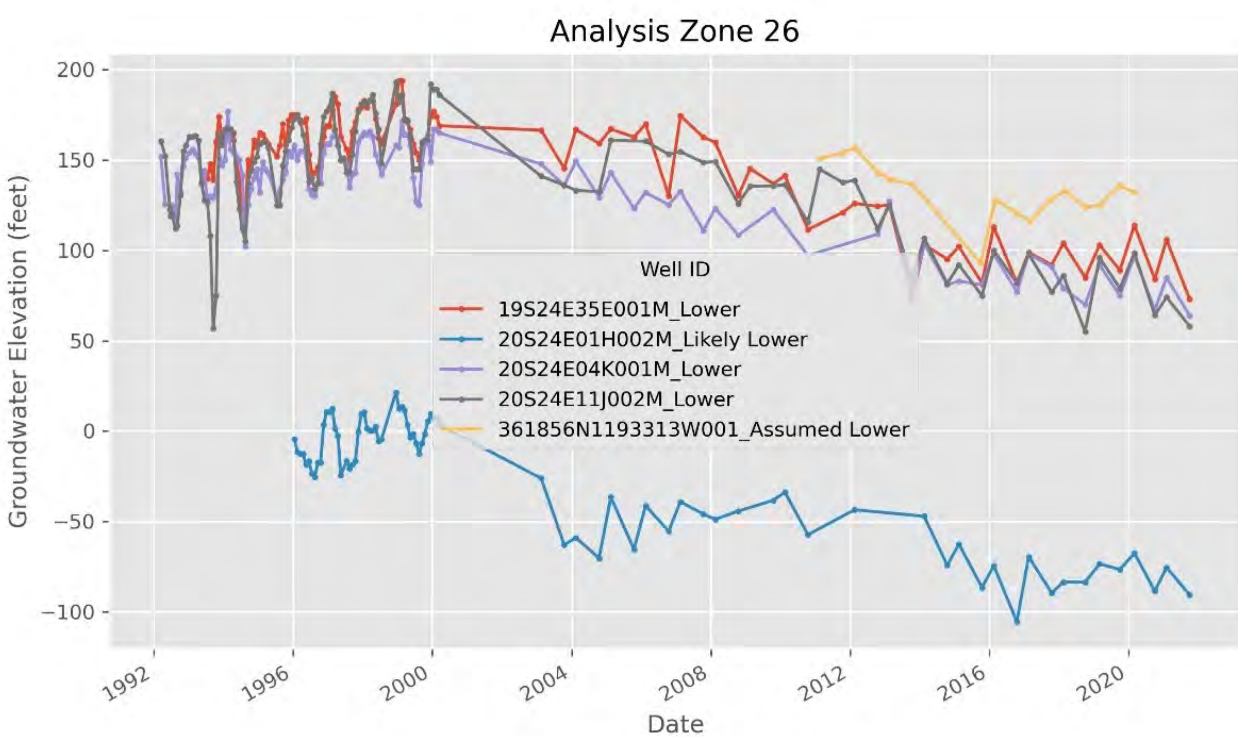

Analysis Zone 21
Well ID
20S25E14F004M_Single
20S25E24R001M_Single
Groundwater Elevation (feet)
260
240
220
200
180
160
140
120
1996
2000
2004
2008
2012
2016
2020
Date

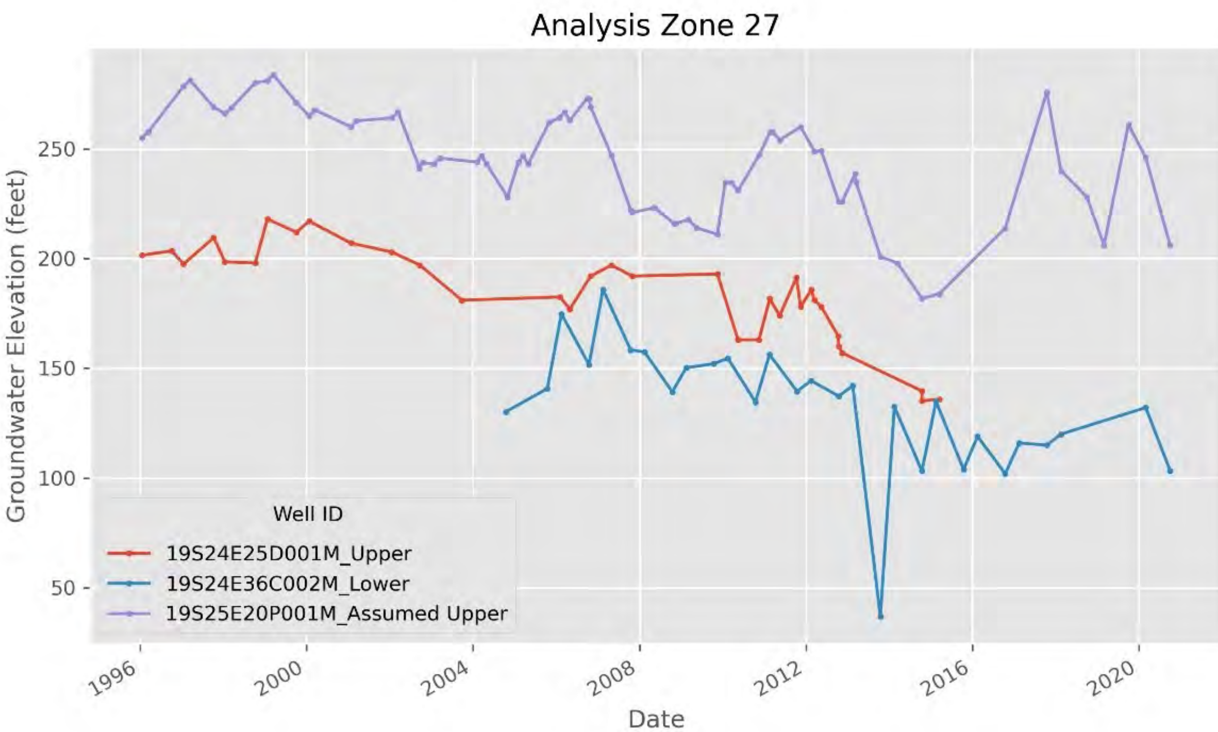

Analysis Zone 22
Well ID
036-01_Single
18S24E13N001M_Single
18S25E30Q001M_Single
19S25E06A001M_Single
Groundwater Elevation (feet)
300
250
200
150
100
50
0
1996
2000
2004
2008
2012
2016
2020
Date

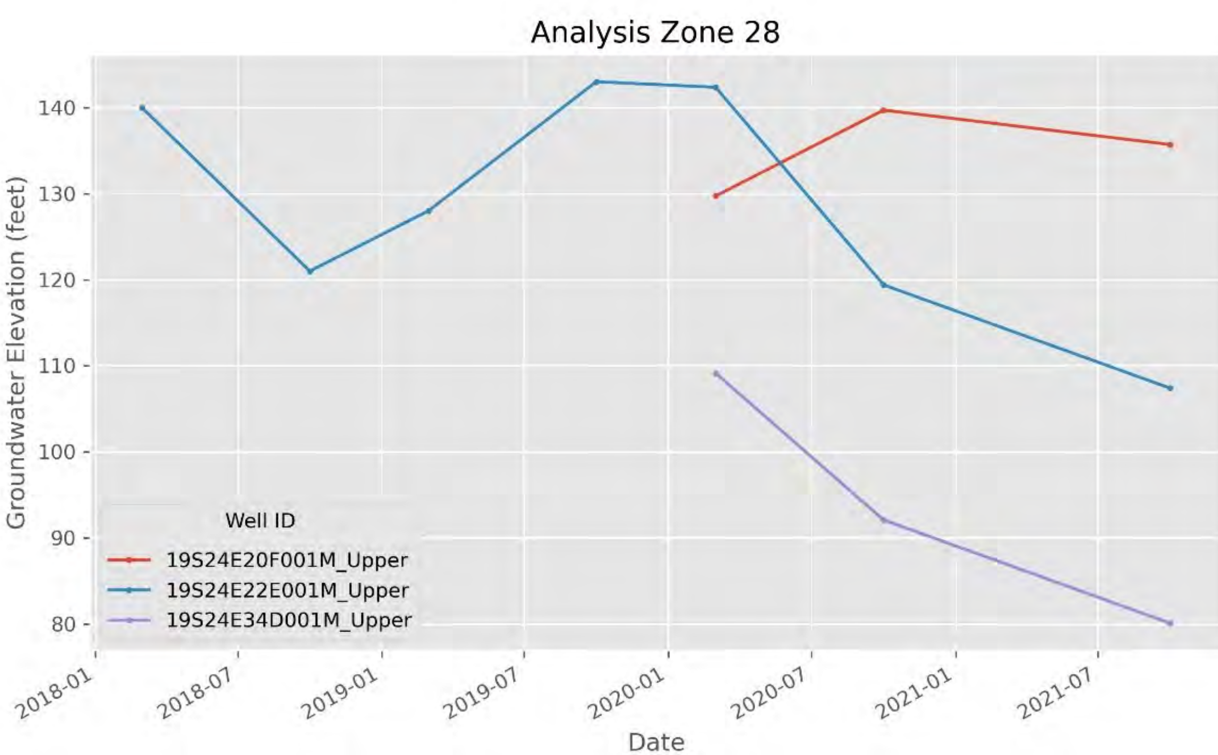

Analysis Zone 23
Groundwater Elevation (feet)
300
280
260
240
220
200
1996
2000
2004
2008
2012
2016
2020
Date
Well ID
053-01_Single
18S25E28R001M_Single

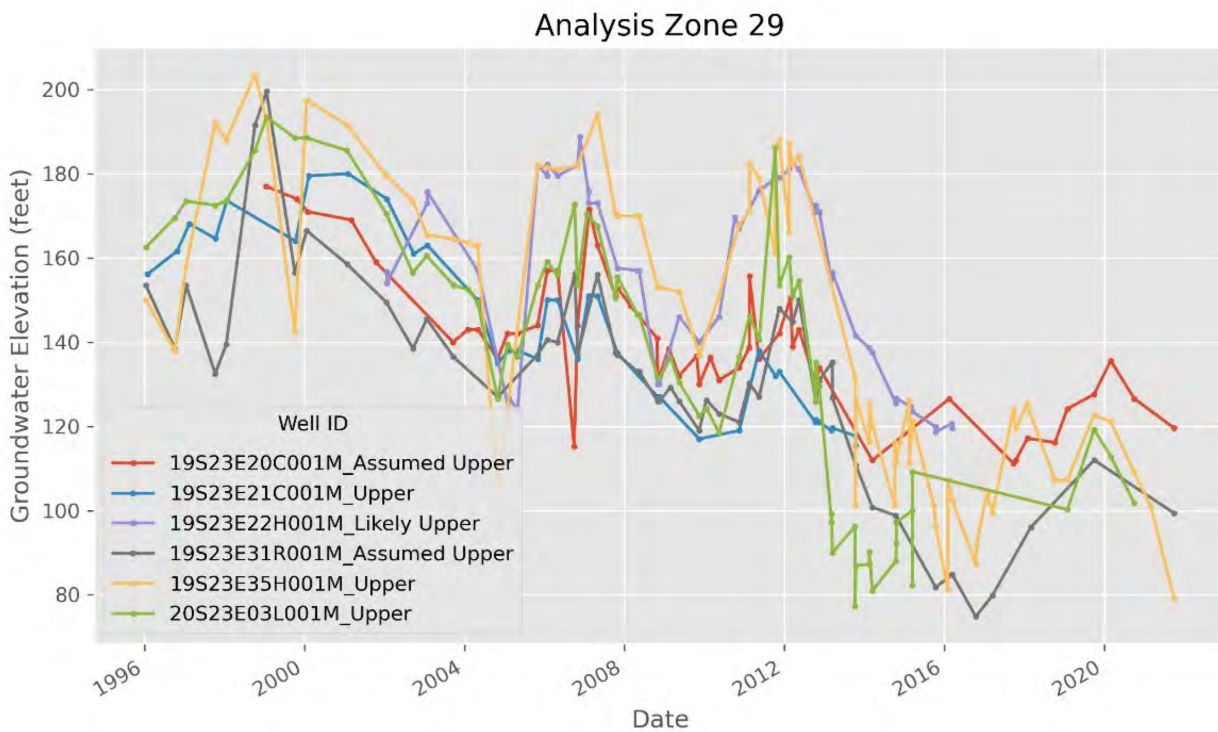

Analysis Zone 24
Groundwater Elevation (feet)
220
200
180
160
140
120
100
1996
2000
2004
2008
2012
2016
2020
Date
Well ID
19S25E32J001M_Single
20S24E24H001M_Upper

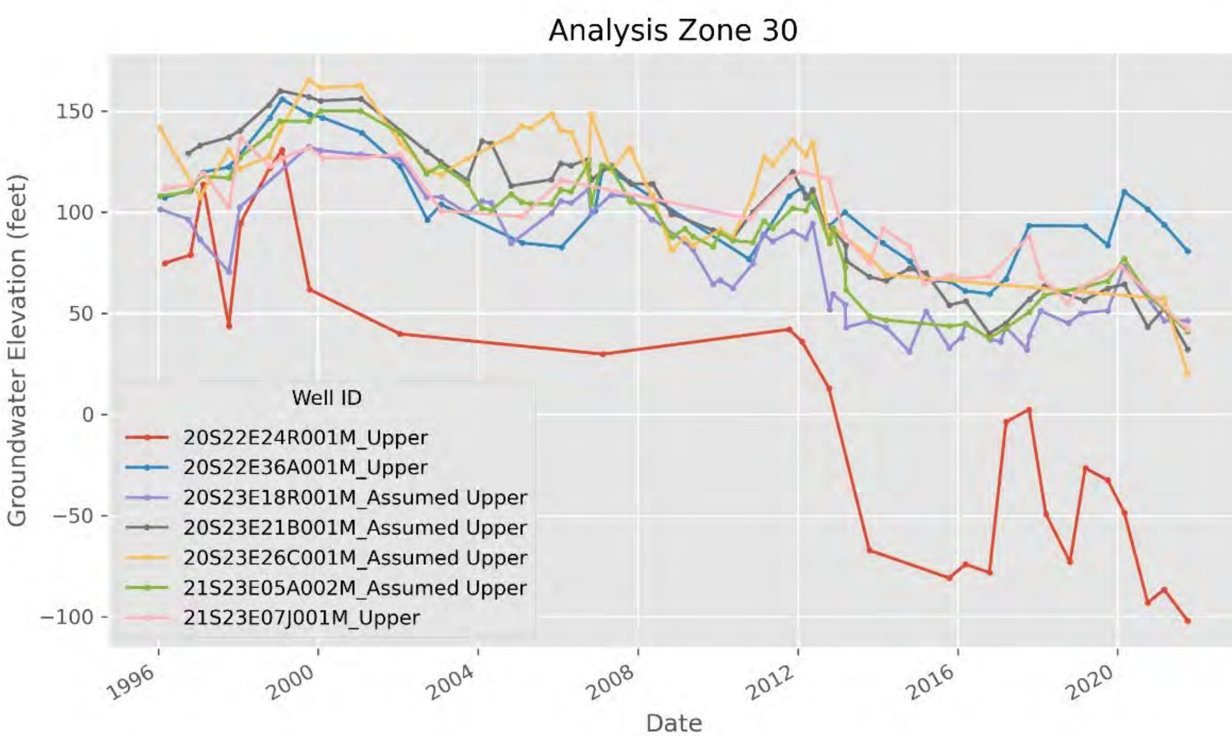

Analysis Zone 25
Groundwater Elevation (feet)
150
100
50
0
Well ID
21S24E03L001M_Likely Upper
21S24E08A001M_Likely Lower
1996
2000
2004
2008
2012
2016
2020
Date

