

ANNUAL REPORT | APRIL 2025

**ANTELOPE SUBBASIN (5-021.54)
GROUNDWATER SUSTAINABILITY PLAN
ANNUAL REPORT – 2024**

SUBMITTED BY



TEHAMA COUNTY
FLOOD CONTROL AND WATER CONSERVATION DISTRICT

**TEHAMA COUNTY FLOOD CONTROL AND WATER
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PREPARED BY



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LIST OF ACRONYMS AND ABBREVIATIONS

Acronym	Meaning
AEM	Airborne electromagnetic
AF	acre-feet
AFY	acre-feet per year
AMSL	above mean sea level
Tehama County GSA	Tehama Flood Control and Water Conservation District Groundwater Sustainability Agency
DWR	Department of Water Resources
DMS	data management system
eWRIMS	Electronic Water Rights Information Management System
GSP	groundwater sustainability plan
GSA	groundwater sustainability agency
InSAR	Interferometric Synthetic Aperture Radar
MO	measurable objective
MT	minimum threshold
PMA	projects and management action
RMS	representative monitoring site
RMSE	root-mean-squared error
SI	sustainability indicator
SGM	sustainable groundwater management
SGMA	Sustainable Groundwater Management Act
SMC	sustainable management criteria
Subbasin	Antelope Subbasin
SWRCB	State Water Resources Control Board
TDS	total dissolved solids
UR	undesirable result
UWMP	Urban Water Management Plan
WY	water year

EXECUTIVE SUMMARY

The Antelope Subbasin (Subbasin) (5-021.54) Annual Report was prepared on behalf of the Tehama County Flood Control and Water Conservation District GSA (Tehama County GSA) to fulfill the statutory requirements set by the Sustainable Groundwater Management Act (SGMA) legislation (§10728) and the Groundwater Sustainability Plan (GSP) regulations (§354.40 and §356.2) developed by the California Department of Water Resources (DWR). The regulations mandate the submission of an annual report to DWR by April 1st after the reporting year, which spans the water year (WY) from October 1st to September 30th. This Annual Report includes information from the recent WY 2024 for the Antelope Subbasin, located within Tehama County, shown in **Figure ES-1**.

Measured conditions in the Subbasin are in compliance with minimum thresholds (MTs) for all applicable sustainability indicators (SIs). An MT is the quantitative value that represents the groundwater conditions measured at a representative monitoring site (RMS) that, when exceeded individually or in combination with MTs at other monitoring sites, may cause an undesirable result (UR) in the Subbasin per DWR's definition. Whether the MT represents a minimum or maximum value is dependent on the SI. As an example of a minimum value, if groundwater levels are lower than the value of the measurable objective (MO) for that site, they are moving in the direction of the MT. As an example of a maximum for the groundwater quality sustainable management criteria (SMC), as the value of the total dissolved solids (TDS) concentrations increase from the MO established for that site, it is moving in the direction of the MT. The SIs and SMC, including MTs, are summarized in **Table ES-1**. Note that seawater intrusion is not an applicable SI in this Subbasin. Each SI is measured at the RMS.

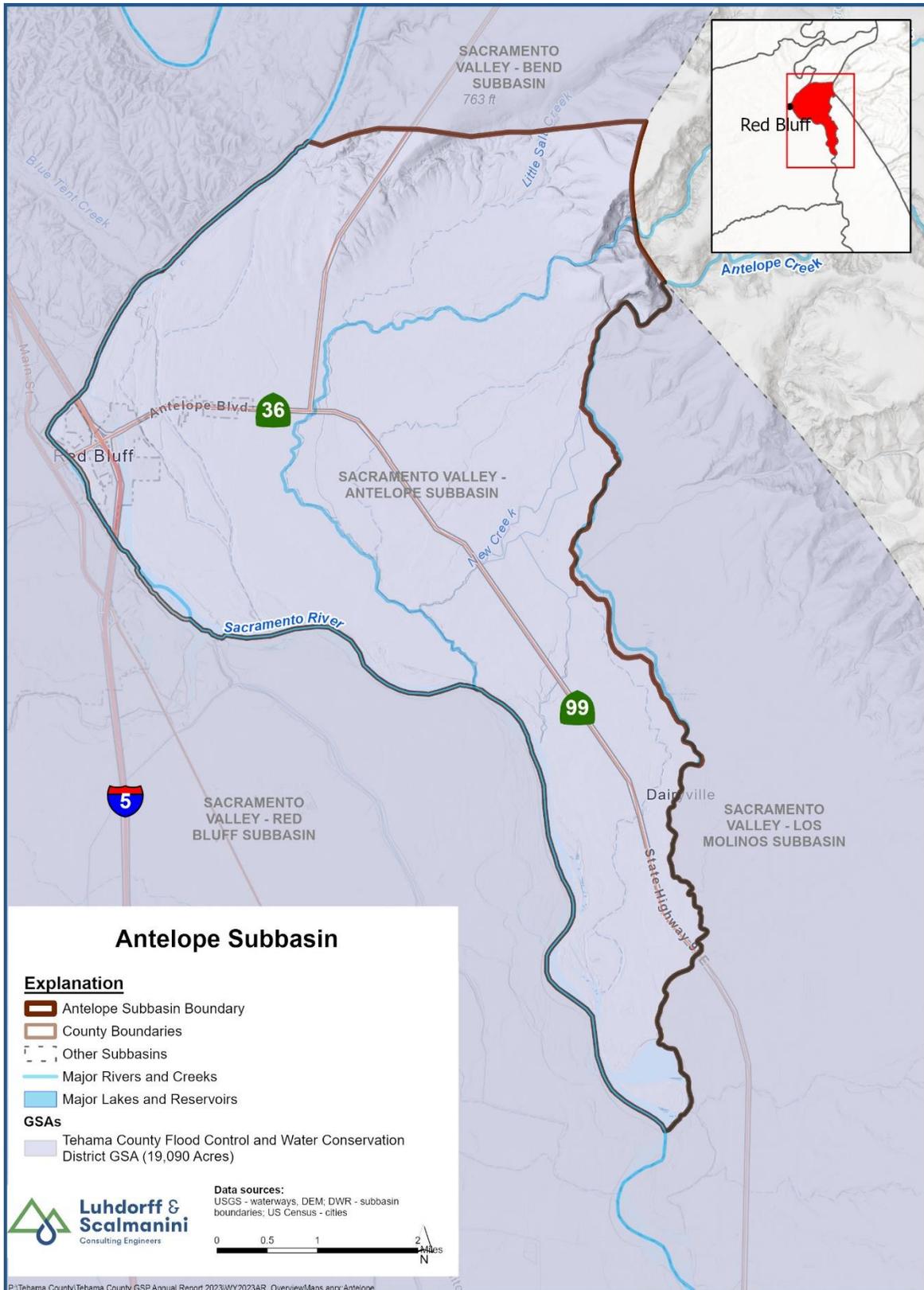


Figure ES-1. Antelope Subbasin and Groundwater Sustainability Agency Boundaries

Table ES-1. Antelope Subbasin Sustainability Indicator Summary			
2024 Status	Undesirable Result Identification	MO Definition	MT Definition
Chronic Lowering of Groundwater Levels			
<p>No indication of undesirable results There were no RMS with spring or fall 2024 groundwater level measurements below the MT.</p>	<p>10 supply wells become dry (after the GSP revision) within a tessellation hexagon or when water levels at any RMP in the future decline 7.5 feet (ft) or more over a five (5) year period.</p>	<p>Upper & Lower Aquifer: Spring 2015 groundwater elevation minus five ft (for wells with increasing or no groundwater trends) or projected spring 2042 groundwater elevation minus five ft for wells with declining groundwater elevations.</p>	<p>Focus Areas: 2020-2022 groundwater lows Outside Focus Areas: 2020-2022 lows minus 20 ft</p>
Reduction of Groundwater Storage			
<p>No indication of undesirable results There were no RMS with spring or fall 2024 groundwater level measurements below the MT.</p>	<p>25% of groundwater elevations measured at same RMS wells exceed the associated MT for two consecutive fall measurements.</p>	<p>Upper & Lower Aquifer: Amount of groundwater storage when groundwater elevations are at their MO.</p>	<p>Upper & Lower Aquifer: Amount of groundwater in storage when groundwater elevations are at their MT.</p>
Degraded Water Quality			
<p>No indication of undesirable results There were no RMS with TDS levels above their MTs. There were two wells with nitrate as N concentrations above their MO, but not above their MT.</p>	<p>TDS: At least 25% of RMS exceed the MT for water quality for 2 consecutive years at each RMS well Or Nitrate: one RMS exceeds the MT for water quality once. With the stipulation for both TDS and nitrate as N that GSP implementation is the cause of the exceedance.</p>	<p>Upper & Lower Aquifer: California lower limit secondary MCL concentration for TDS of 500 mg/L measured at RMS wells. Nitrate: concentration of 5 mg/L nitrate as N at all RMS wells.</p>	<p>Upper & Lower Aquifer: TDS concentration of 750 mg/L at all RMS wells. Nitrate: concentration of 10 mg/L nitrate as N at all RMS wells.</p>

Table ES-1. Antelope Subbasin Sustainability Indicator Summary			
2024 Status	Undesirable Result Identification	MO Definition	MT Definition
Land Subsidence			
No indication of undesirable results No InSAR pixel exceeded MT in WY 2024.	50% of RMS exceed the MT over a 5-year period that is irreversible and is caused by lowering groundwater elevations.	One foot over 20 years (Zero inelastic subsidence, in addition to any measurement error). If InSAR data are used, the measurement error is 0.1 ft, and any measurement 0.1 ft or less would not be considered inelastic subsidence.	Two ft over 20 years (i.e., no more than 0.5 ft of cumulative subsidence over a five-year period (beyond the measurement error), solely due to lowering of groundwater elevations.
Depletion of Interconnected Surface Water			
No indication of undesirable results There were no RMS with spring or fall 2024 groundwater level measurements below the MT.	25% of groundwater elevations measured at RMS wells drop below the associated threshold during two consecutive fall measurements.	Same as the chronic lowering of groundwater levels.	Same as the chronic lowering of groundwater levels.