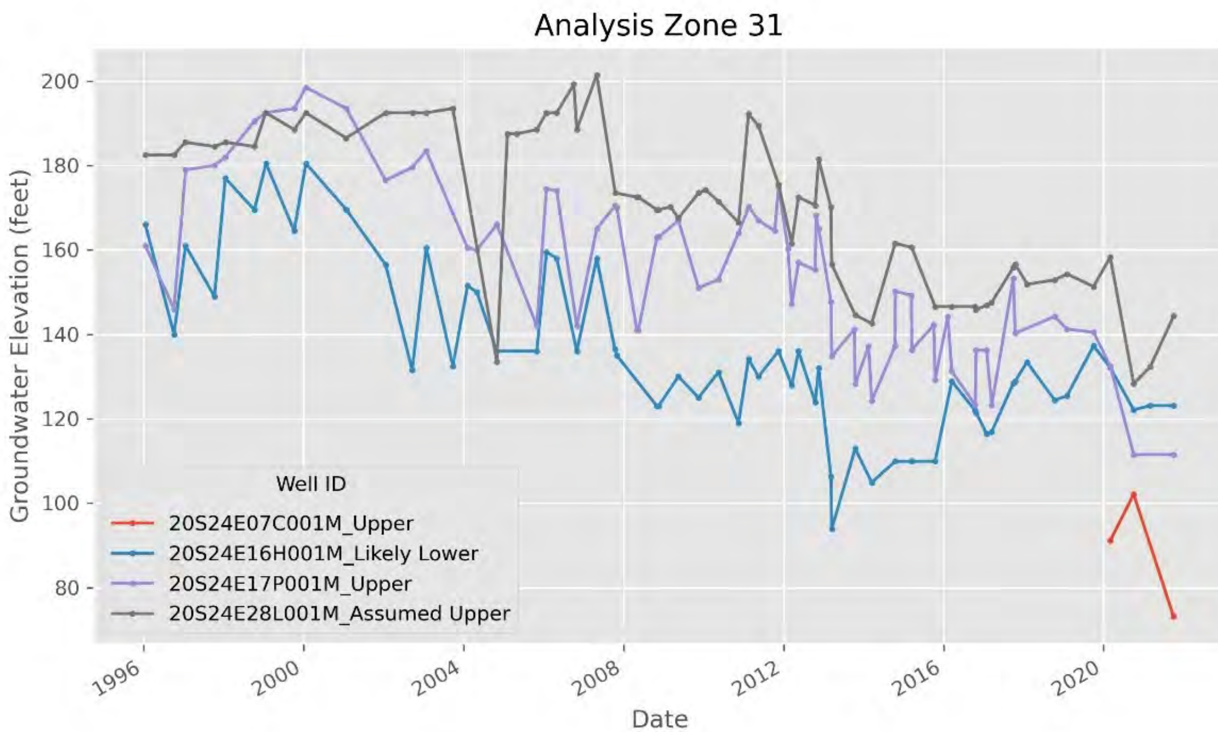

Analysis Zone 26
Groundwater Elevation (feet)
200
150
100
50
0
−50
−100
Well ID
19S24E35E001M_Lower
20S24E01H002M_Likely Lower
20S24E04K001M_Lower
20S24E11J002M_Lower
361856N1193313W001_Assumed Lower
1992
1996
2000
2004
2008
2012
2016
2020
Date

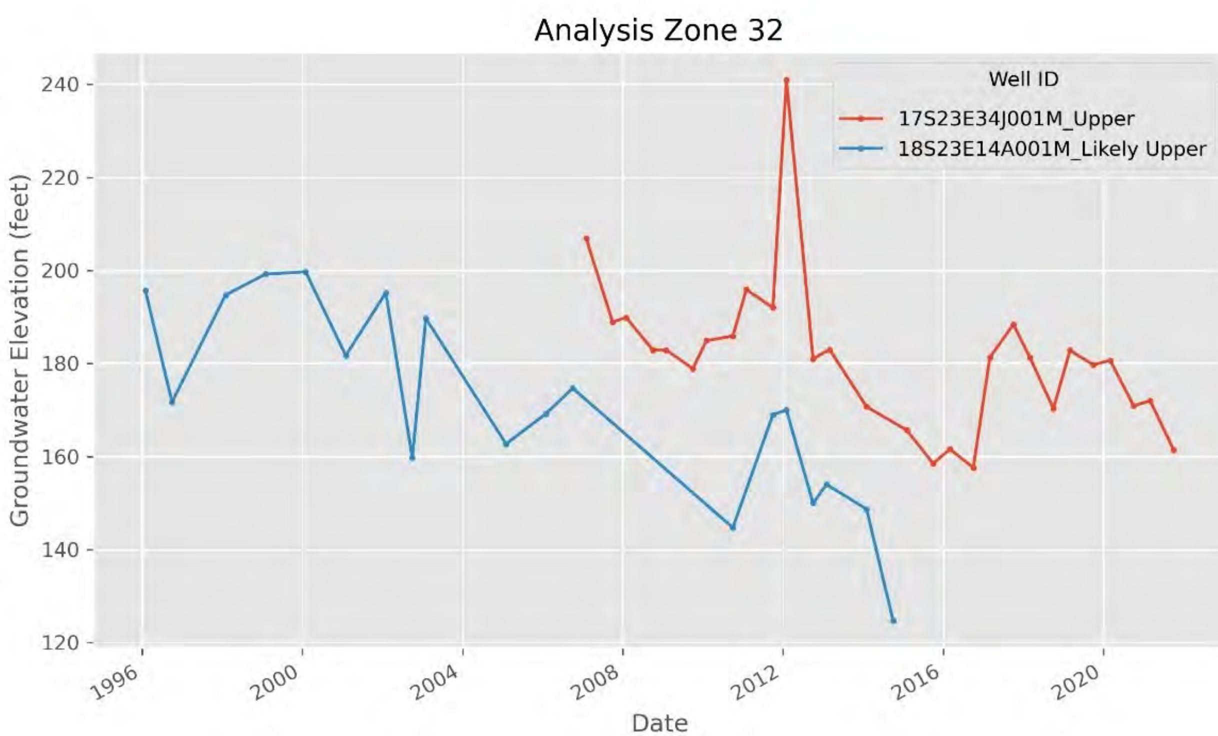

Analysis Zone 27
Groundwater Elevation (feet)
250
200
150
100
50
Well ID
19S24E25D001M_Upper
19S24E36C002M_Lower
19S25E20P001M_Assumed Upper
1996
2000
2004
2008
2012
2016
2020
Date

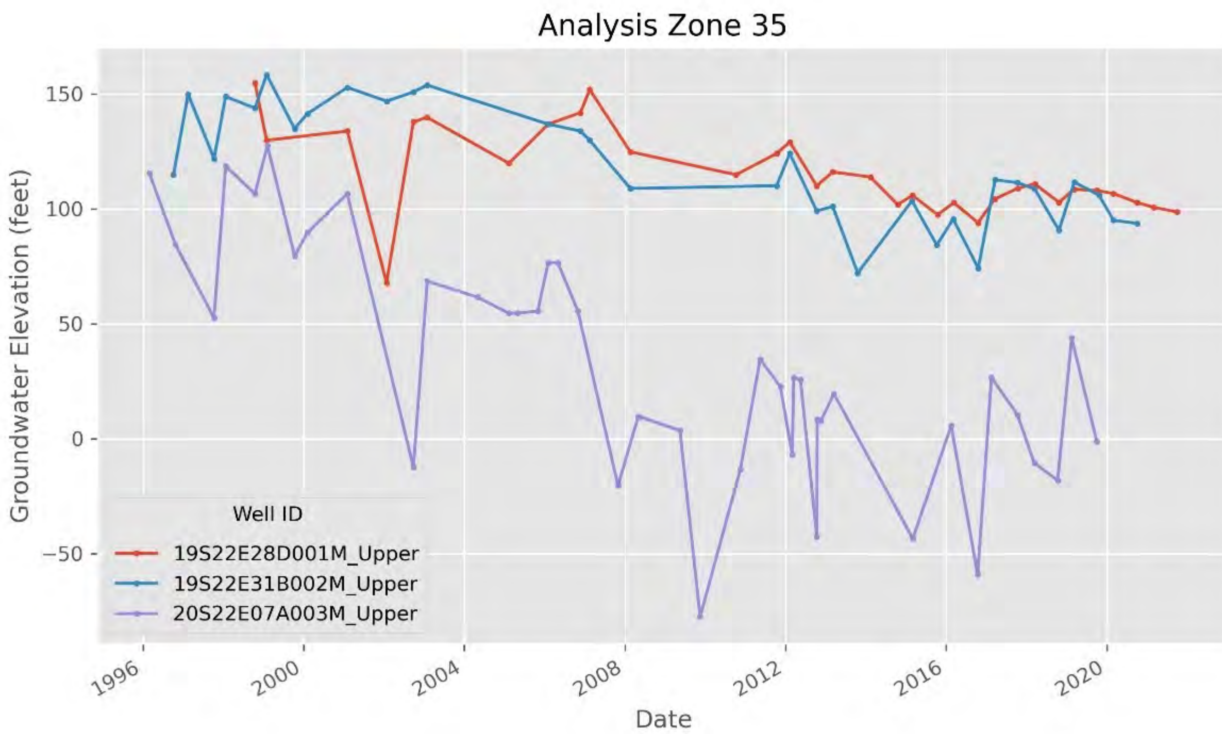

Analysis Zone 28
Groundwater Elevation (feet)
140
130
120
110
100
90
80
Well ID
19S24E20F001M_Upper
19S24E22E001M_Upper
19S24E34D001M_Upper
2018-01
2018-07
2019-01
2019-07
2020-01
2020-07
2021-01
2021-07
Date

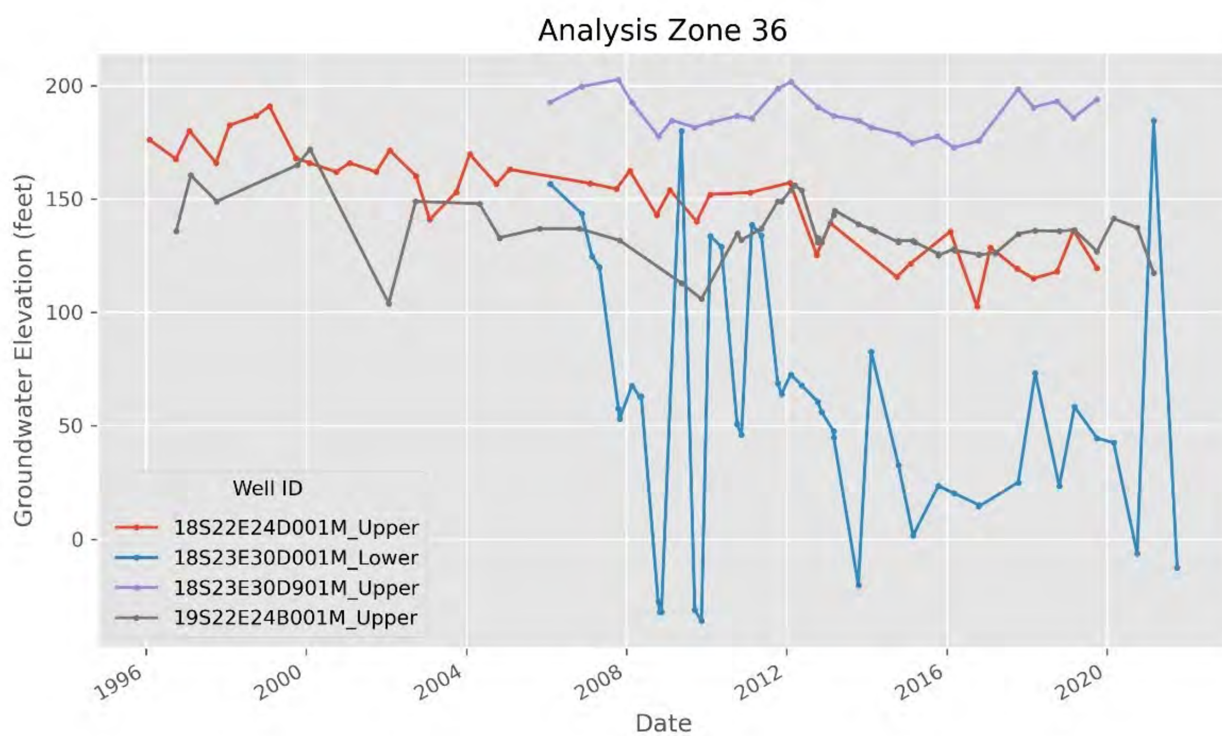

Analysis Zone 29
Groundwater Elevation (feet)
Date
Well ID
19S23E20C001M_Assumed Upper
19S23E21C001M_Upper
19S23E22H001M_Likely Upper
19S23E31R001M_Assumed Upper
19S23E35H001M_Upper
20S23E03L001M_Upper
200
180
160
140
120
100
80
1996
2000
2004
2008
2012
2016
2020

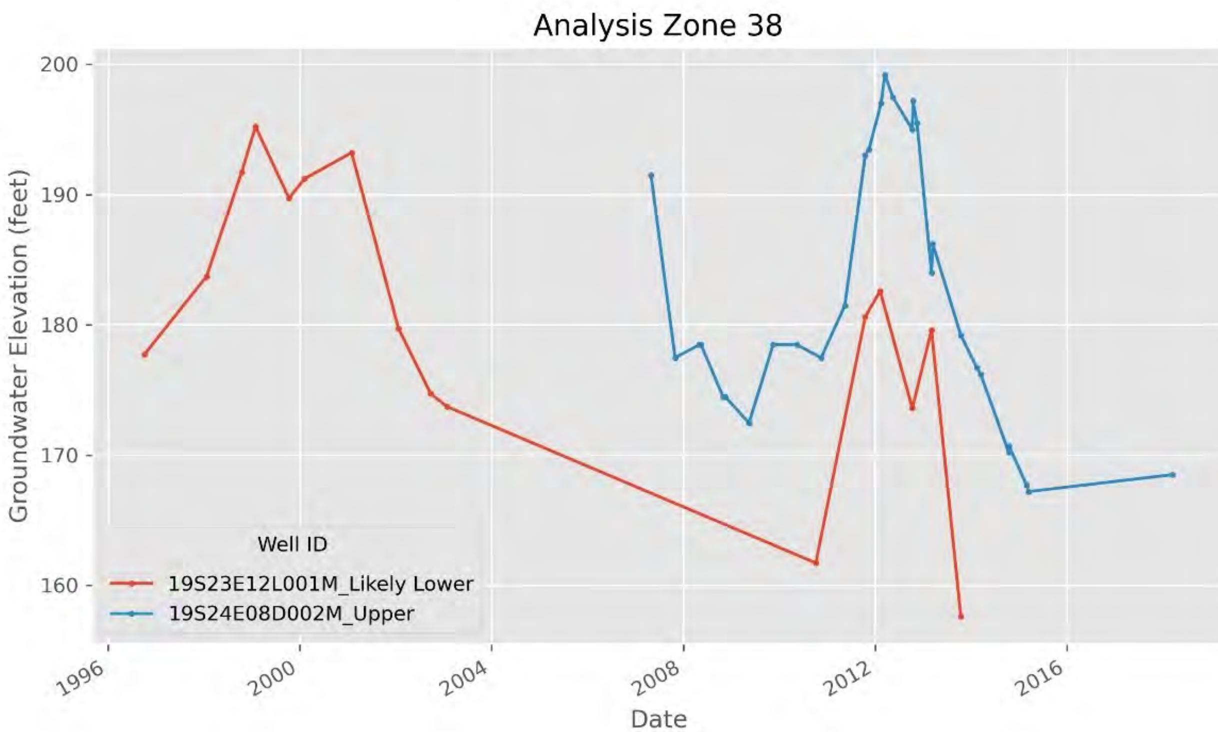

Analysis Zone 30
Groundwater Elevation (feet)
Date
Well ID
20S22E24R001M_Upper
20S22E36A001M_Upper
20S23E18R001M_Assumed Upper
20S23E21B001M_Assumed Upper
20S23E26C001M_Assumed Upper
21S23E05A002M_Assumed Upper
21S23E07J001M_Upper
150
100
50
0
−50
−100
1996
2000
2004
2008
2012
2016
2020

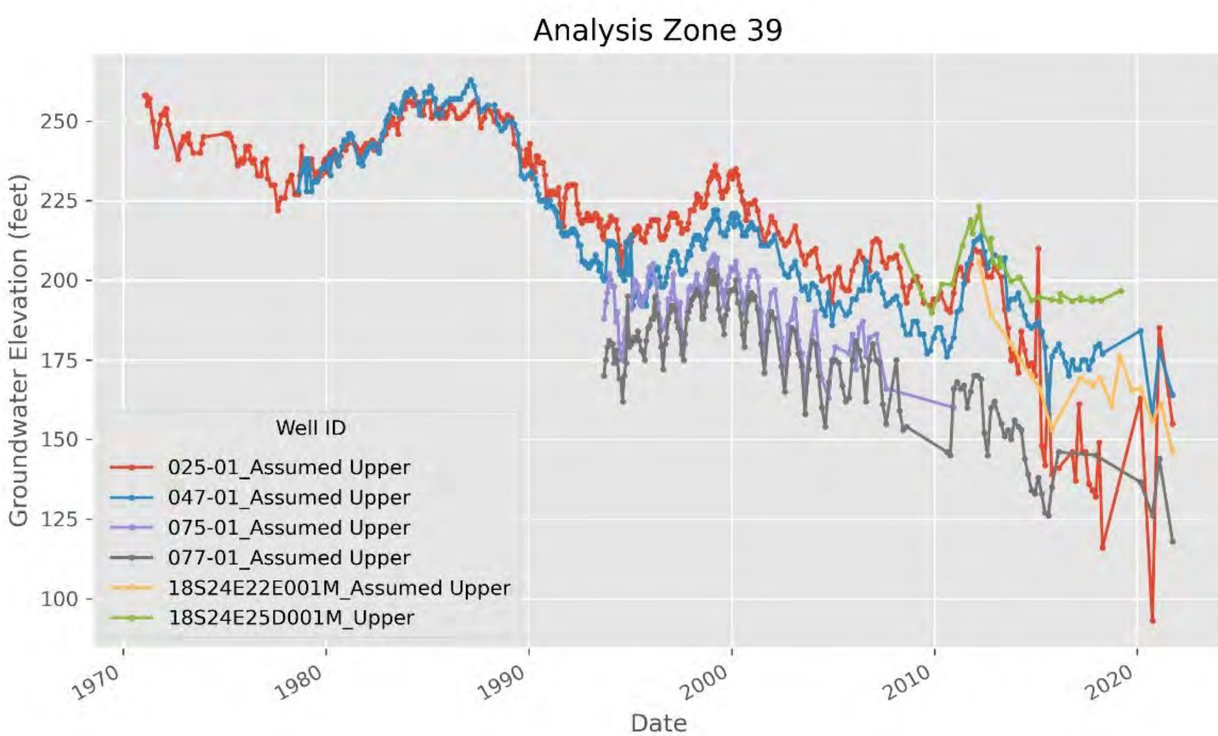

Analysis Zone 31
Groundwater Elevation (feet)
200
180
160
140
120
100
80
Well ID
20S24E07C001M_Upper
20S24E16H001M_Likely Lower
20S24E17P001M_Upper
20S24E28L001M_Assumed Upper
1996
2000
2004
2008
2012
2016
2020
Date


Analysis Zone 32
Groundwater Elevation (feet)
240
220
200
180
160
140
120
Well ID
17S23E34J001M_Upper
18S23E14A001M_Likely Upper
1996
2000
2004
2008
2012
2016
2020
Date


Analysis Zone 35
Groundwater Elevation (feet)
150
100
50
0
−50
Well ID
19S22E28D001M_Upper
19S22E31B002M_Upper
20S22E07A003M_Upper
1996
2000
2004
2008
2012
2016
2020
Date

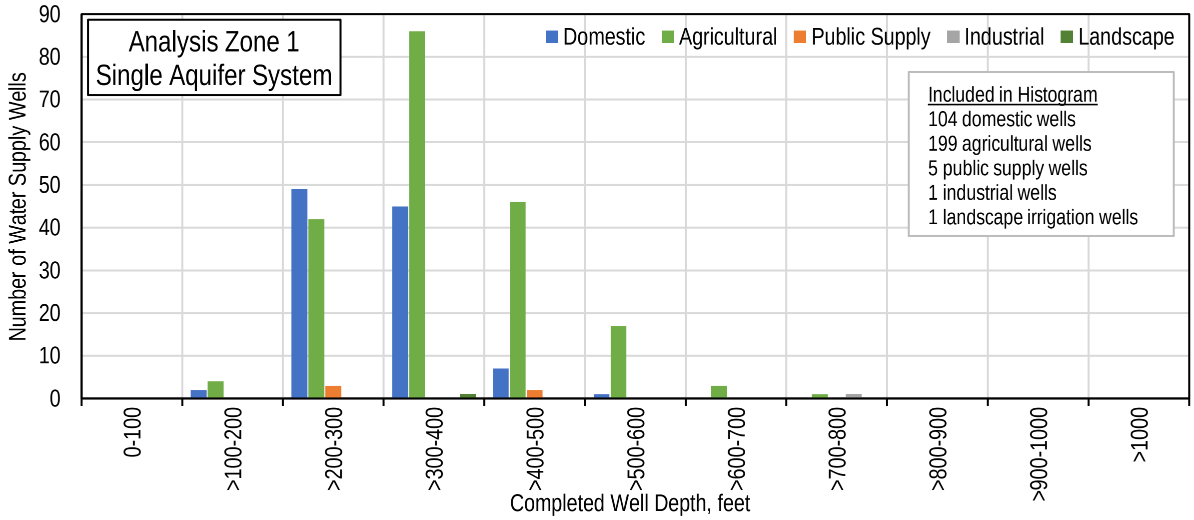

Analysis Zone 36
Groundwater Elevation (feet)
200
150
100
50
0
Well ID
18S22E24D001M_Upper
18S23E30D001M_Lower
18S23E30D901M_Upper
19S22E24B001M_Upper
1996
2000
2004
2008
2012
2016
2020
Date

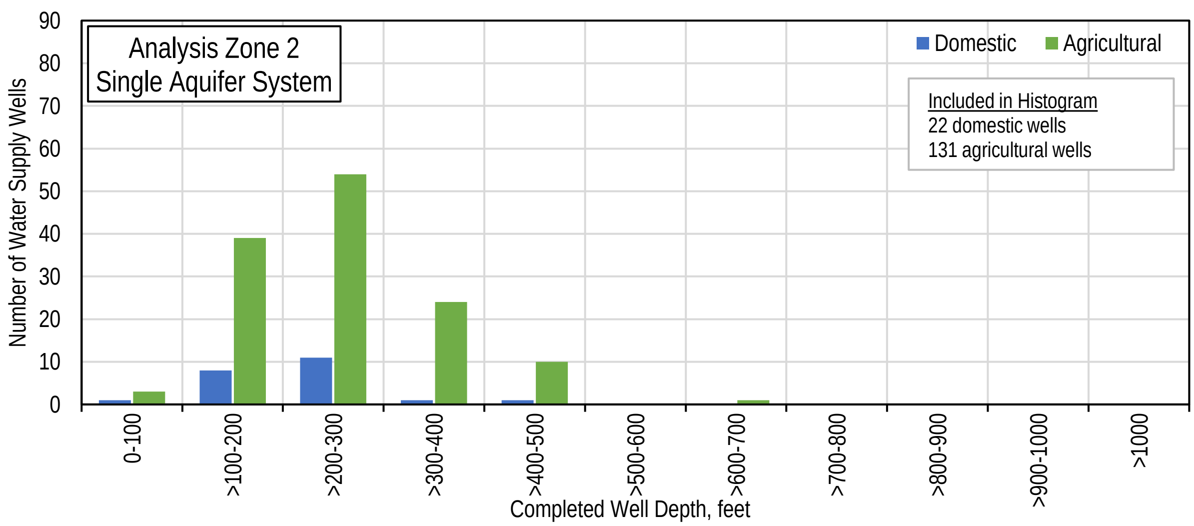

Analysis Zone 38
Groundwater Elevation (feet)
200
190
180
170
160
1996
2000
2004
2008
2012
2016
Date
Well ID
19S23E12L001M_Likely Lower
19S24E08D002M_Upper

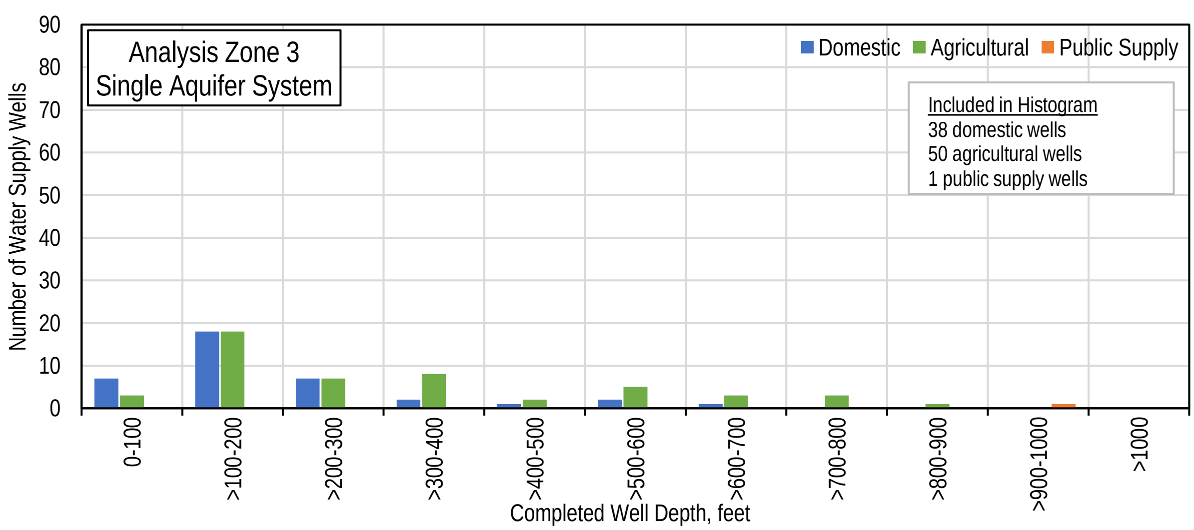

Analysis Zone 39
Groundwater Elevation (feet)
250
225
200
175
150
125
100
1970
1980
1990
2000
2010
2020
Date
Well ID
025-01_Assumed Upper
047-01_Assumed Upper
075-01_Assumed Upper
077-01_Assumed Upper
18S24E22E001M_Assumed Upper
18S24E25D001M_Upper