Notes:

TDS is the primary water quality constituent of concern.

MO = Measurable Objective; MT = Minimum Threshold; RMS = representative monitoring site; mg/L = milligrams per liter.

Current Groundwater Level and Storage Conditions

The current groundwater conditions in the Subbasin are characterized by groundwater elevations that have remained above the MO in spring 2024 but fell slightly below the MO in fall 2024 for RMS Well Ant-1U. However, water levels in all RMS wells remained above the corresponding MT and remained within the Subbasin's established margin of operational flexibility in WY 2024. Importantly, none of the RMS wells experienced a decline below the MT for 24 consecutive months, hence avoiding undesirable results as defined in the GSP.

Generally, groundwater elevations are, on average, 21 ft above the MT throughout the Subbasin and, on average, 12 ft above the MO in spring 2024 and 1 foot below the MO in fall 2024. Elevations are mostly near or slightly higher than those observed in recent years. This positive trend is influenced by the above-normal hydrologic conditions experienced in WY 2024, which resulted in increased surface water supplies available for irrigation despite increased groundwater extractions, which contributed to the recovery of groundwater conditions relative to the dry period from WY 2020 to WY 2022.

Fluctuations in groundwater levels and storage within the Subbasin are influenced by the balance between aquifer recharge and extraction. Groundwater levels serve as a proxy for estimating changes in groundwater storage, with observed patterns closely mirroring those in the broader Sacramento Valley. In years characterized by drought and low precipitation, diminished surface water supplies lead to increased extraction and reduced recharge, causing a decline in groundwater storage.

WY 2024, classified as an above normal WY, marked an increase in cumulative groundwater storage, totaling approximately 5,100 acre-feet (AF) in the Upper and Lower Aquifer. For context, in the past 34 years, the largest decrease in groundwater storage is estimated to be -15,000 AF, and the highest increase was estimated to be 12,000 AF. **Figure ES-2** shows groundwater pumping, as well as annual and cumulative changes in groundwater storage from WY 1990 to WY 2024.

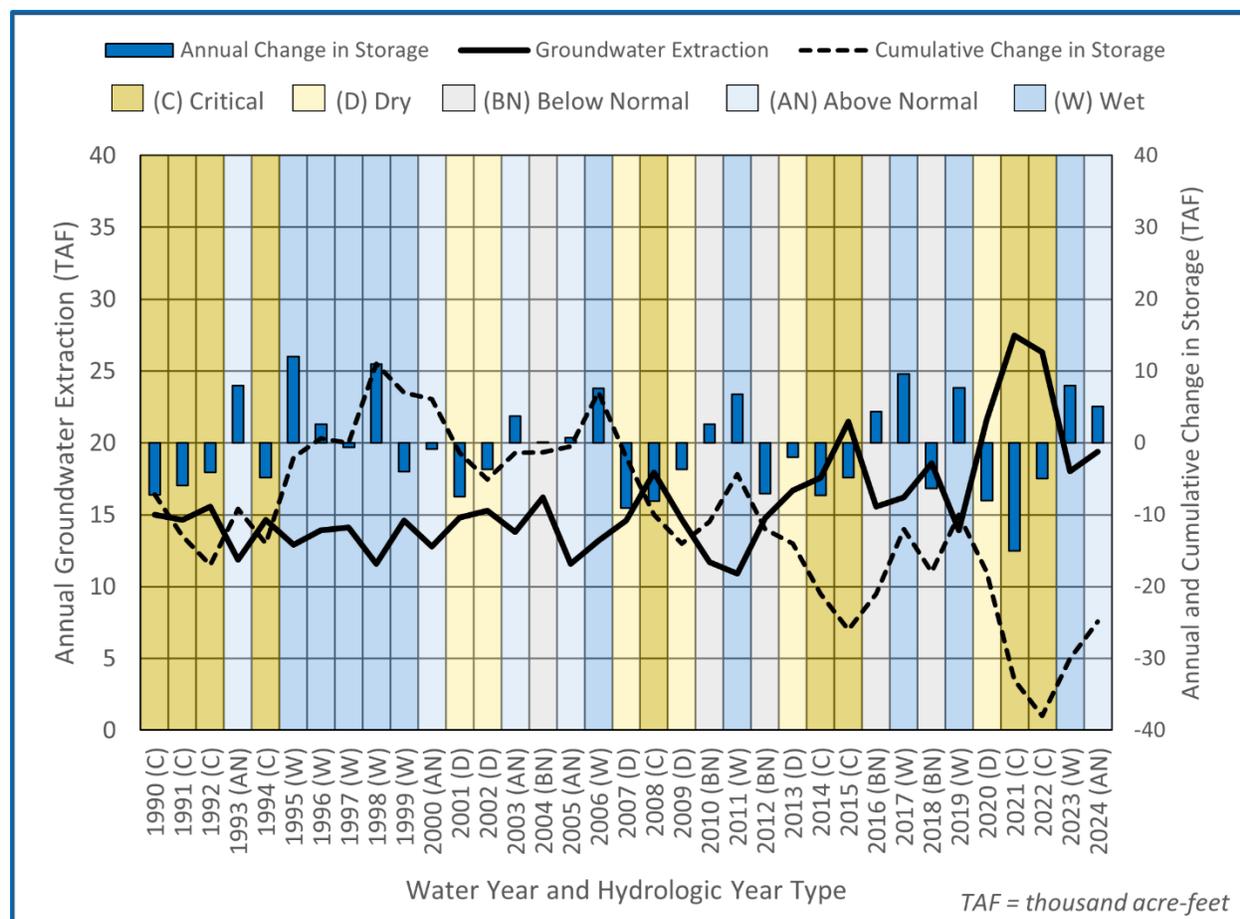


Figure ES-2. Antelope Subbasin Groundwater Pumping, Annual and Cumulative Change in Storage from WY 1990 to WY 2024

Water Use

Groundwater extraction was approximately 19,400 AF in WY 2024, higher than the 18,000 AF extracted in WY 2023. The annual volume of surface water delivered to the Subbasin from surface water features such as Salt Creek and Antelope Creek was about 8,700 AF in WY 2024, lower than the 9,000 AF delivered in WY 2023. The increase in groundwater extraction in WY 2024 compared to WY 2023 is attributed to decreased precipitation in WY 2024, where decreased precipitation was not able to meet evapotranspiration demands. Additionally, surface water use decreased slightly from WY 2024 compared to WY 2023.

Groundwater provides the majority (69%) of the water for agriculture in the Subbasin, and surface water is the source for the remainder (31%). Groundwater also met the demand for municipal and rural residential users. The volume of groundwater and surface water used on an annual basis within the Subbasin is summarized directly from measured and reported groundwater pumping and surface water diversions when available; however, a water budget approach has been used to estimate the remaining unmeasured volume of groundwater extraction. **Table ES-2** provides a summary of water use by water sector. Numbers are rounded to the nearest 100.

Table ES-2. Antelope Subbasin Total Water Use by Water Use Sector				
Sector	WY 2024 (AF)			Total Irrigated Area (acres)
	Groundwater	Surface Water	Total	
Agricultural	17,700	8,700	26,400	8,100
Municipal	300	0	300	0
Rural Residential	1,400	0	1,400	0
Total	19,400	8,700	28,100	8,100

GSP Implementation Progress

The main activities and updates since the previous annual report are as follows:

- The Tehama County GSA completed the WY 2024 Annual Report and other critical tasks.
- The Tehama County GSA coordinated a proposal seeking funding through DWR’s SGM Grant Program. Coordination efforts included planning and refinement of PMAs, evaluating and ranking PMAs, and preparing and submitting the grant application. The grant application was submitted in December 2022, and DWR released a final award list in September 2023; results are summarized below in **Table 5-4**.
- An airborne electromagnetic (AEM) survey by DWR took place in the summer of 2022. The data collected provides a better understanding of aquifer characteristics and will help support future efforts to refine the current hydrogeologic conceptual model. Data are available at: <https://data.cnra.ca.gov/dataset/aem>.
- All sustainability indicators (SIs) are above their MTs (see summary **Table 5-1**).
- Progress has been made on 2 PMAs since the last annual report (**Table 5-4**).

Several other actions continue in the Subbasin to fulfill the requirements of the GSP. These include:

- Monitoring and recording groundwater levels and groundwater quality.
- Maintaining and updating the data management system (DMS) with newly collected data.
- Annual reporting on Subbasin conditions and submission to DWR as required by SGMA.
- Ongoing intra- and inter-basin coordination.

DWR proposed two recommended corrective actions that will enhance the GSP (below). The GSAs have revised the GSP to address these corrective actions. The revised GSP was submitted in April 2024.

1. Providing more detailed explanation and justification regarding the selection of the sustainable management criteria for groundwater levels, particularly undesirable results and minimum thresholds, and quantitatively describe the effects of those criteria on the interests of beneficial uses and users of groundwater.