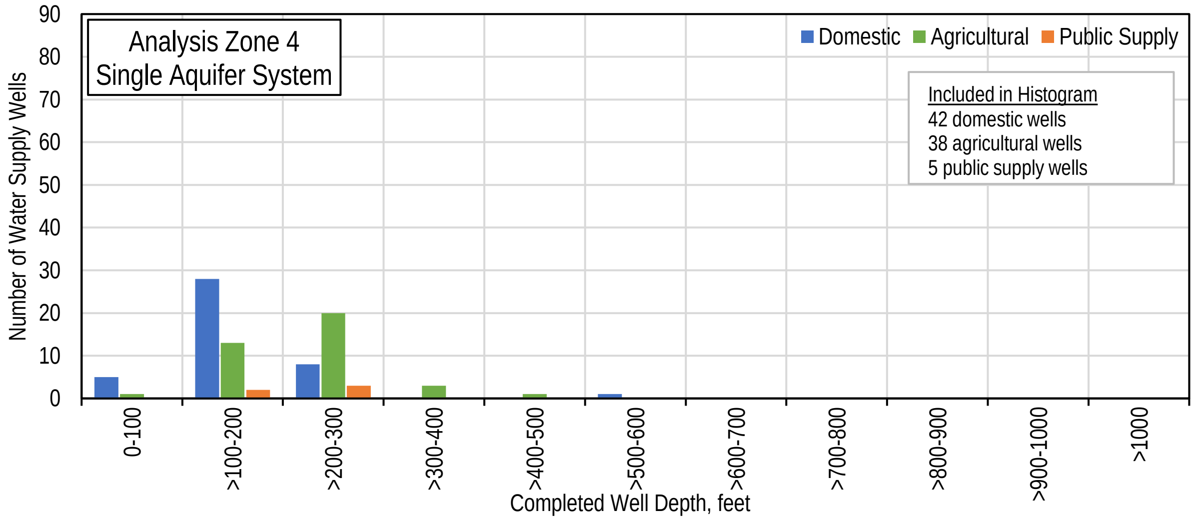
Appendix B

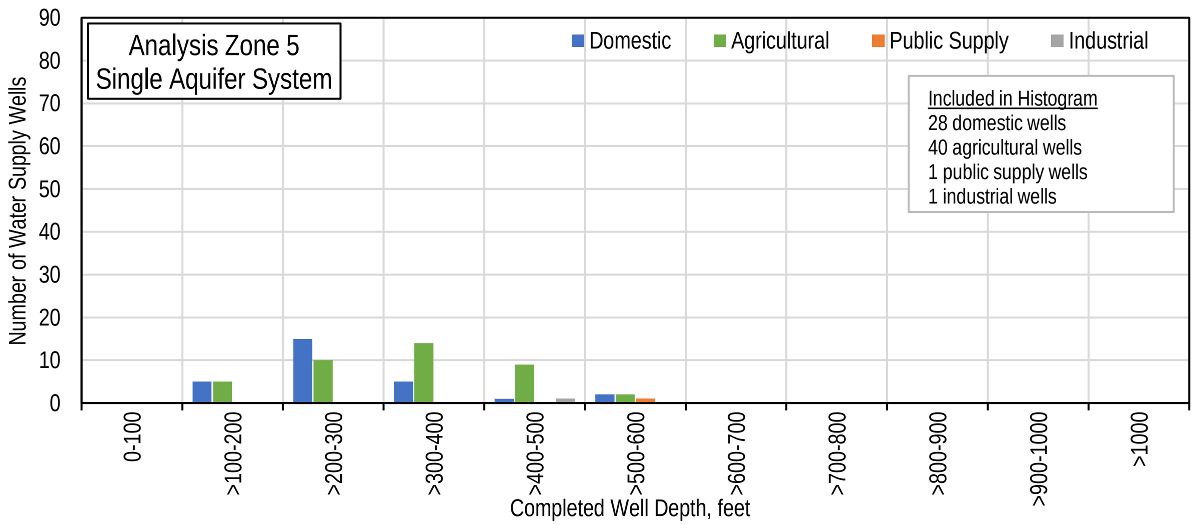
Completed Well Depth Histograms
by Analysis Zone

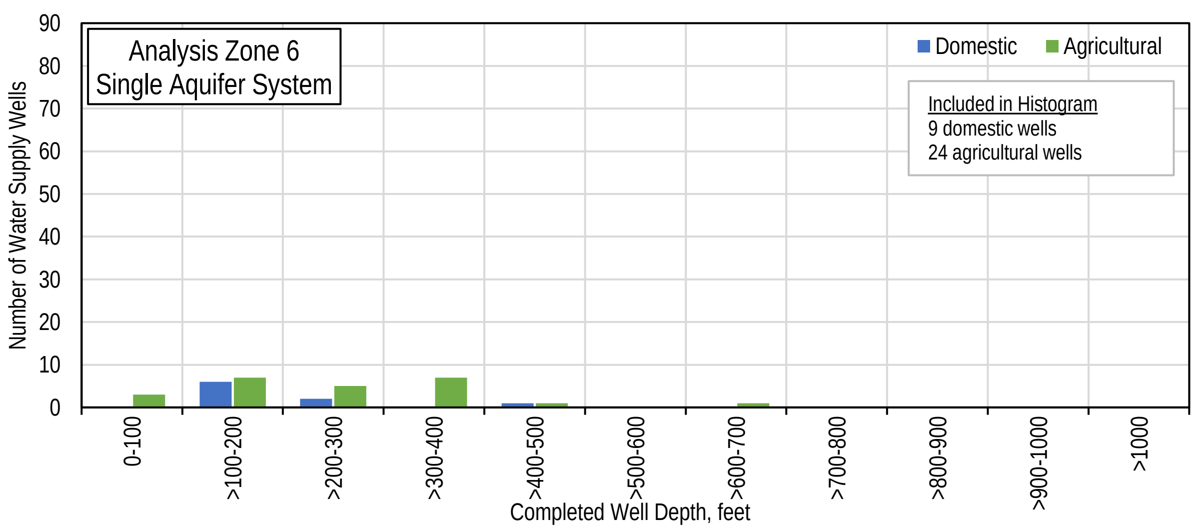

Analysis Zone 1
Single Aquifer System
Domestic
Agricultural
Public Supply
Industrial
Landscape
Included in Histogram
104 domestic wells
199 agricultural wells
5 public supply wells
1 industrial wells
1 landscape irrigation wells
Number of Water Supply Wells
Completed Well Depth, feet
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000

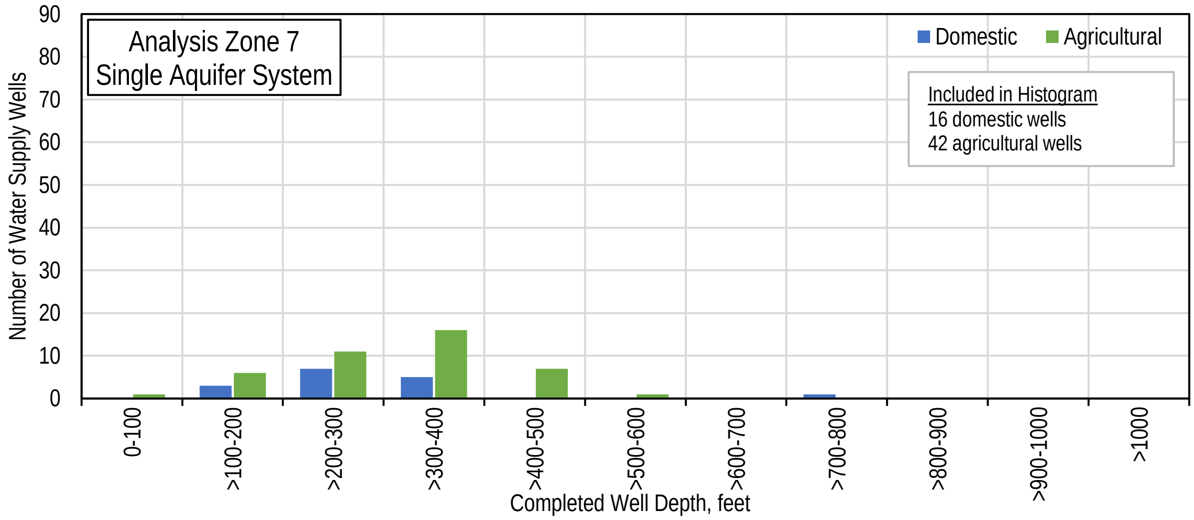

Analysis Zone 2
Single Aquifer System
Domestic
Agricultural
Included in Histogram
22 domestic wells
131 agricultural wells
Number of Water Supply Wells
Completed Well Depth, feet
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000

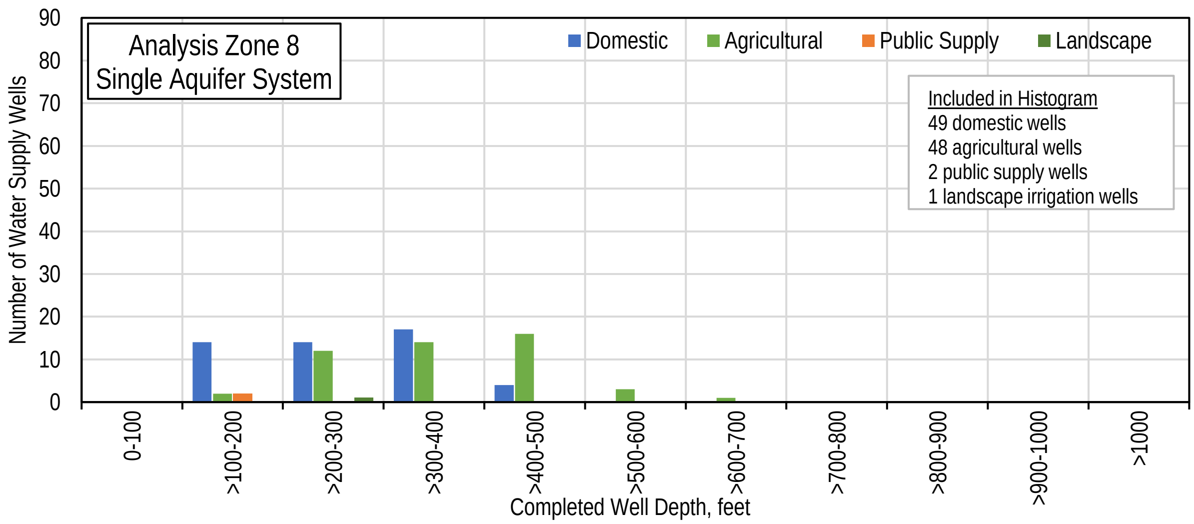

Analysis Zone 3
Single Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
38 domestic wells
50 agricultural wells
1 public supply wells
Number of Water Supply Wells
Completed Well Depth, feet
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000

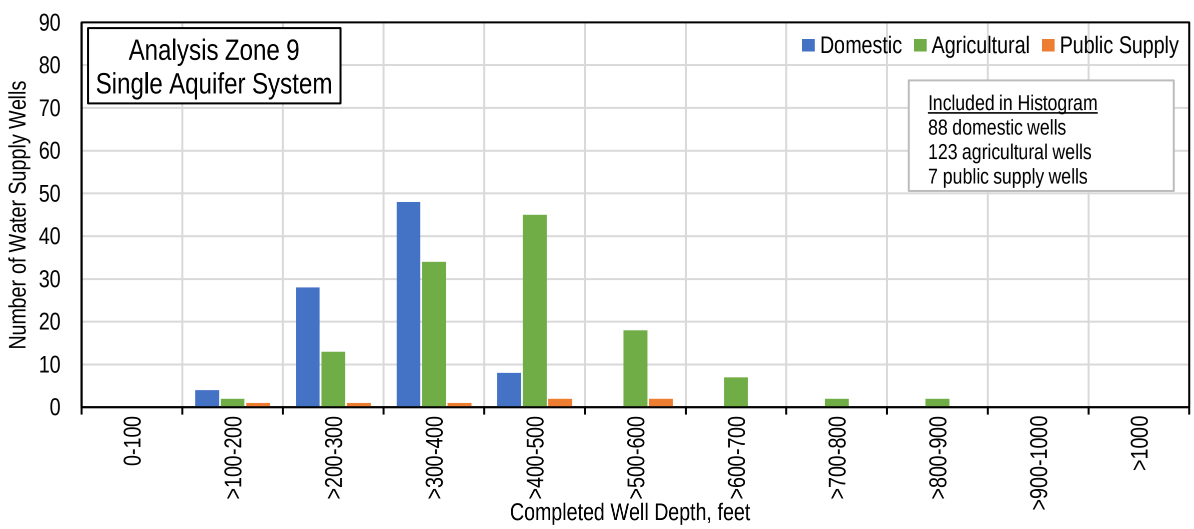

Analysis Zone 4
Single Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
42 domestic wells
38 agricultural wells
5 public supply wells
Number of Water Supply Wells
90
80
70
60
50
40
30
20
10
0
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

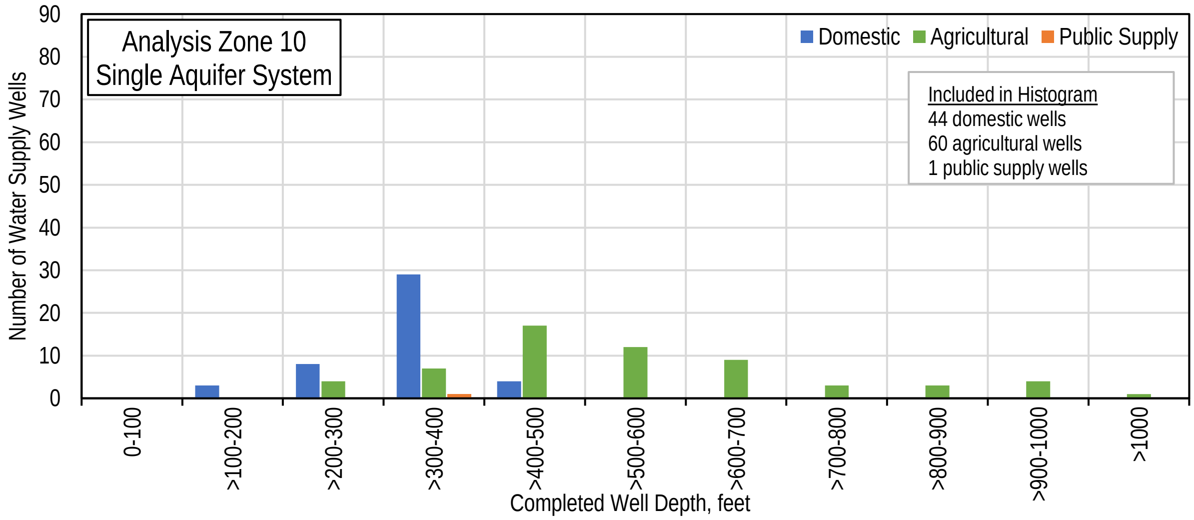

Analysis Zone 5
Single Aquifer System
Domestic
Agricultural
Public Supply
Industrial
Included in Histogram
28 domestic wells
40 agricultural wells
1 public supply wells
1 industrial wells
Number of Water Supply Wells
90
80
70
60
50
40
30
20
10
0
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

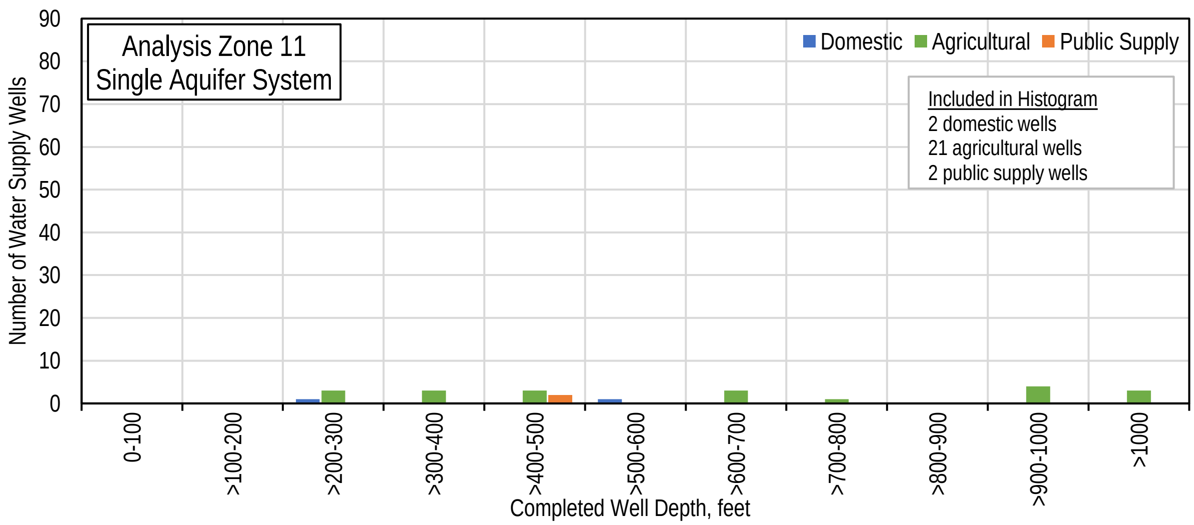

Analysis Zone 6
Single Aquifer System
Domestic
Agricultural
Included in Histogram
9 domestic wells
24 agricultural wells
Number of Water Supply Wells
90
80
70
60
50
40
30
20
10
0
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

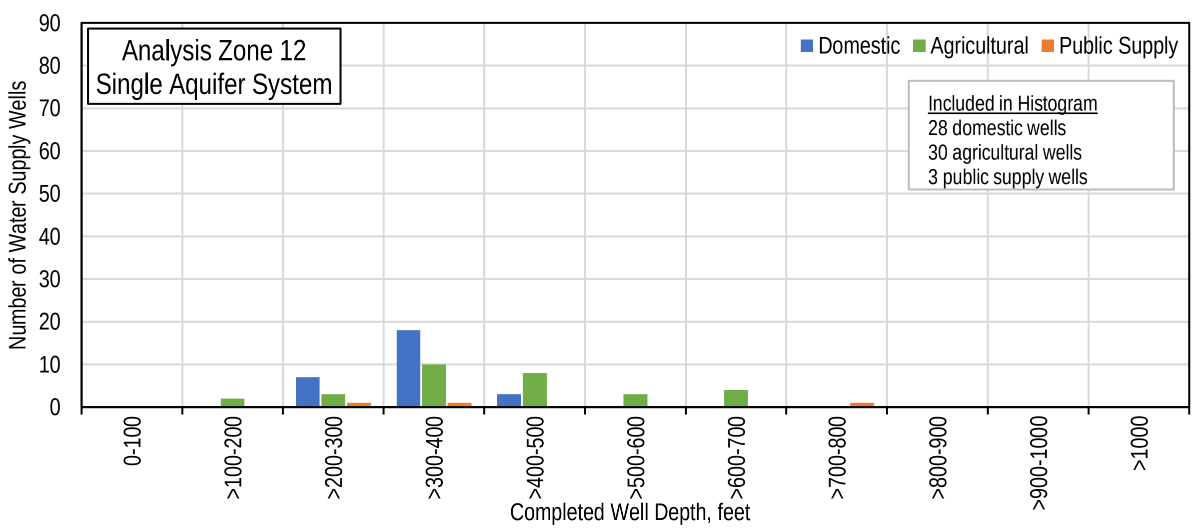

Analysis Zone 7
Single Aquifer System
Domestic
Agricultural
Included in Histogram
16 domestic wells
42 agricultural wells
Number of Water Supply Wells
90
80
70
60
50
40
30
20
10
0
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

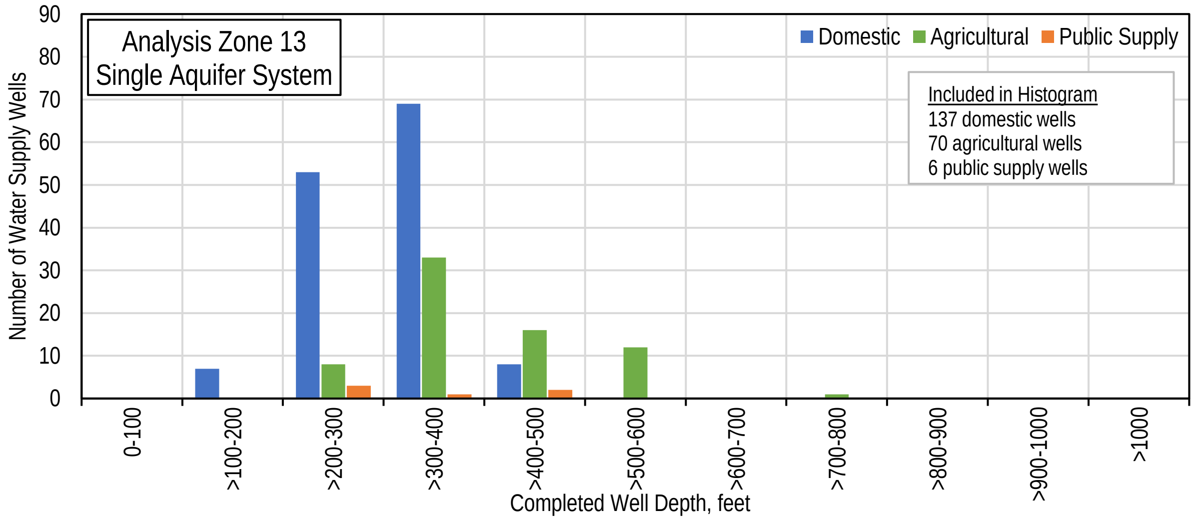

Analysis Zone 8
Single Aquifer System
Domestic
Agricultural
Public Supply
Landscape
Included in Histogram
49 domestic wells
48 agricultural wells
2 public supply wells
1 landscape irrigation wells
Number of Water Supply Wells
90
80
70
60
50
40
30
20
10
0
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

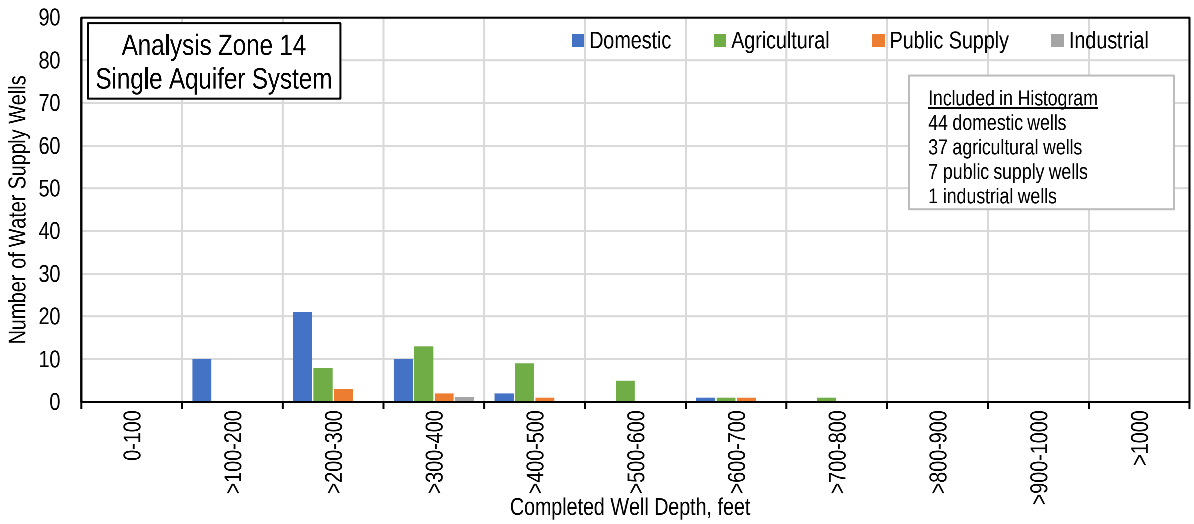

Analysis Zone 9
Single Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
88 domestic wells
123 agricultural wells
7 public supply wells
Number of Water Supply Wells
90
80
70
60
50
40
30
20
10
0
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

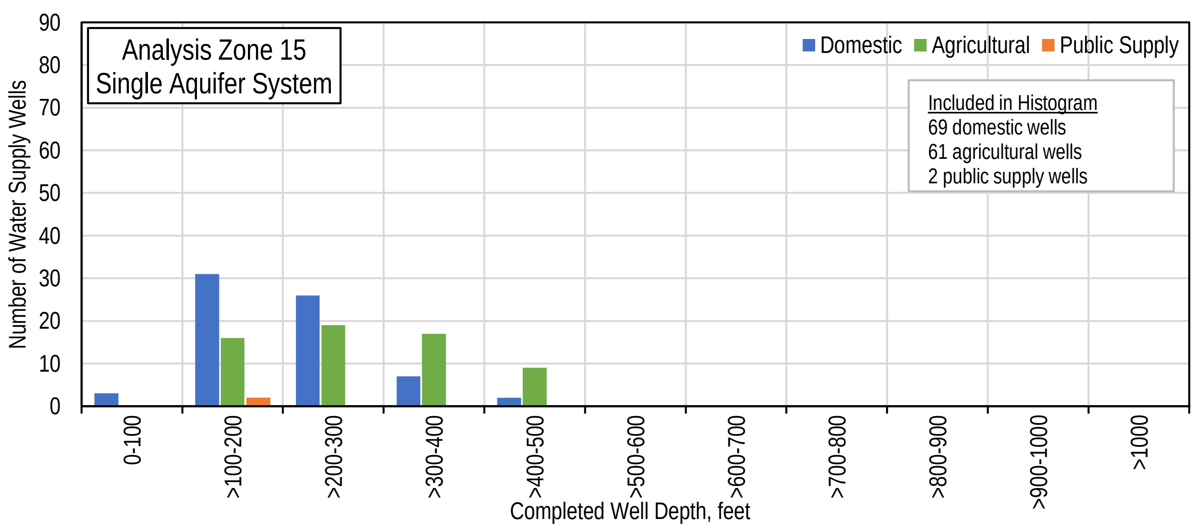

Analysis Zone 10
Single Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
44 domestic wells
60 agricultural wells
1 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

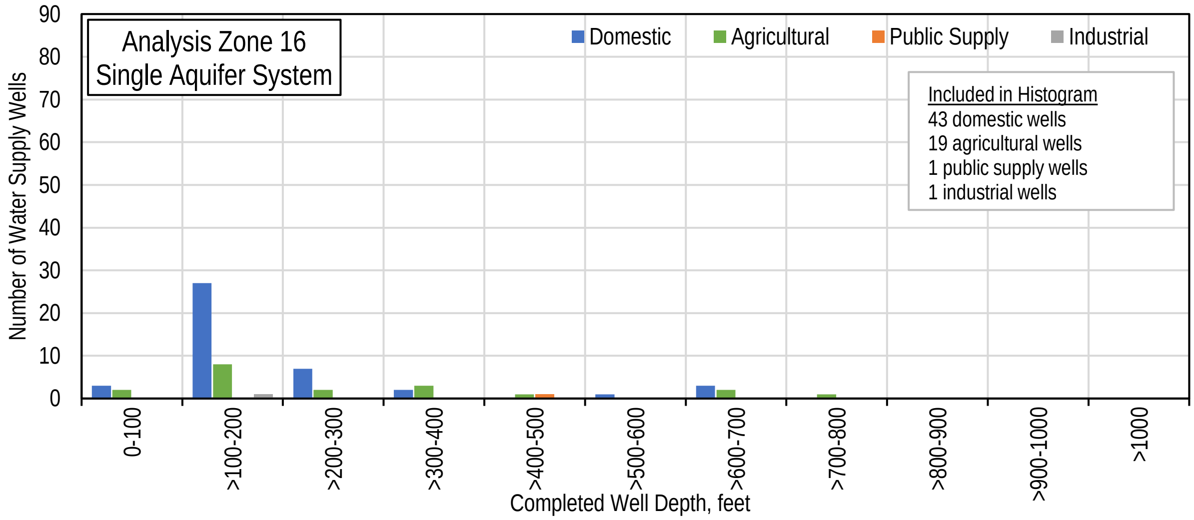

Analysis Zone 11
Single Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
2 domestic wells
21 agricultural wells
2 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