The GSA must provide a more detailed explanation and justification regarding the selection of sustainable management criteria for degraded groundwater quality, particularly the selection and exclusion of constituents of concern for monitoring and sustainable management.

Since 2023, the Tehama County GSA prepared to implement future projects to address recommended corrective actions, which will largely be funded by the SGM Implementation Grant Program. The ongoing implementation of PMAs, outlined in **Section 5**, aims to address these corrective actions effectively through the Periodic Evaluation of the GSP, which is due in January 2027.

1 GENERAL INFORMATION §356.2(A)

This Annual Report for the Antelope Subbasin (Subbasin) (5-021.54) was prepared on behalf of the Tehama Flood Control and Water Conservation District (Tehama County GSA) to fulfill the statutory requirements of the Sustainable Groundwater Management Act (SGMA) legislation (§10728) and regulatory requirements developed by the California Department of Water Resources (DWR) included in the Groundwater Sustainability Plan (GSP) regulations (§354.40 and §356.2). The regulations require the Groundwater Sustainability Agencies (GSAs) to submit an annual report to DWR by April 1st following the reporting year, which spans the water year (WY) from October 1st to September 30th. This Annual Report is the fourth annual report submitted on behalf of the Subbasin and includes data for the most recent WY 2024. Public seeking information on Antelope Subbasin and GSP Implementation, Technical Advisory Committee meeting schedules and recordings, and other resources should visit the Tehama County GSA website (<https://tehamacountywater.org/gsa/>).

1.1 Report Contents

This report is the fourth annual report prepared for the Antelope Subbasin GSP submitted in January 2022 (revisions submitted in April 2024). The first annual report included data elements for the first reporting year, WY 2021, as well as a “bridge year,” WY 2020. The second and third annual reports contain data only for the current reporting year, WY 2022 and WY 2023, respectively. Data elements presented in this report refer to WY 2024, the 12-month period spanning October 2023 through September 2024 unless otherwise noted. Pursuant to GSP regulations, this Annual Report includes:

- Groundwater Elevation Data
- Water Supply and Use
- Change in Groundwater Storage
- GSP Implementation Progress

1.2 Subbasin Setting

The Subbasin is a 30 square mile (19,100 acre) area on the eastern side of Tehama County. The Subbasin is managed by the Tehama County GSA.

The Subbasin is shown in **Figure 1-1** and **Figure 1-2**. The Subbasin lies in the northeastern portion of the Sacramento Groundwater Basin, **Figure 1-1**. The Subbasin’s northern boundary is the Bend Subbasin, the western and southern boundary is the Sacramento River and the Red Bluff Subbasin, and the eastern boundary is Antelope Creek and the Los Molinos Subbasin (DWR, 2018), **Figure 1-2**. Several surface water features are located in the Subbasin, including the East Sand Slough and Salt Creek. Smaller local streams entering and traversing the Subbasin include Millrace Creek, New Creek, and Craig Creek. Groundwater generally flows from north/northeast to south/southwest.

The Antelope GSP estimates the sustainable yield of the Subbasin to be 18,000 acre-feet (AF) based on projected long-term groundwater pumping averages of 13,000 acre-feet per year (AFY) and an annual decrease in storage of 9,100 AFY (Tehama County FCWCD, 2021). Water use in the Subbasin is dominated (94%) by agricultural uses. Municipal and household water use accounts for 6% of water used. Groundwater constitutes the majority (69%) of the Subbasin’s water supplies, with surface water comprising the remaining portion (31%).