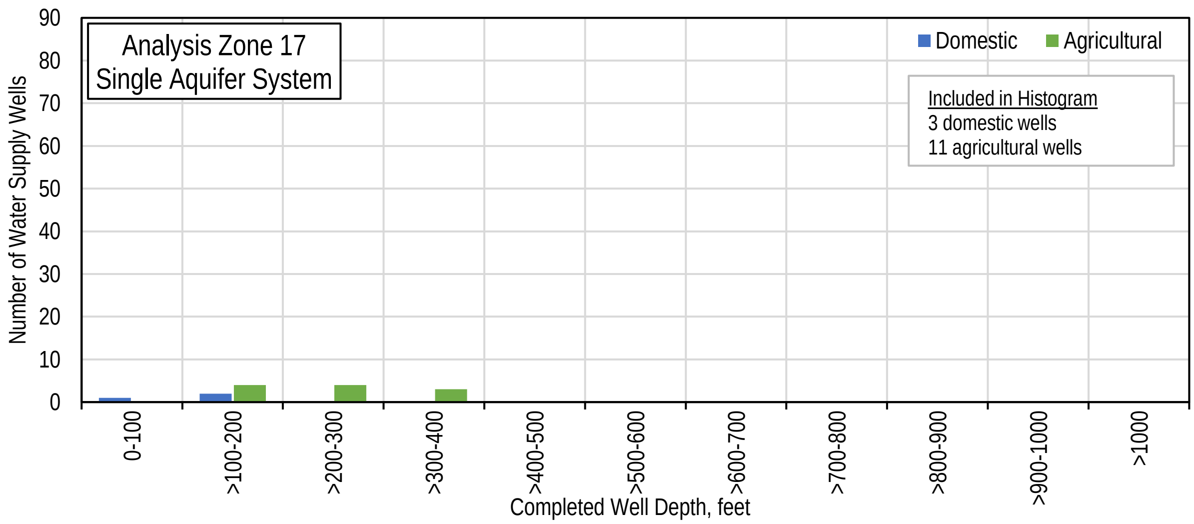

Analysis Zone 12
Single Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
28 domestic wells
30 agricultural wells
3 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

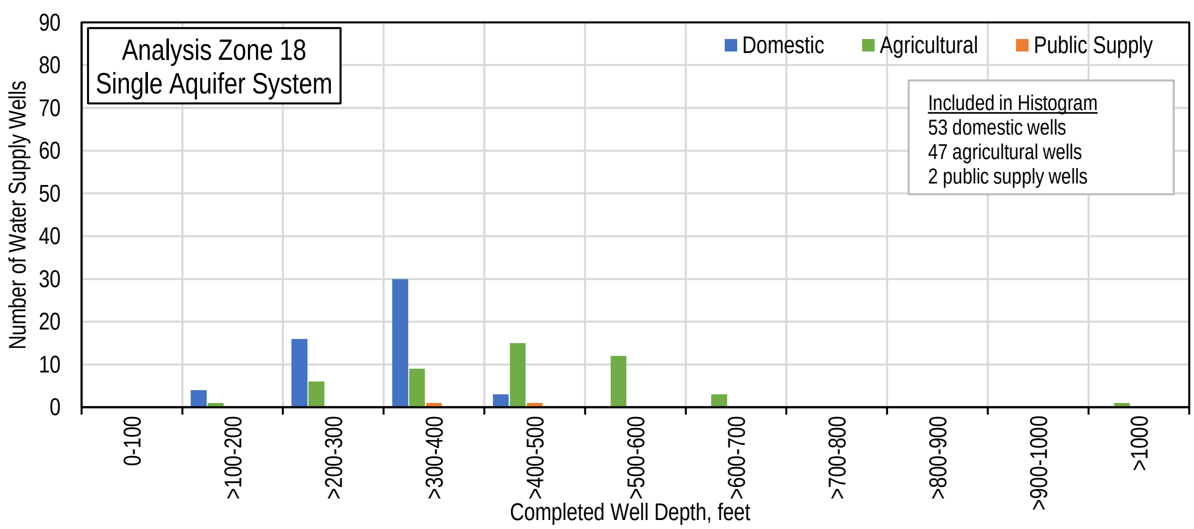

Analysis Zone 13
Single Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
137 domestic wells
70 agricultural wells
6 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

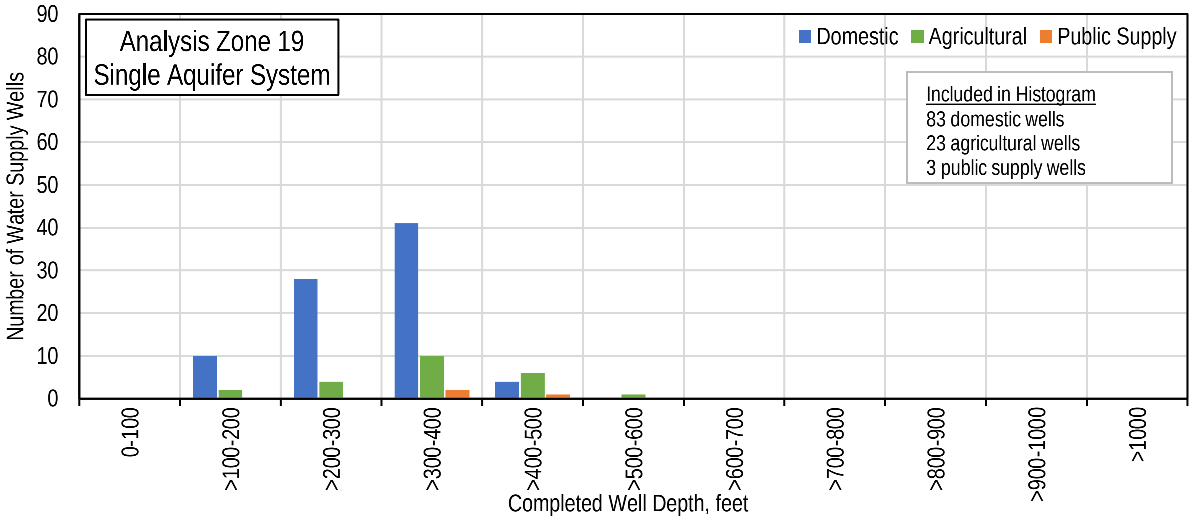

Analysis Zone 14
Single Aquifer System
Domestic
Agricultural
Public Supply
Industrial
Included in Histogram
44 domestic wells
37 agricultural wells
7 public supply wells
1 industrial wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

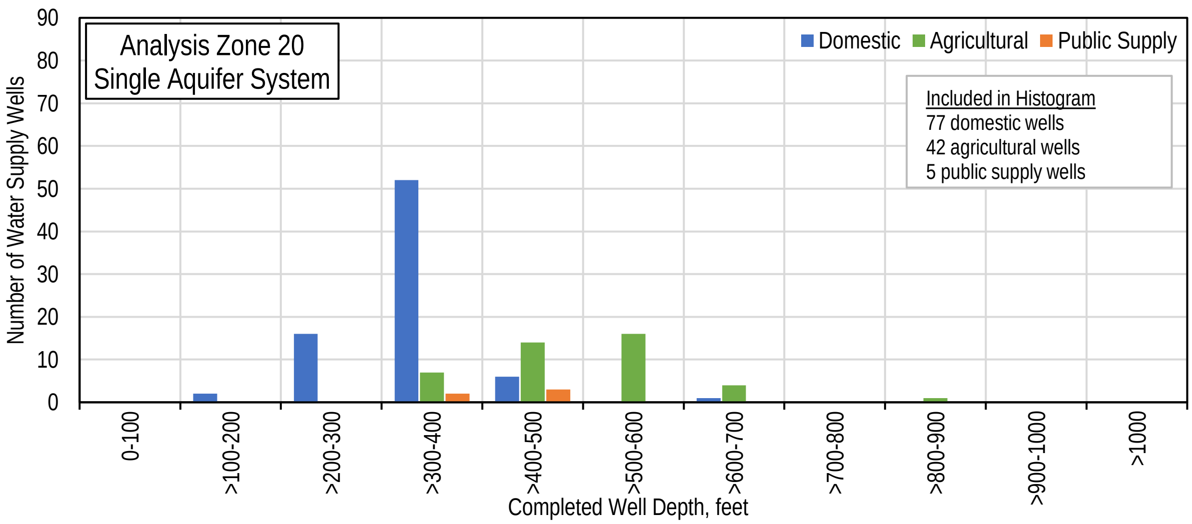

Analysis Zone 15
Single Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
69 domestic wells
61 agricultural wells
2 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

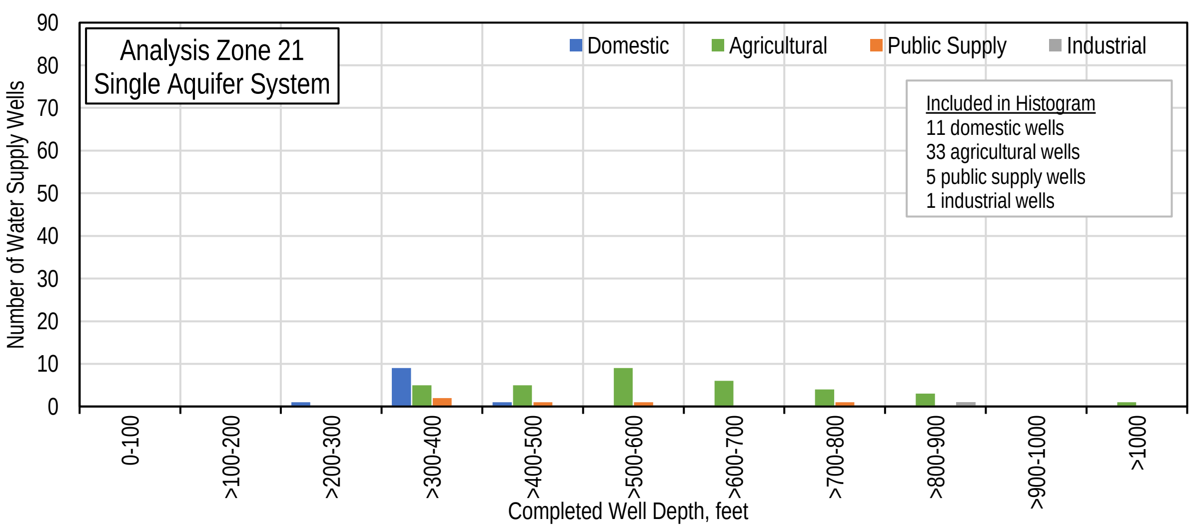

Analysis Zone 16
Single Aquifer System
Domestic
Agricultural
Public Supply
Industrial
Included in Histogram
43 domestic wells
19 agricultural wells
1 public supply wells
1 industrial wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

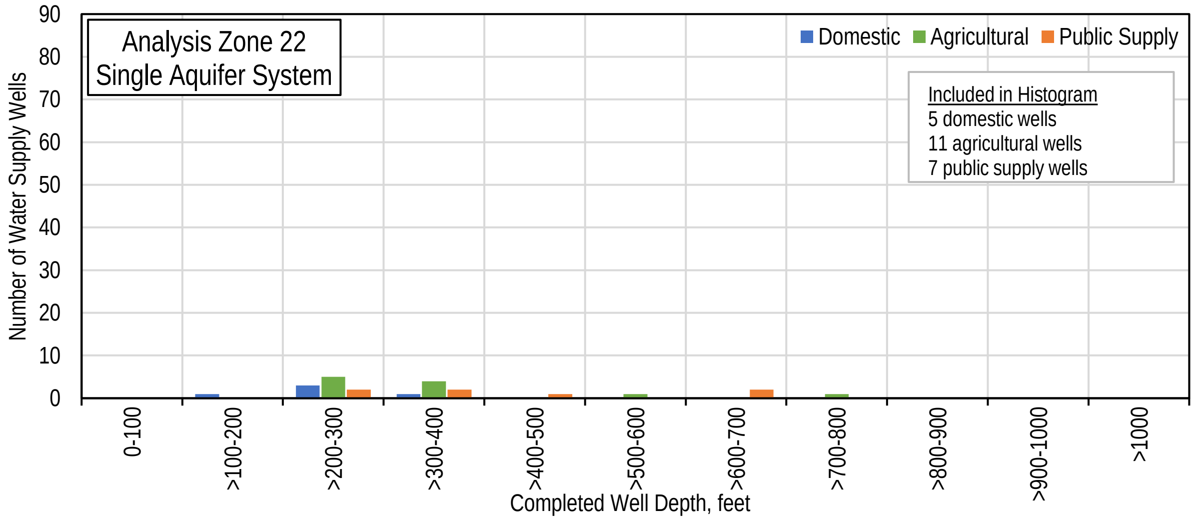

Analysis Zone 17
Single Aquifer System
Domestic
Agricultural
Included in Histogram
3 domestic wells
11 agricultural wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

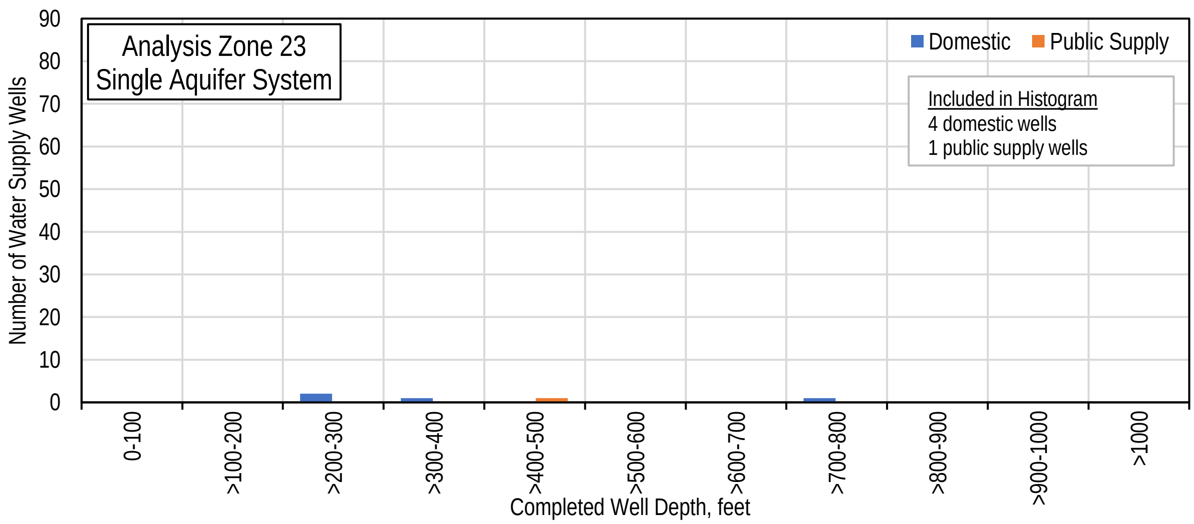

Analysis Zone 18
Single Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
53 domestic wells
47 agricultural wells
2 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

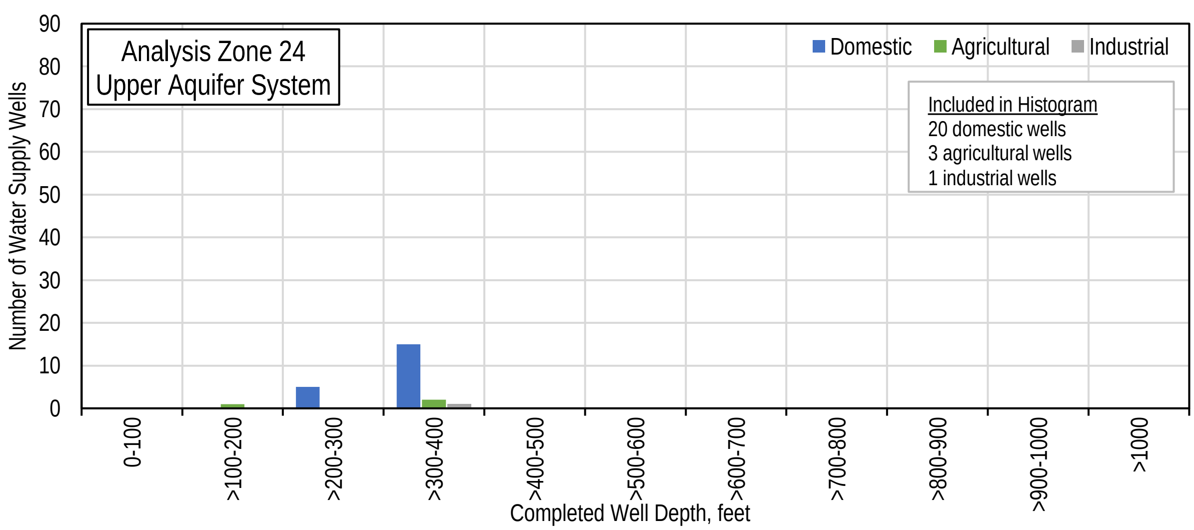

Analysis Zone 19
Single Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
83 domestic wells
23 agricultural wells
3 public supply wells
Number of Water Supply Wells
Completed Well Depth, feet
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000

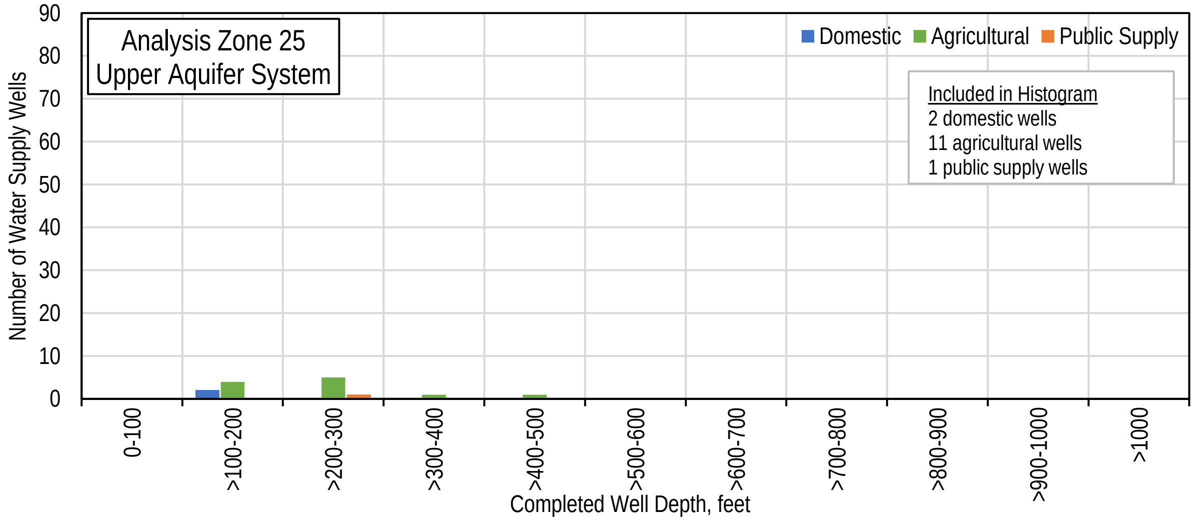

Analysis Zone 20
Single Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
77 domestic wells
42 agricultural wells
5 public supply wells
Number of Water Supply Wells
Completed Well Depth, feet
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000

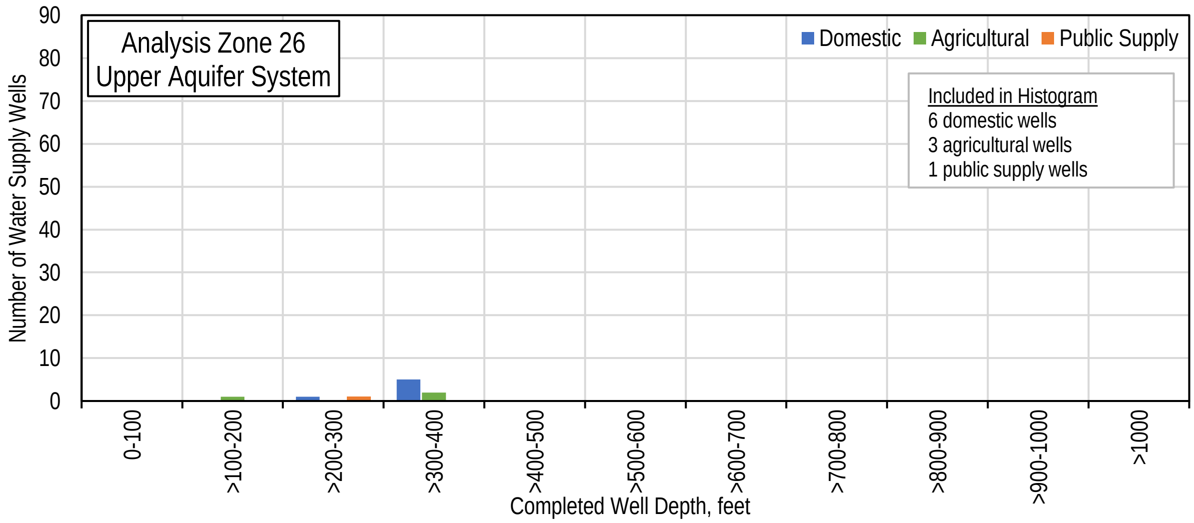

Analysis Zone 21
Single Aquifer System
Domestic
Agricultural
Public Supply
Industrial
Included in Histogram
11 domestic wells
33 agricultural wells
5 public supply wells
1 industrial wells
Number of Water Supply Wells
Completed Well Depth, feet
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000

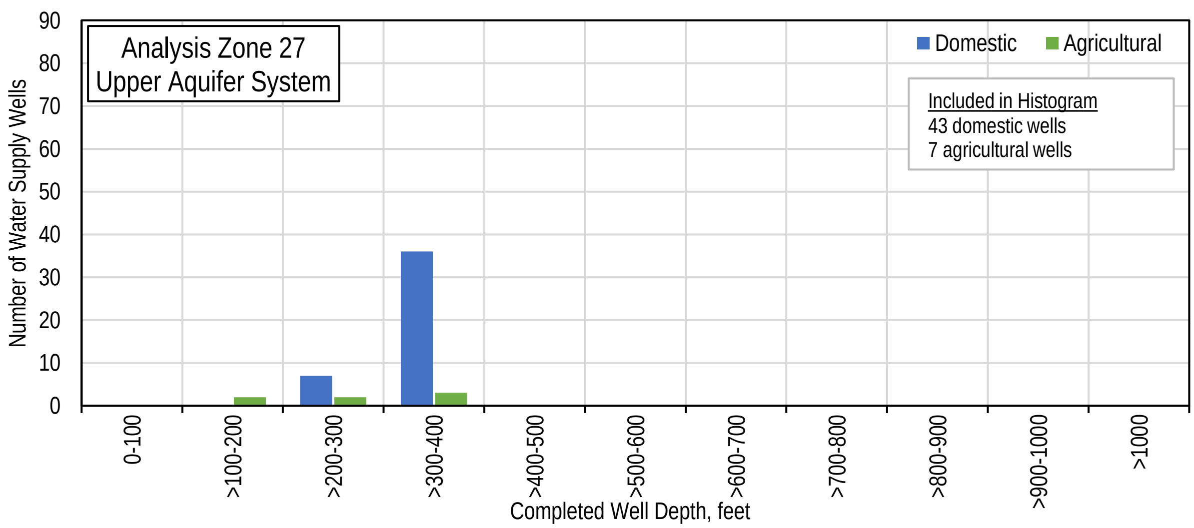

Analysis Zone 22
Single Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
5 domestic wells
11 agricultural wells
7 public supply wells
Number of Water Supply Wells
90
80
70
60
50
40
30
20
10
0
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

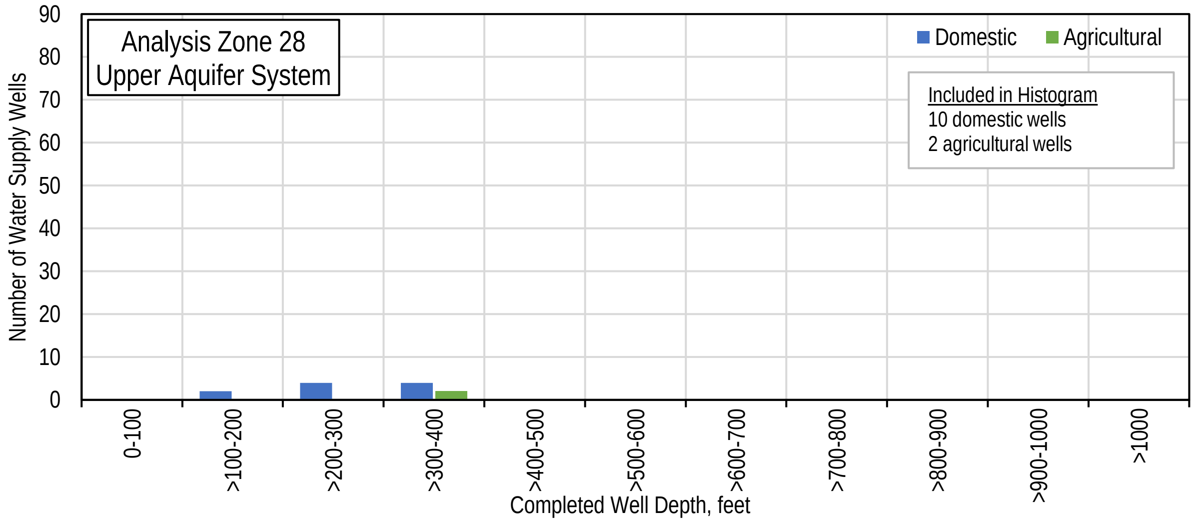

Analysis Zone 23
Single Aquifer System
Domestic
Public Supply
Included in Histogram
4 domestic wells
1 public supply wells
Number of Water Supply Wells
90
80
70
60
50
40
30
20
10
0
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

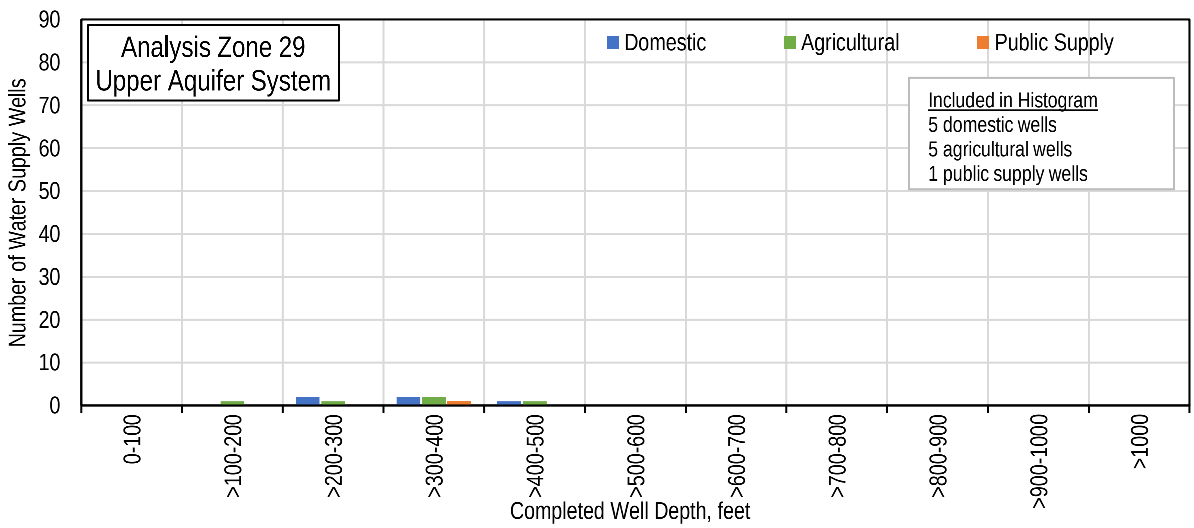

Analysis Zone 24
Upper Aquifer System
Domestic
Agricultural
Industrial
Included in Histogram
20 domestic wells
3 agricultural wells
1 industrial wells
Number of Water Supply Wells
90
80
70
60
50
40
30
20
10
0
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

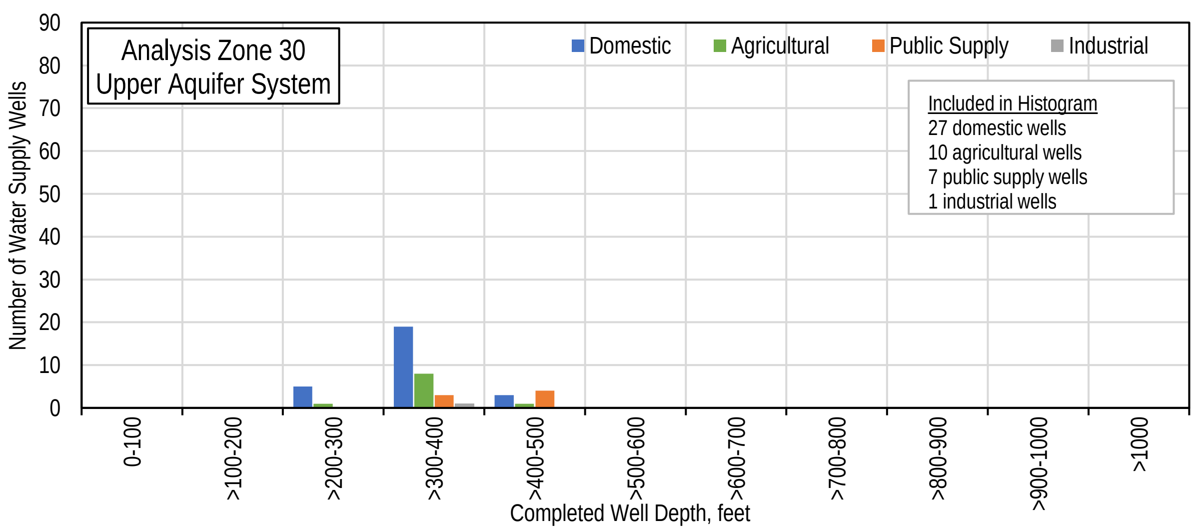

Analysis Zone 25
Upper Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
2 domestic wells
11 agricultural wells
1 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