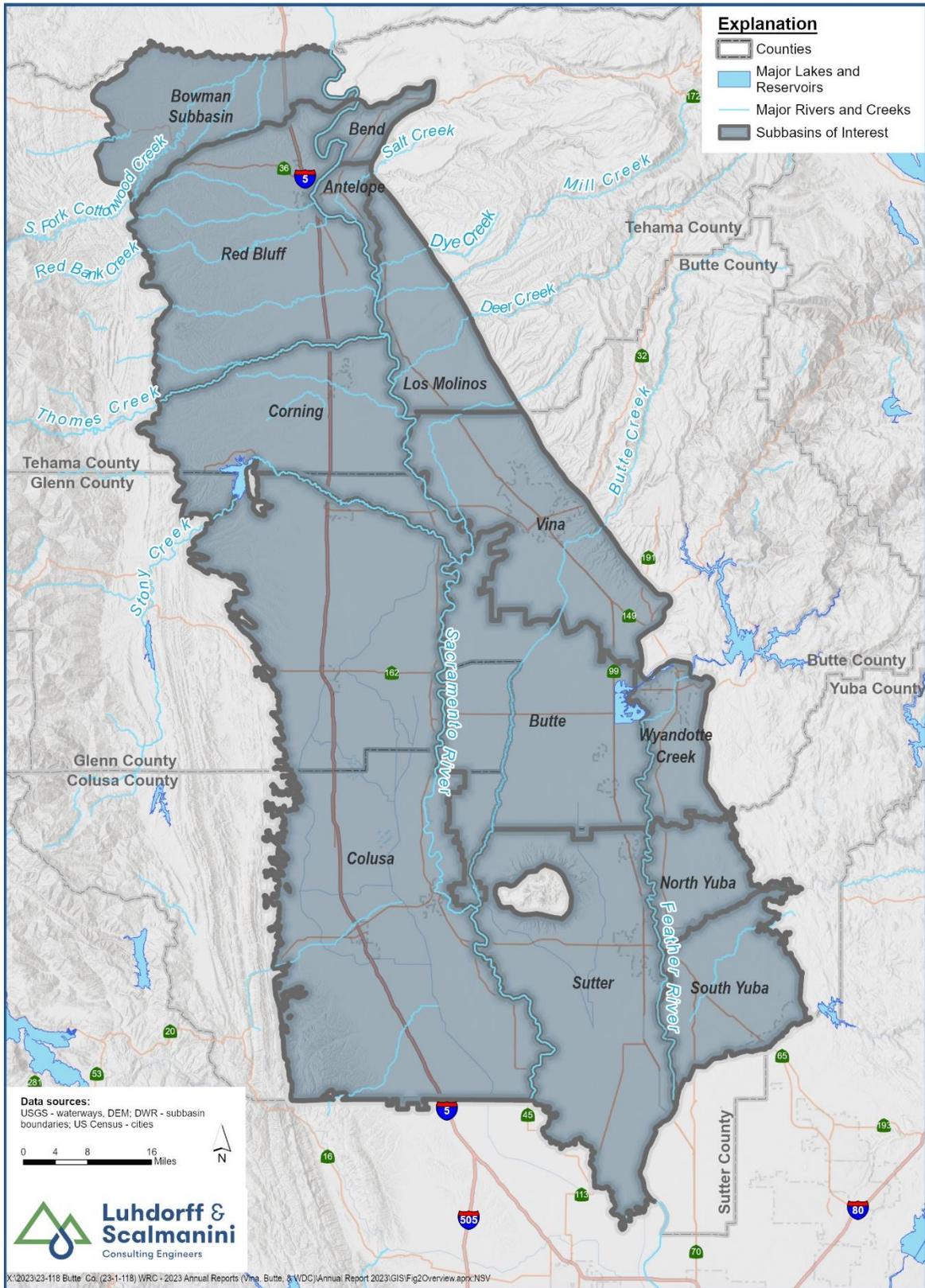


Figure 1-1. Subbasins in the North Sacramento Valley

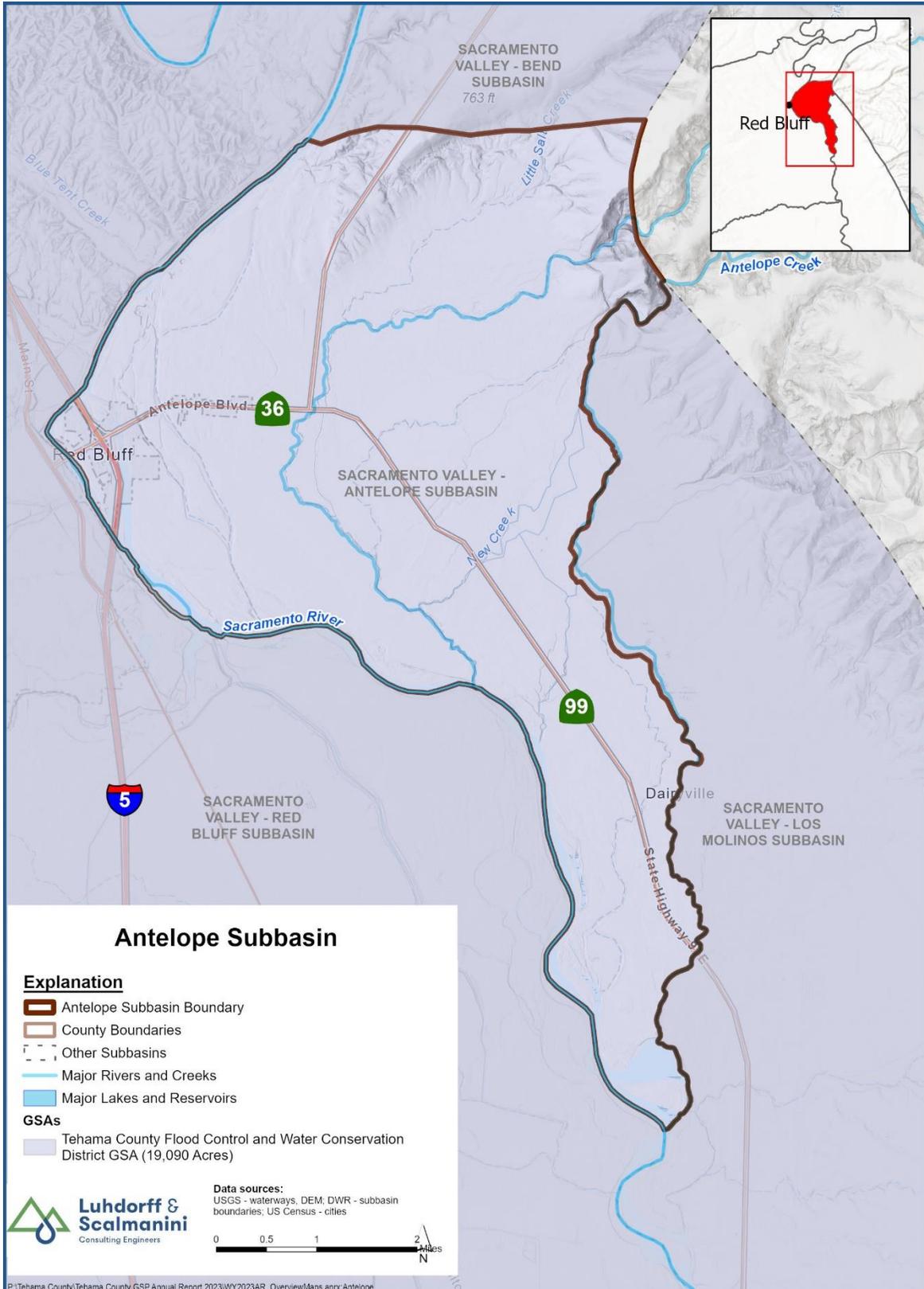


Figure 1-2. Antelope Subbasin and Groundwater Sustainability Agency Boundaries

2 GROUNDWATER ELEVATIONS §356.2(B)(1)

Groundwater elevations in the Subbasin typically fluctuate seasonally between and within water years, particularly in groundwater-dependent areas or during drought years when groundwater is used to compensate for diminished surface water supplies. Seasonal fluctuations of groundwater levels occur in response to groundwater pumping and recovery, land and water use activities, recharge, and natural discharge. Sources of recharge into the groundwater system include precipitation, applied irrigation water, and seepage from local creeks and rivers.

Groundwater pumping for irrigation typically occurs from April to September, although depending on the timing of rainfall, it may shift earlier and/or later into the season. Consequently, groundwater levels are usually highest in the spring and lowest during the irrigation season in the summer months. Fall groundwater measurements (typically measured in October) indicate groundwater conditions after the primary irrigation season.

Groundwater levels in the Subbasin are monitored in representative monitoring site (RMS) wells that were selected in the GSP to represent localized groundwater conditions for specified areas of the Subbasin. RMS wells include a mixture of domestic wells, irrigation wells, and dedicated observation wells. In total, there are five (5) RMS wells used to monitor conditions in the Upper and Lower Aquifer. **Appendix A** contains hydrographs showing groundwater elevations and the approximate locations of the RMS wells. Sustainable management criteria (SMC), as described in **Appendix B**, are assigned to groundwater levels at the RMS wells.

Certain RMS wells measured by DWR and Tehama County are equipped with data loggers and pressure transducers, which continuously monitor and record hourly changes in groundwater levels. These and the remaining wells in the network are measured by hand at least two times each year in March and October. Data from groundwater level monitoring wells are available from DWR's online SGMA Data Viewer tool (<https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer>).

Spring and fall 2024 groundwater elevation measurements for RMS wells in the Upper Aquifer systems are summarized in **Table 5-2**. The groundwater level monitoring methods are consistent with the protocols described in the Antelope Subbasin GSP. Depending on the well, groundwater elevations are measured using steel tape, electric sounder, or pressure transducers. The accuracy of groundwater level measurements is typically either 0.01 feet or 0.1 feet (ft), depending on the equipment used.

The following sub-sections provide a summary of groundwater elevations and conditions during WY 2024 through the presentation and description of groundwater elevation contours (**Section 2.1**) and hydrographs of groundwater elevations (**Section 2.2; Appendix A**).

2.1 Groundwater Elevation Contour Maps – §356.2(b)(1)(A)

Groundwater elevation contour maps for spring and fall 2024 were prepared for the Upper Aquifer, as shown in **Figures 2-1** and **2-2**. Spring contours are intended to generally represent seasonal high groundwater elevations (shallower depth to water), and fall contours are intended to generally represent seasonal low groundwater elevations (deeper depth to water). Groundwater elevation contours were

developed by creating a continuous groundwater elevation surface based on available monitoring well data using the kriging interpolation method. Questionable groundwater elevation measurements were excluded, and minor adjustments to the contours were made based on professional judgment.

The contour maps of the Upper Aquifer (**Figures 2-1 and 2-2**) each show that groundwater elevations are generally higher in the northern and eastern areas of the Subbasin versus the southern and western areas, indicating a general gradient – and thus groundwater flow – from the north/northeast to the south/southwest. The contour maps illustrate several general features of the groundwater flow system in the Antelope Subbasin, including:

- Overall, north/northeast to south/southwest groundwater flow is consistent with recharge from the Sierra Nevada Range.
- Movement of water towards the Sacramento River in both the fall and the spring.
- The higher concentration of contours in the north-central portion of the Subbasin indicates a steeper gradient and could suggest higher groundwater flow. Nonetheless, the contours are consistent with the current understanding of recharge coming from the Sierra Nevada foothills. New sources of information and data may improve understanding of this area.

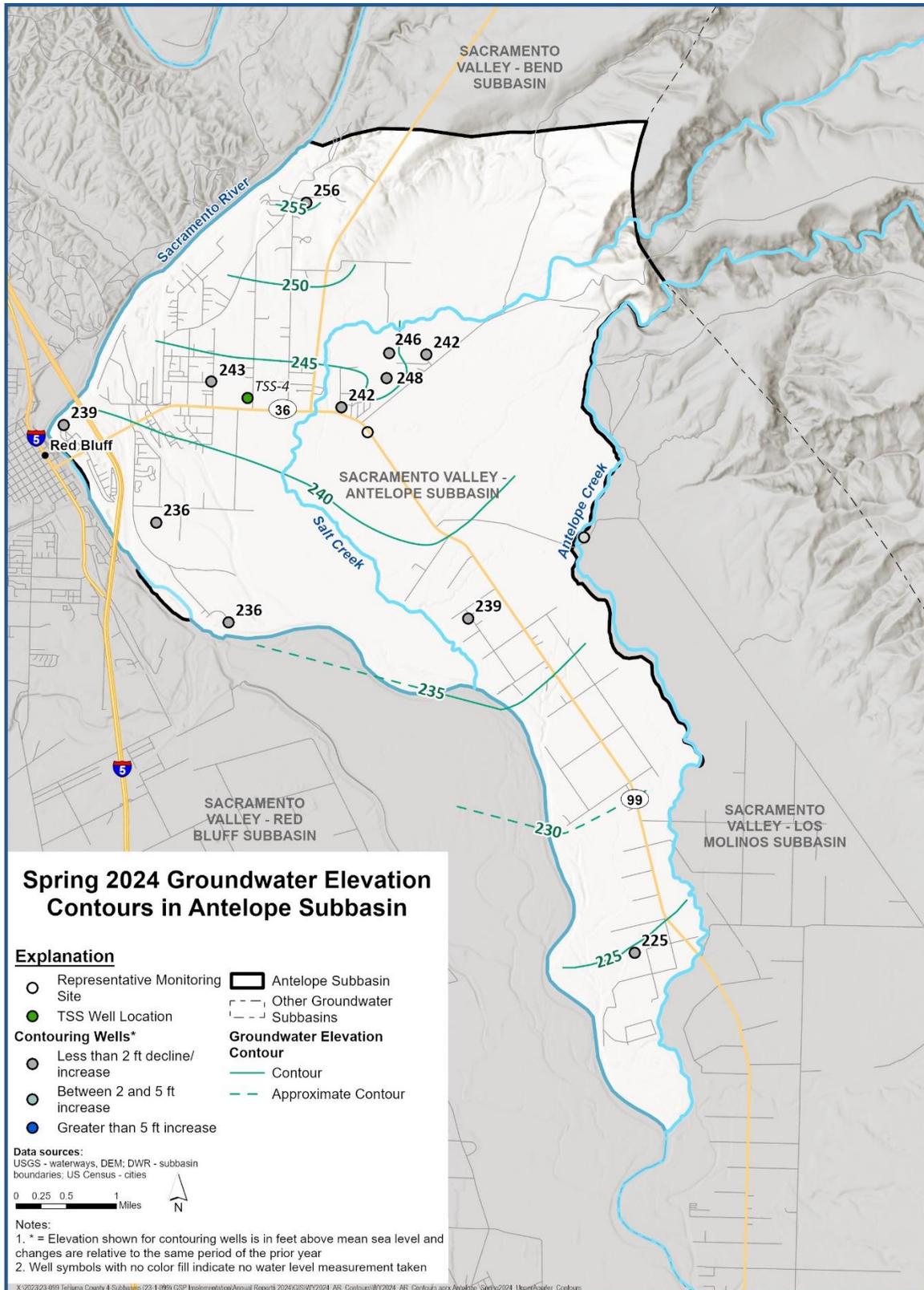


Figure 2-1. Antelope Subbasin Contours of Equal Groundwater Elevation for the Upper Aquifer, Spring 2024 (Seasonal High)

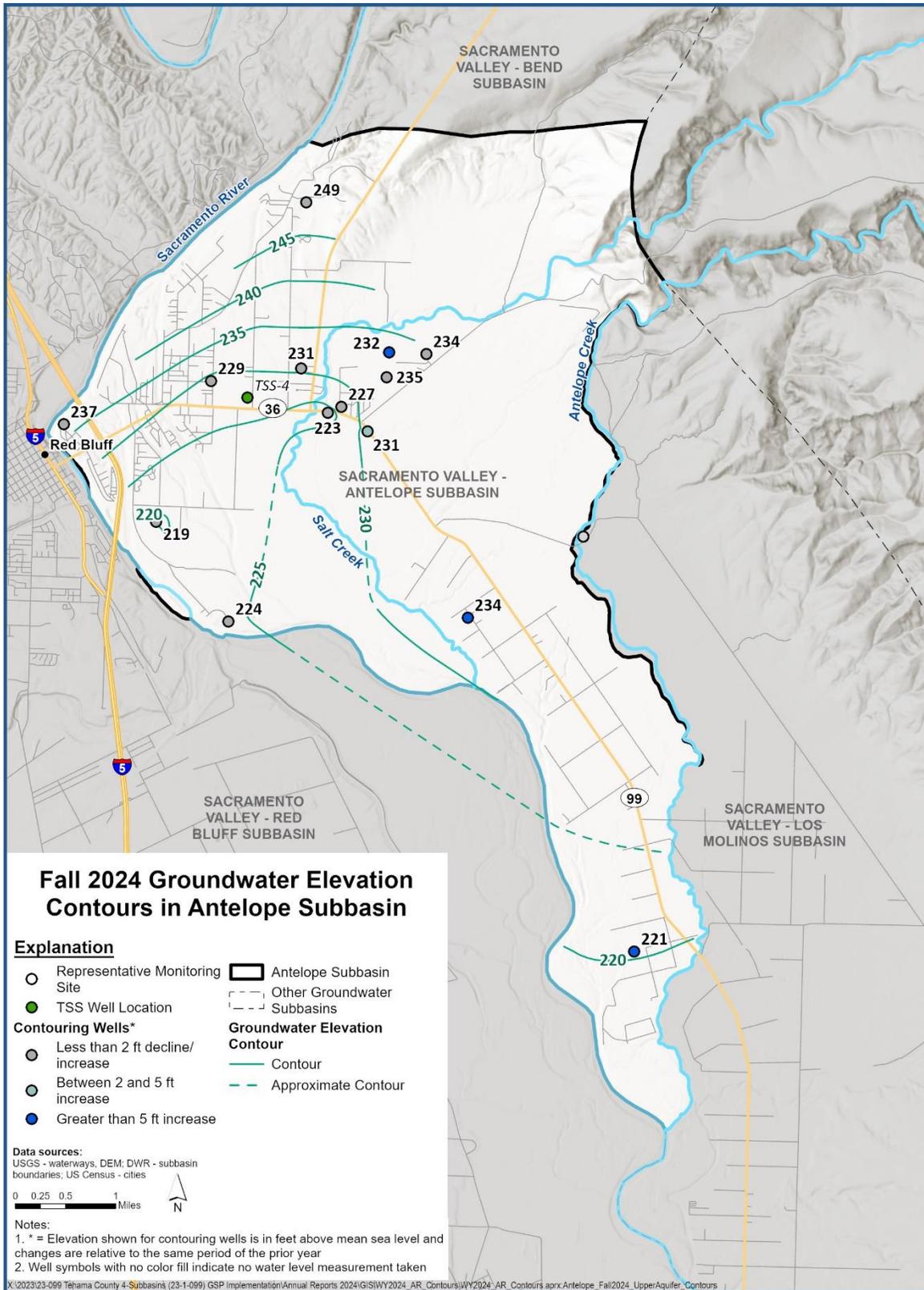


Figure 2-2. Antelope Subbasin Contours of Equal Groundwater Elevation for the Upper Aquifer, Fall 2024 (Seasonal Low)

2.2 Hydrographs of Groundwater Elevations – §356.2(b)(1)(B)

Groundwater elevation hydrographs for each RMS well are presented in **Appendix A**. The pink trendline on each hydrograph illustrates general groundwater level changes during the spring months, a period typically free from groundwater pumping, thereby reflecting the least-influenced groundwater levels. Groundwater level records from recent spring seasons were used to calculate changes in groundwater levels, the average water level, and the average annual rate of change. The trendline was developed based on the available data and historical records for each specific monitoring site. While most sites have data spanning the past 21 years (Spring 2003 to Spring 2021), some long-established monitoring wells contain extended historical records (over 21 years), whereas newly installed wells have more limited datasets. **Appendix B** explains the SMC terminology defined in Section 6 of the GSP (e.g., minimum threshold [MT], measurable objective [MO], interim milestone [IM]). **Table 5-1** summarizes the MOs, MTs, and identification of undesirable results for WY 2024, and **Table 5-2** contains a summary of the spring 2024 (seasonal high) and fall 2024 (seasonal low) groundwater elevations measured at each well. **Table 5-2** also summarizes the established MO and MT for groundwater elevations, the changes in groundwater elevations from WY 2023 to WY 2024, and the differences between the 2024 groundwater elevations and the MO.

Historically, groundwater levels have typically remained at or above their respective MOs in the Subbasin. The GSP also established IMs to provide numerical metrics for GSAs to track the Subbasin's conditions relative to the overall sustainability goal, ensuring that the groundwater management of the Subbasin remains sustainable.

Spring and fall 2024 groundwater elevations were generally near seasonal groundwater elevations in previous years. In WY 2024, the average seasonal high was 243 feet above mean sea level (AMSL), and the average seasonal low was 227 feet AMSL. In WY 2021, the average seasonal high was 239 feet AMSL; in WY 2022, the average seasonal high was 236 feet AMSL; and in WY 2023, the average seasonal high was 244 AMSL. Increases in groundwater level elevations are generally expected to result from decreased groundwater extraction in WY 2024 relative to water years 2023 and 2022, as well as increased recharge due to above-normal climate conditions.

All wells remained above the MO in spring 2024. Ant-1U fell below the MO by 1 foot in fall 2024. All measured groundwater elevations remained above the corresponding MT of that RMS well, avoiding undesirable results related to groundwater level as defined in the GSP. On average, groundwater levels in RMS wells were roughly 31 ft higher than MT elevations in spring 2024 and 14 ft higher than MT elevations in fall 2024. All measured groundwater levels remained within the Subbasin's margin of operational flexibility and above the MTs.

3 WATER SUPPLY AND USE

As required by §356.2, this section summarizes water supply and use in the Subbasin, categorized by groundwater extraction volumes, surface water supply, and total supply. The total water available for use in the Subbasin was tabulated from groundwater extraction volumes reported in **Table 3-1** and the surface water supply reported in **Table 3-2**. The total water available is summarized in **Table 3-3** for WY 2024. Groundwater extraction volumes are either based on measured data or are estimates from a water use

analysis based on 2024 land use data and climate conditions. Water use data for the subbasin is in **Appendix D**. The water use analysis methodology is discussed in **Appendix E**. Surface water use was estimated using historic deliveries when records were not available.

Table 3-1. Antelope Subbasin Groundwater Use by Water Use Sector	
Sector	WY 2024 (AF)
Agricultural	17,700
Municipal	300
Rural Residential	1,400
Total	19,400

3.1 Groundwater Extraction – §356.2(b)(2)

Groundwater extraction in the Subbasin is summarized in **Table 3-1**. Groundwater extraction is reported from pumping records where available, and the remaining groundwater extraction is estimated through the water use analysis approach described in the previous section and in **Appendix E**.

The majority of the Subbasin relies on groundwater supplies for agricultural irrigation. In years characterized by drought and low precipitation, reduced surface water supplies lead to increased extraction and reduced recharge, causing a decline in groundwater storage. Contrastingly, in wet years, such as WY 2023 and above normal years such as WY 2024, climate conditions help to increase and bolster groundwater storage.

Municipal water users extracted approximately 300 AF in the Subbasin in WY 2024. Municipal water supplies are measured and provided by the City of Red Bluff and Los Molinos Mutual Water Company. Fourteen percent of the City of Red Bluff lies within the Subbasin; the remainder is in the neighboring Red Bluff Subbasin; water use data was allocated between the Subbasin based on spatial distribution. The record of municipal supplies does not distinguish between urban and industrial water uses.

Rural residential water users rely on private domestic wells to meet their household water needs. Rural residential groundwater extraction was quantified based on average per capita water use and estimated population. The average per capita water use reported in the City of Red Bluff's 2020 Urban Water Management Plan (UWMP) 2020 water use (City of Red Bluff, 2020) is considered to be representative of the area. Water use in 2020 was 253 gallons per capita per day. Population estimates were based on average household sizes from the US census and aggregated to those living outside city water district boundaries. Population estimates from the 2020 Census were used to estimate residential groundwater pumping.

The total estimated groundwater extraction was approximately 19,400 AF in WY 2024, the majority of which was used to meet agricultural water demands (approximately 17,700 AF). The total groundwater extraction is about 3,600 AF more than the historical groundwater pumping average (15,800 AFY; **Table 4-1**) and higher than 12,500 AF, which was the average annual extraction of the last four above-normal WYs on record (1993, 2000, 2003, and 2005). The increase in groundwater extraction in WY

2024 (19,400 AFY) compared to WY 2023 (18,000 AFY) is attributed to decreased precipitation in WY 2024, where decreased precipitation was unable to meet evapotranspiration demands. **Figure 3-1** shows the general areas where groundwater is applied in the Subbasin. About 91% of the total groundwater extraction was used by the agricultural sector, while the remaining 9% was used for municipal and rural residential water needs.