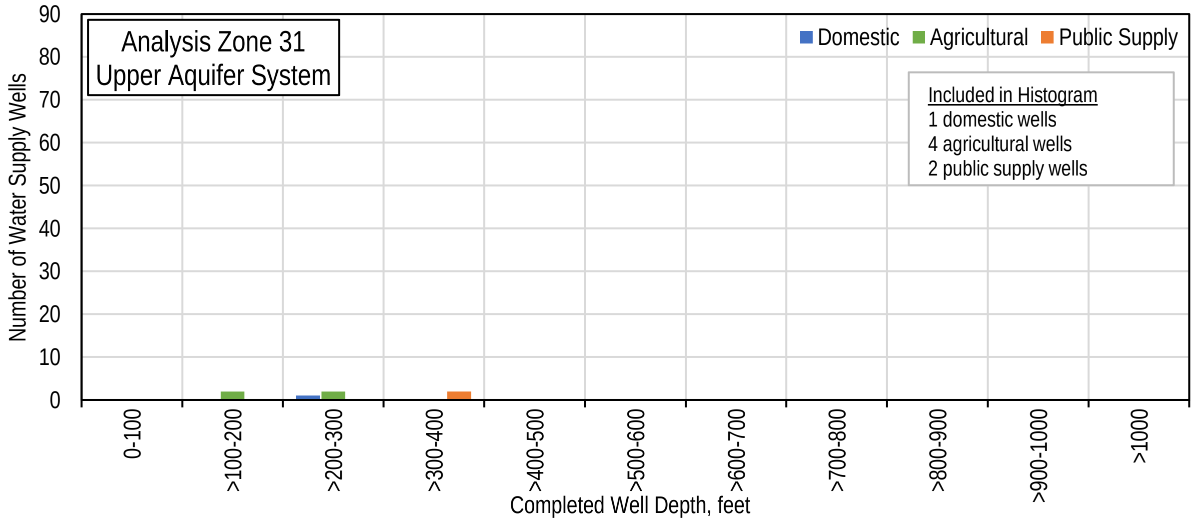

Analysis Zone 26
Upper Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
6 domestic wells
3 agricultural wells
1 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

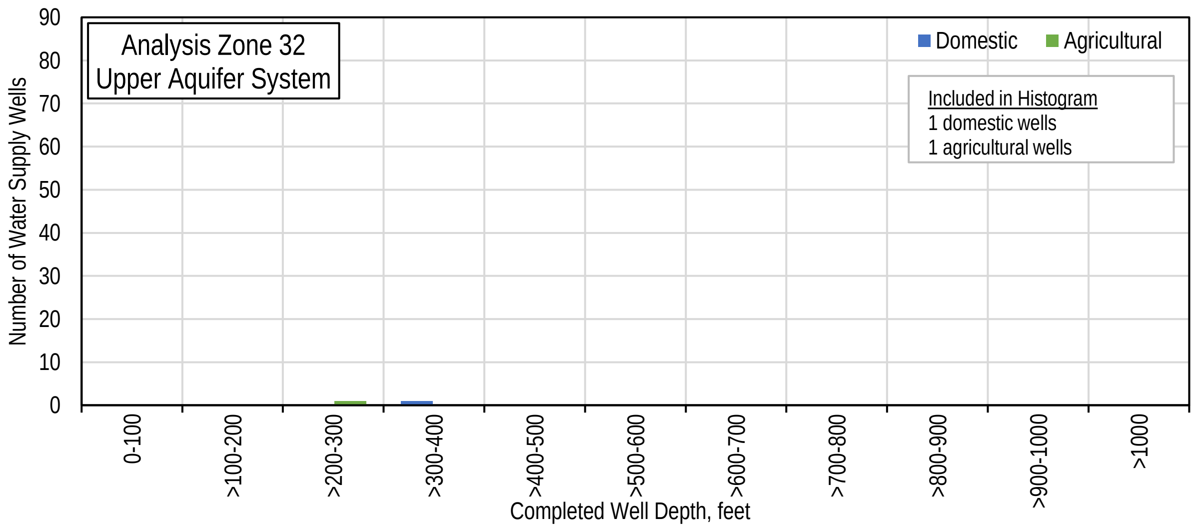

Analysis Zone 27
Upper Aquifer System
Domestic
Agricultural
Included in Histogram
43 domestic wells
7 agricultural wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

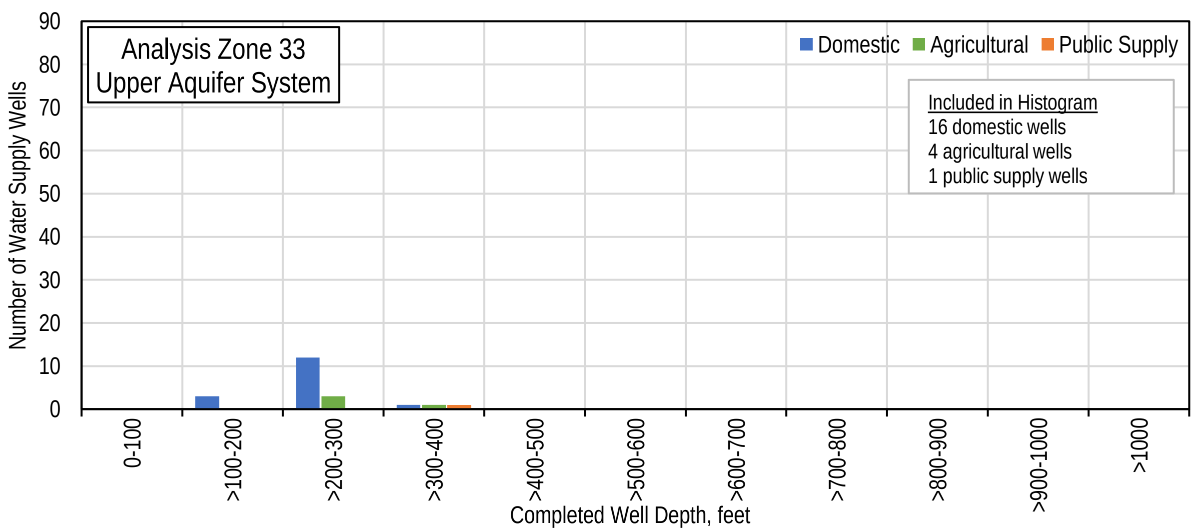

Analysis Zone 28
Upper Aquifer System
Domestic
Agricultural
Included in Histogram
10 domestic wells
2 agricultural wells
Number of Water Supply Wells
90
80
70
60
50
40
30
20
10
0
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

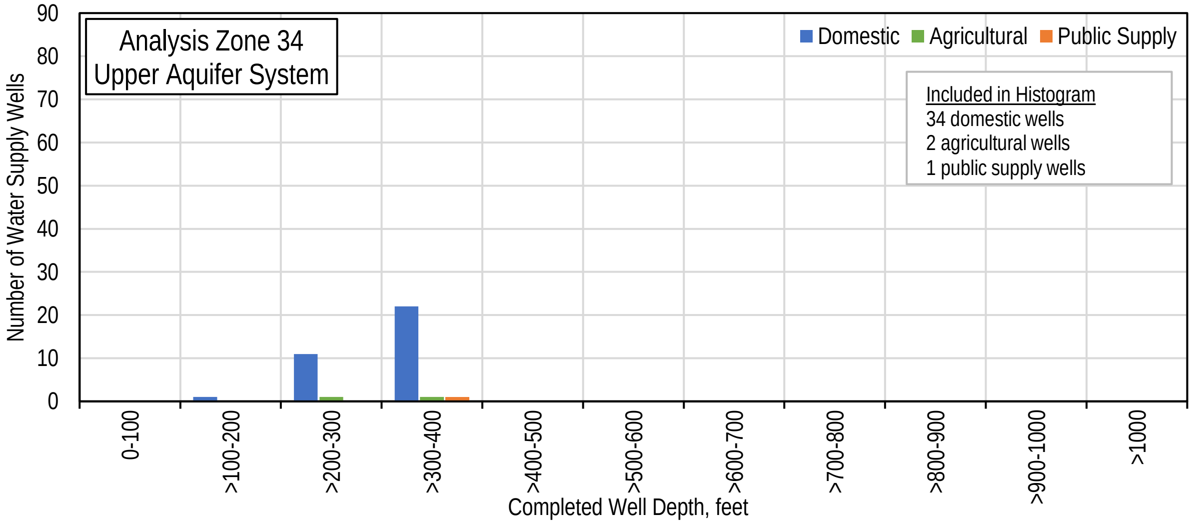

Analysis Zone 29
Upper Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
5 domestic wells
5 agricultural wells
1 public supply wells
Number of Water Supply Wells
90
80
70
60
50
40
30
20
10
0
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

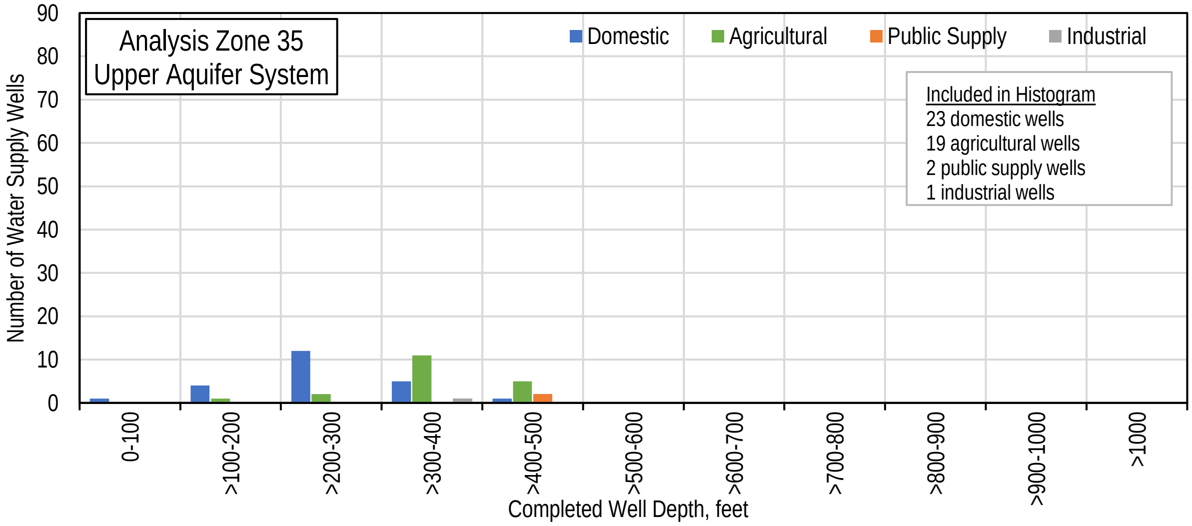

Analysis Zone 30
Upper Aquifer System
Domestic
Agricultural
Public Supply
Industrial
Included in Histogram
27 domestic wells
10 agricultural wells
7 public supply wells
1 industrial wells
Number of Water Supply Wells
90
80
70
60
50
40
30
20
10
0
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet

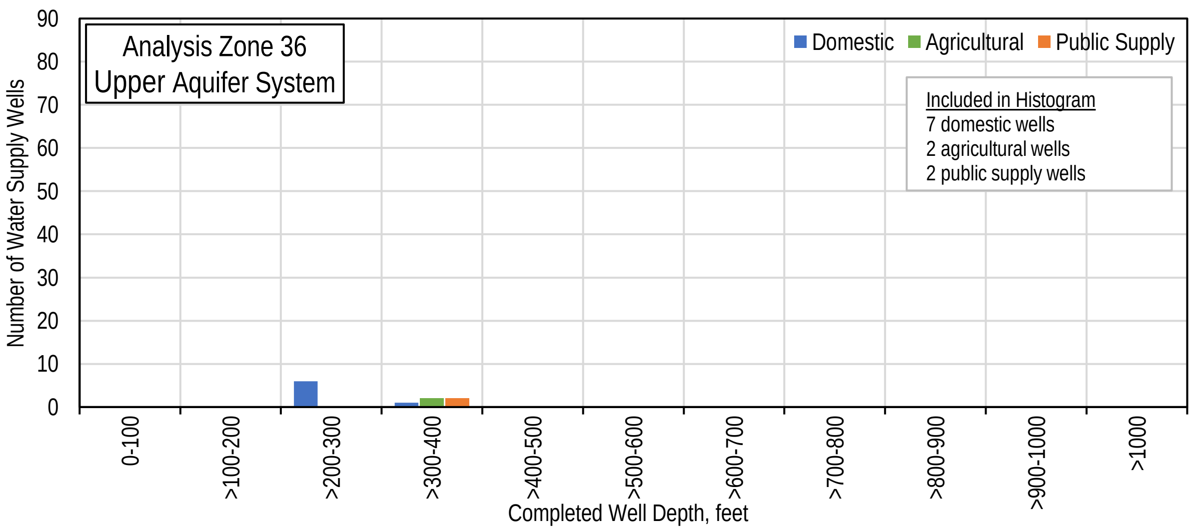

Analysis Zone 31
Upper Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
1 domestic wells
4 agricultural wells
2 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet


Analysis Zone 32
Upper Aquifer System
Domestic
Agricultural
Included in Histogram
1 domestic wells
1 agricultural wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet


Analysis Zone 33
Upper Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
16 domestic wells
4 agricultural wells
1 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet


Analysis Zone 34
Upper Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
34 domestic wells
2 agricultural wells
1 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet


Analysis Zone 35
Upper Aquifer System
Domestic
Agricultural
Public Supply
Industrial
Included in Histogram
23 domestic wells
19 agricultural wells
2 public supply wells
1 industrial wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet


Analysis Zone 36
Upper Aquifer System
Domestic
Agricultural
Public Supply
Included in Histogram
7 domestic wells
2 agricultural wells
2 public supply wells
Number of Water Supply Wells
0
10
20
30
40
50
60
70
80
90
0-100
>100-200
>200-300
>300-400
>400-500
>500-600
>600-700
>700-800
>800-900
>900-1000
>1000
Completed Well Depth, feet