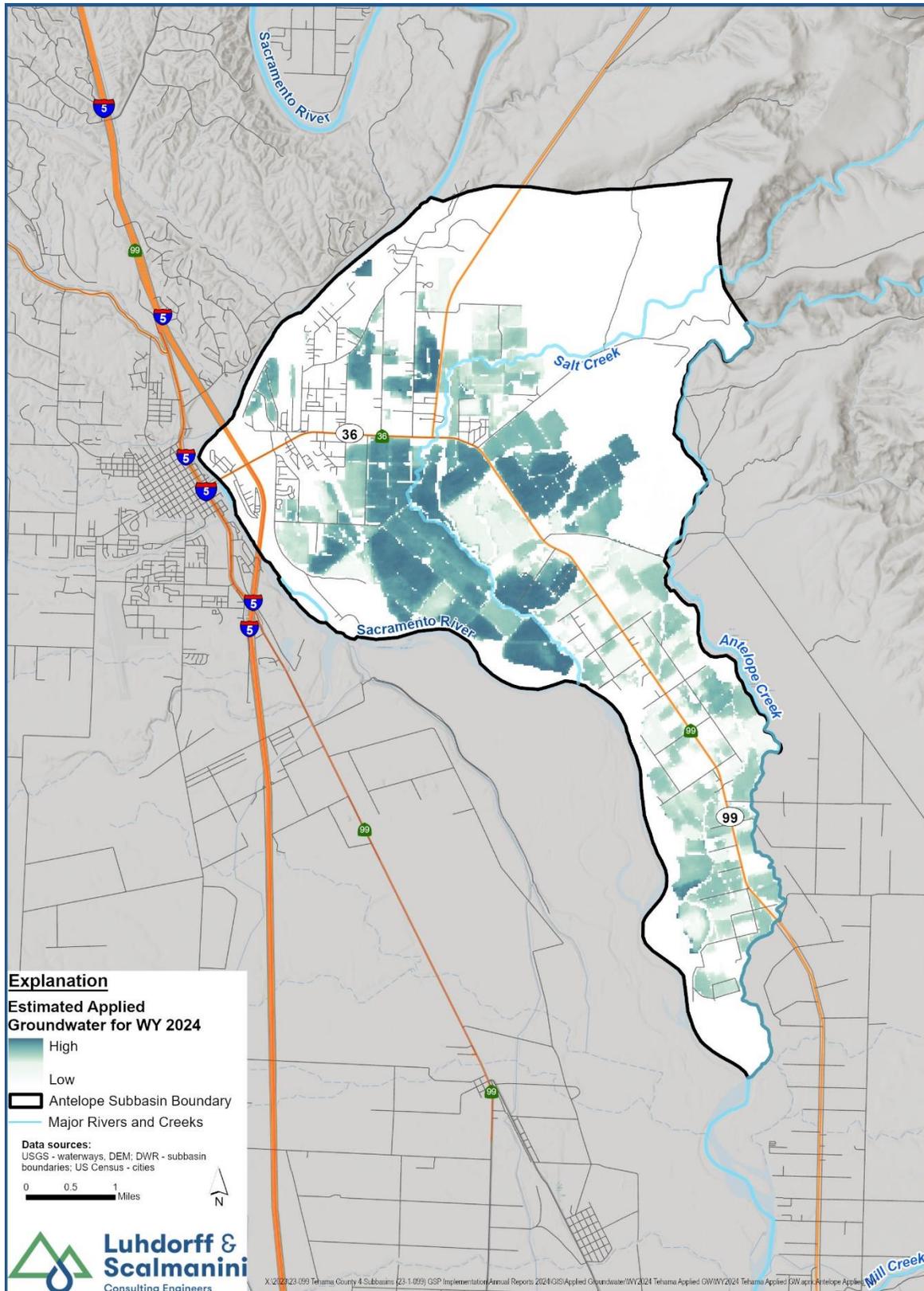


Figure 3-1. Antelope Subbasin Estimated Applied Groundwater – WY 2024

3.2 Surface Water Supply – §356.2(b)(3)

Surface water supplies used or available for use in the Subbasin are summarized in **Table 3-2**. Surface water supplies are reported directly from water supplier records or collected from publicly available sources (water rights diversion records, etc.) where available. Missing surface water supply data were estimated based on available historical diversions data in similar water years.

Surface water provided about 33% of the agricultural water demand in the Subbasin for WY 2024. Diversions from surface water features such as Antelope Creek were accessed from the State Water Resource Control Board’s (SWRCB) Electronic Water Rights Information Management System (eWRIMS; SWRCB, 2023a). Data from eWRIMS on surface water delivery indicated which water rights holders in the Subbasin had made diversions during WY 2024. There are currently no surface water supplies for municipal use in the Antelope Subbasin. Total surface water diversions and deliveries for the Antelope Subbasin are estimated to be about 10,300 AF and 8,700 AF, respectively.

WY 2024 was an above normal WY, indicating less overall precipitation than the wet hydrologic conditions in WY 2023. Despite these conditions in WY 2024, surface water use decreased slightly from WY 2023.

Sector	Diverted (AF)	Applied (AF)
Agricultural	10,300	8,700
Total	10,300	8,700

3.3 Total Water Use by Sector – §356.2(b)(4)

Total water demand in the subbasin for WY 2024 was divided between surface water (31%) and groundwater (69%). The total water available for use in the Subbasin was tabulated from groundwater extraction volumes reported in **Table 3-1** and the surface water supply reported in **Table 3-2**. The total water available is summarized in **Table 3-3** for WY 2024. The results are either based on measured data or estimates, as described in the previous two sections.

Sector	WY 2024 (AF)			Total Irrigated Area (acres)
	Groundwater	Surface Water	Total	
Agricultural	17,700	8,700	26,400	8,100
Municipal	300	0	300	0
Rural Residential	1,400	0	1,400	0
Total	19,400	8,700	28,100	8,100

3.4 Uncertainties in Water Use Estimates

Estimated uncertainties in the water budget components are presented in **Table 3-4**. The uncertainty of these water budget components is based on typical accuracies given in technical literature and the cumulative estimated accuracy of all inputs used to calculate the components.

Table 3-4. Antelope Subbasin Estimated Uncertainty in Water Use Estimates			
Water Budget Component	Data Source	Estimated Uncertainty (%)	Source
Groundwater Water			
Agricultural	Measurement	20%	Typical uncertainty from water balance calculation.
Municipal/Industrial	Measurement /Estimate	5%	Typical accuracy of municipal water system reporting.
Rural Residential	Calculation	15%	Estimated from per capita water use and Census information.
Surface Water			
Agricultural	Calculation	10% ¹	Estimated from Senate Bill 88 measurement accuracy standards.

¹ Higher uncertainty of 10-20% is typical for estimated surface water inflows, including un-gaged inflows from small watersheds into creeks that enter the Basin.

4 GROUNDWATER STORAGE

Long-term fluctuations in groundwater levels and groundwater in storage occur when there is an imbalance between the volume of water recharged into the aquifer and the volume of water removed from the aquifer, either by extraction or natural discharge to surface water bodies. If, over a period of years, the amount of water recharged to the aquifer exceeds the amount of water removed from the aquifer, then groundwater levels will increase and groundwater storage increases (i.e., positive change in storage). Conversely, if, over time, the amount of water removed from the aquifer exceeds the amount of water recharged, then groundwater levels decline, and groundwater storage decreases. These long-term changes can be linked to various factors, including increased or decreased groundwater extraction or variations in recharge associated with wet or dry hydrologic cycles.

A review of the RMS well hydrographs (**Appendix A**) indicates that groundwater elevations are either relatively stable or showing a declining trend over time. Declines may be influenced by the significant percentage of water years since 2006 that have been dry (i.e., characterized as below normal, dry, or critical). Since groundwater storage is closely related to groundwater levels, measured changes in groundwater levels can serve as a proxy for and be utilized to estimate changes in groundwater storage. Changes in groundwater storage in the Subbasin follow a pattern typically seen in the majority of the Sacramento Valley. During normal to wet years, groundwater is withdrawn during the summer for irrigation and replenished during the winter through recharge of precipitation and surface water inflows, allowing groundwater storage to potentially rebound by the following spring. During dry years and

drought conditions, this pattern is disrupted when more groundwater may be pumped to meet irrigation demand, and less recharge may occur due to reduced precipitation, diminished or curtailed surface water supplies, and lower stream levels.

In WY 2024, an above normal WY, cumulative (Upper and Lower Aquifer) groundwater storage increased by approximately 5,100 AF. Increased groundwater extraction in WY 2024 relative to WY 2023 contributed to less positive groundwater storage compared to WY 2023. Despite these and related factors, such as decreased stream flows, resulted in higher groundwater levels in spring 2024 compared to spring 2023.

The following sections present a summary of groundwater use and change in storage over time, along with a description of the uncertainty in storage change estimates.

4.1 Change in Groundwater Storage – §356.2(b)(5)(B)

Annual groundwater pumping, groundwater storage changes, and the cumulative change in storage over time are presented for WY 1990 through WY 2024 in **Table 4-1** and **Figure 4-1**. In contrast to WY 2023, WY 2024 was an above-normal WY and saw a marked increase in groundwater storage, totaling approximately 5,100 AF in the Upper and Lower Aquifer. For context, in the past 34 years, the largest decrease in groundwater storage is estimated to be -15,000 AF, and the highest increase was estimated to be 12,000 AF.

The Tehama Integrated Hydrogeologic Model (TIHM) was used to estimate groundwater pumping, groundwater uptake, change in storage, and cumulative change in storage for WY 1990 through WY 2019 (Tehama County GSA, 2021).

It should be noted that the groundwater model was not used to estimate storage changes for WY 2020 through WY 2024. Therefore, future updates to the model may result in different estimates for WY 2020 through WY 2024 groundwater storage changes. The approach of using measured groundwater elevation changes to estimate storage changes is considered reasonable and cost-effective for the purposes of the annual report. **Table 4-1** includes estimates of annual groundwater pumping, annual storage change, and cumulative storage change for WYs 1990-2024. Estimates of annual groundwater pumping for WYs 2022-2024 are described in **Section 3**, and **Appendix E**. Change in annual storage and cumulative change in storage for WYs 2021-through WY 2024 was estimated based on the methods described in **Section 4.2**. Groundwater extraction methods for the entire period, including pumping for agricultural, municipal, and rural residential purposes.

The annual and cumulative changes in groundwater storage are both calculated for the period from WY 2020 through WY 2024 based on the methodology described in **Section 4.2**. This methodology differs from the methodology reported in the GSP; however, it is anticipated that the methodology described in **Section 4.2** will be utilized for future annual reports.

Table 4-1. Antelope Subbasin Annual Groundwater Extraction and Change in Storage			
Water Year (Hydrologic Year Type)	Groundwater Extraction¹ (AF)	Annual Change in Storage (AF)	Cumulative Change in Storage (AF)
1990 (C)	15,000	-7,200	-7,200
1991 (C)	14,620	-5,900	-13,000
1992 (C)	15,550	-4,100	-17,000
1993 (AN)	11,870	8,000	-9,200
1994 (C)	14,620	-4,800	-14,000
1995 (W)	12,900	12,000	-2,000
1996 (W)	13,900	2,600	600
1997 (W)	14,100	-600	0
1998 (W)	11,600	11,000	11,000
1999 (W)	14,600	-4,000	7,000
2000 (AN)	12,800	-880	6,100
2001 (D)	14,800	-7,500	-1,400
2002 (D)	15,300	-3,700	-5,100
2003 (AN)	13,800	3,700	-1,400
2004 (BN)	16,200	81	-1,300
2005 (AN)	11,600	780	-520
2006 (W)	13,200	7,600	7,100
2007 (D)	14,600	-9,100	-2,000
2008 (C)	17,920	-8,100	-10,000
2009 (D)	14,670	-3,700	-14,000
2010 (BN)	11,700	2,600	-11,000
2011 (W)	10,880	6,800	-4,400
2012 (BN)	14,740	-7,100	-12,000
2013 (D)	16,680	-2,000	-14,000
2014 (C)	17,560	-7,300	-21,000
2015 (C) ²	21,490	-4,800	-26,000
2016 (BN)	15,570	4,400	-21,000
2017 (W)	16,200	9,600	-12,000
2018 (BN)	18,600	-6,300	-18,000
2019 (W)	13,920	7,700	-10,000
2020 (D)	21,590	-8,000	-18,000

Table 4-1. Antelope Subbasin Annual Groundwater Extraction and Change in Storage			
Water Year (Hydrologic Year Type)	Groundwater Extraction¹ (AF)	Annual Change in Storage (AF)	Cumulative Change in Storage (AF)
2021 (C) ²	27,460	-15,000	-33,000
2022 (C) ²	26,300	-5,000	-38,000
2023 (W)	18,000	8,000	-30,000
2024 (AN)	19,400	5,100	-24,900
Historic Averages (1990-2023)³			
1990-2023 (34 years)	15,800	-900	
W (10 years)	13,900	6,000	
AN (4 years)	12,500	2,900	
BN (5 years)	15,400	-1,300	
D (6 years)	16,300	-5,700	
C (9 years)	18,900	-6,900	

Notes:

Positive values indicate inflows to the groundwater system, and negative values indicate outflows from the groundwater system.

AF = Acre-feet

Water Year Types Classified According to the Sacramento Valley Water Year Index: AN = Above Normal, BN = Below Normal, C = Critical; D = Dry, W = Wet

¹ Groundwater extraction and storage for WY 1990 through WY 2019 are from the Tehama Integrated Hydrologic Model (TIHM), groundwater extraction values for WY 2020 through WY 2024 are described in **Section 3** and **Appendix E**. Annual change in storage values for WY 2020 through WY 2024 were estimated using the method described in **Section 4**.

² Indicated cutback year with reduced surface water supply availability.

³ The historical average calculation covers the period from 1990 to 2023, excluding the current water year.

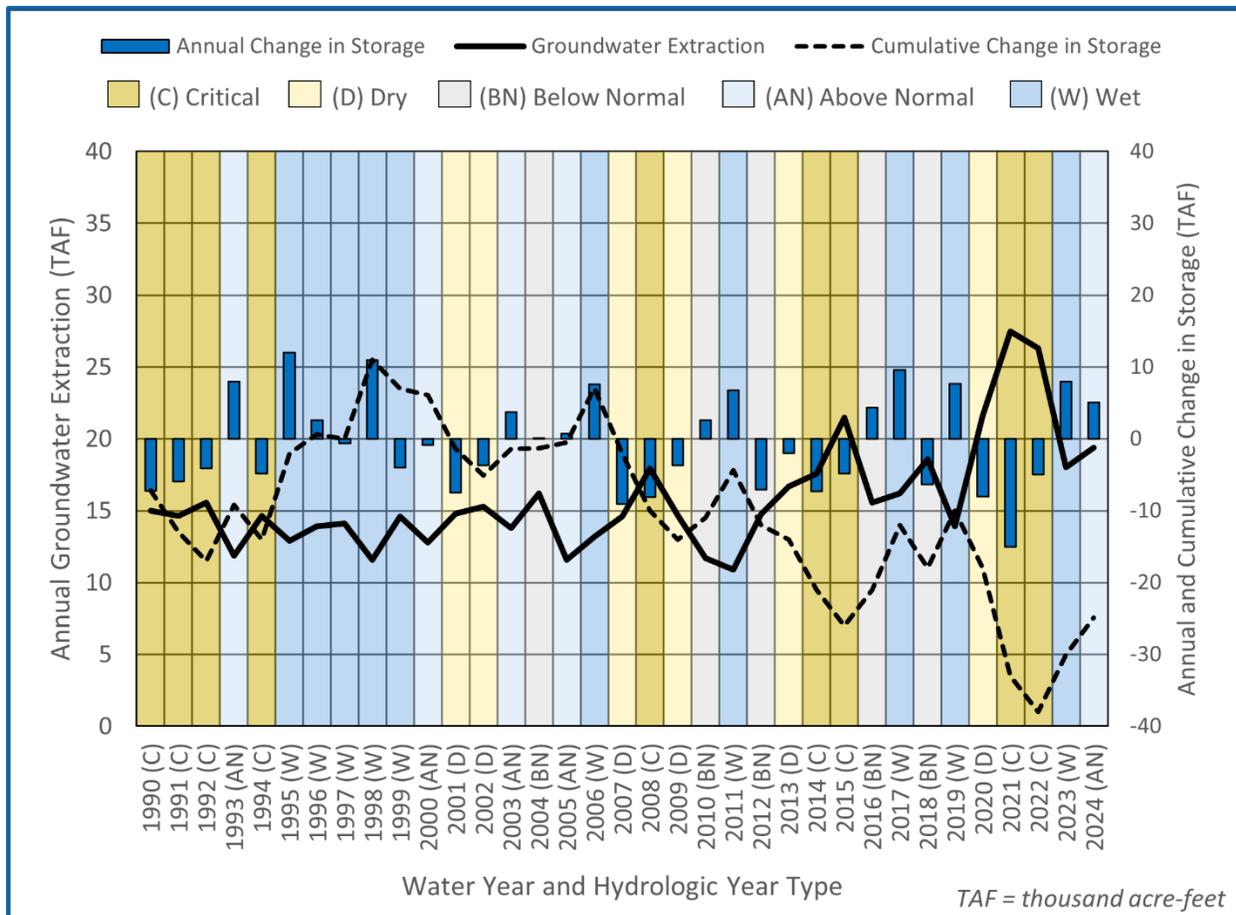


Figure 4-1. Antelope Subbasin Groundwater Extraction and Change in Groundwater Storage from WY 1990 to WY 2024

4.2 Groundwater Storage Maps – §356.2(b)(5)(A)

The spatial distribution of estimated changes in groundwater storage in the Upper Aquifer for the period from spring 2023 to spring 2024 are shown in **Figure 4-2**. Since groundwater storage is closely related to groundwater levels, measured changes in groundwater levels can serve as a proxy for and be utilized to estimate changes in groundwater storage.

Groundwater level data obtained from the DWR Water Data Library (DWR, 2025) were generally recorded on a monthly to quarterly basis. For Water Year 2023–2024, a raster surface representing seasonal high groundwater level changes was generated by spatially interpolating (kriging) data from selected wells across the subbasin. These seasonal high changes were calculated by subtracting groundwater levels recorded in the spring of 2023 from those recorded in the spring of 2024.

The selected wells represent sites with groundwater level records that are considered representative of subbasin conditions. In areas—mostly near the subbasin boundaries—where polygon-specific groundwater data were unavailable, interpolated raster pixel values from the selected wells were used for groundwater storage change calculations. In cases where multiple groundwater level records existed within a single

polygon, an average groundwater level was assigned to that polygon. Groundwater storage change was then calculated by multiplying the change in seasonal high groundwater level (2024 minus 2023) by the specific yield (Sy) value assigned to each polygon, and by the polygon area (in acres), resulting in groundwater storage changes from 2023 to 2024 expressed in acre-feet. It should be noted that the groundwater model as described in the GSP was not used to estimate storage changes for WY 2021 through WY 2024. The approach of using measured groundwater elevation changes to estimate storage changes is considered reasonable and cost-effective for the purposes of the annual report.

Sufficient groundwater level data were not available to interpolate water level changes in the Lower Aquifer. Therefore, Lower Aquifer storage change was estimated using the Upper Aquifer storage change and the historical ratio of storage changes in the two aquifers for critical years. The summation of the changes in the Upper and Lower Aquifers provides the total groundwater storage change in the Subbasin.

Negative changes in storage values indicate lowering groundwater levels and depletion of groundwater storage, whereas positive changes in storage values represent rising groundwater levels and accretion of groundwater in storage. As shown in **Figure 4-2**, the change in storage within the Upper Aquifer from spring 2023 to spring 2024 was between 10 and 300 AF per polygon. The northeast portion of the Subbasin experienced a larger positive change in storage, while the surrounding portions of the subbasin experienced a lower positive change in storage. Total groundwater storage change in the Upper Aquifer was estimated to be approximately 800 AF between spring 2023 and spring 2024. As shown in **Figure 4-3**, due to the lack of a sufficient number of monitoring wells in the lower aquifer, polygon boundaries could not be established. total groundwater storage change in the Lower Aquifer was estimated to be approximately 4,300 AF between spring 2023 and spring 2024.

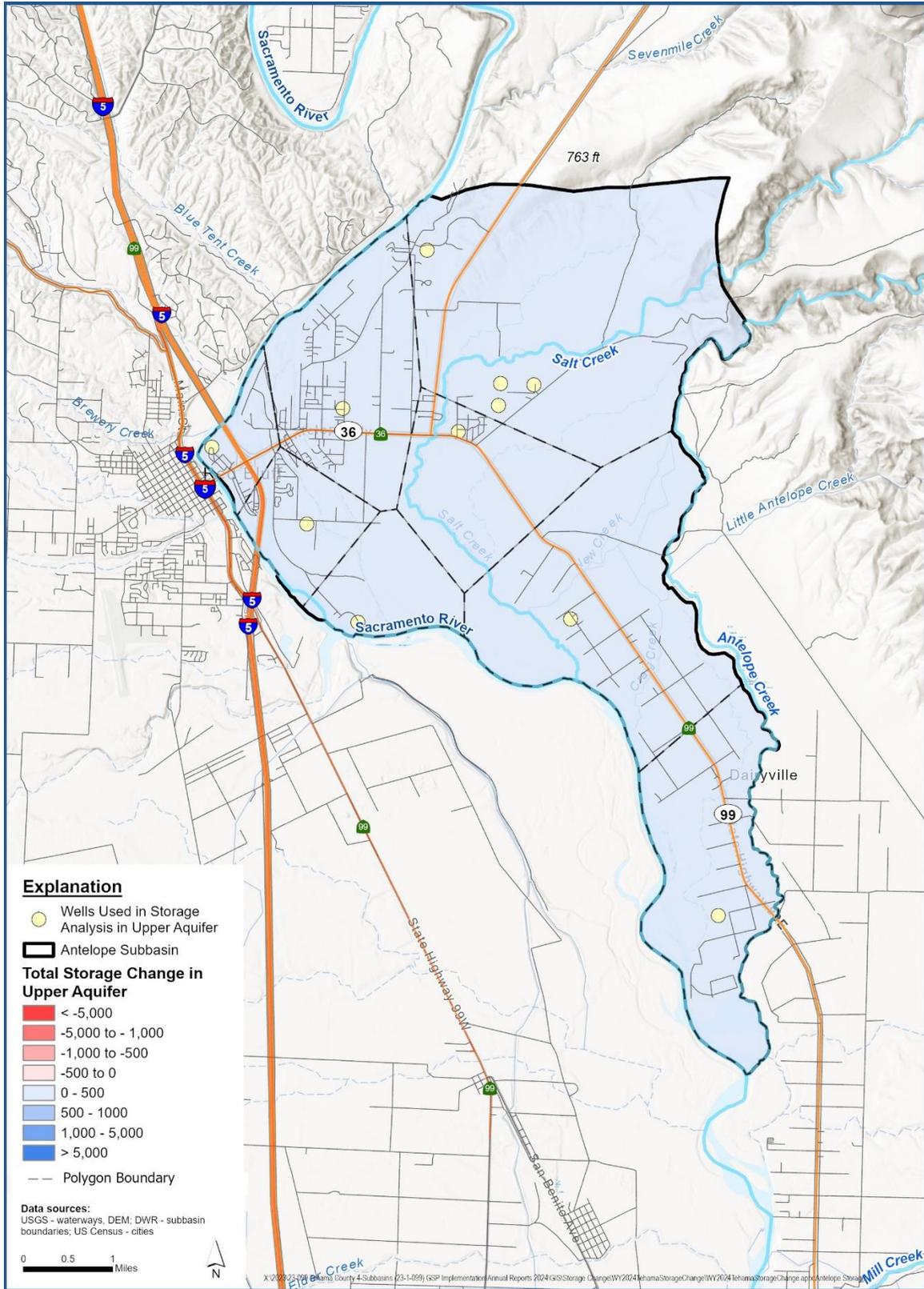


Figure 4-2. Antelope Subbasin Change in Groundwater Storage from Spring 2023 to Spring 2024 in the Upper Aquifer

**Figure 4-3. Antelope Subbasin Change in Groundwater Storage
from Spring 2023 to Spring 2024 in the Lower Aquifer**

4.3 Uncertainty in Groundwater Storage Estimates

The uncertainty associated with the change in groundwater storage estimates depends in part on the underlying uncertainty of the groundwater level data, the representative area, and the calibrated storage coefficient parameter used to calculate the change in groundwater storage. As described in **Section 4.2**, the calibrated storage coefficient (0.0115 - 0.062) from the TIHM was used to calculate the change in storage for this WY. Based on a comparison of storage change estimates from the TIHM for similar water year types, the calculated storage change is reasonable. Thus, the uncertainty of the estimated change in groundwater storage is typically 20-30% for integrated hydrologic models. Therefore, the approach described in **Section 4.2** is considered to have similar uncertainty.

5 GSP IMPLEMENTATION PROGRESS – §356.2(B)(5)(C)

5.1 Main Activities of Water Year 2024

The main activities and updates since the previous annual report are as follows:

- The Tehama County GSA completed the WY 2023 Annual Report and other compliance tasks.
- The GSAs received from DWR “incomplete” determination letters in October 2023; re-submitted GSP in April 2024; 2 major commitments to develop GDM and WM programs.
- The Tehama County GSA coordinated a proposal seeking funding through DWR’s SGM Grant Program. Coordination efforts included planning and refinement of PMAs, evaluating and ranking PMAs, and preparing and submitting the grant application. The grant application was submitted in December 2022, and DWR released a final award list in September 2023; results are summarized below in **Table 5-4**.
- All sustainability indicators (SIs) are above their MTs (see summary **Table 5-1**).
- Progress has been made on 2 PMAs since the last annual report (**Tables 5-4 and 5-5**).

Several other actions continue in the Subbasin to fulfill the requirements of the GSP. These include:

- Monitoring and recording groundwater levels and groundwater quality.
- Maintaining and updating the data management system (DMS) with newly collected data.
- Annual reporting of Subbasin conditions and submission to DWR as required by SGMA.
- Ongoing intra- and inter-basin coordination.

DWR proposed two recommended corrective actions that will enhance the GSP (below). The GSAs have revised the GSP to address these corrective actions. The revised GSP was submitted in April 2024.

1. Providing more detailed explanation and justification regarding the selection of the sustainable management criteria for groundwater levels, particularly undesirable results and minimum

thresholds, and quantitatively describe the effects of those criteria on the interests of beneficial uses and users of groundwater.

2. The GSA must provide more detailed explanation and justification regarding the selection of sustainable management criteria for degraded groundwater quality, particularly the selection and exclusion of constituents of concern for monitoring and sustainable management.

5.2 Progress Toward Achieving Interim Milestones

All SIs are in compliance with their MTs (see summary **Table 5-1**). An MT is the quantitative value that represents the groundwater conditions at an RMS site that, when exceeded individually or in combination with MTs at other monitoring sites, may cause a UR in the subbasin per DWR's definition. Whether the MT represents a minimum or maximum value is dependent on the SI. As an example of a minimum value, if groundwater levels are lower than the value of the MO for that site, they are moving in the direction of the MT. As an example of a maximum for the groundwater quality SMC, as the value of total dissolved solids (TDS) concentrations increase from the MO established for that site, it is moving in the direction of the MT. Seawater Intrusion is not an applicable SI.

Groundwater elevations remained above the MOs in spring 2024; one well fell below their MO in fall 2024. No wells fell below their MTs in WY 2024 and avoided URs since less than 20% of wells fell below their MTs for two consecutive years, hence avoiding URs as defined in the GSP.

Overall, groundwater conditions in the Subbasin are on track to meet the first 5-year 2027 interim milestones for groundwater levels at each of the RMS wells. Groundwater elevations are all above the MTs throughout the Subbasin, with elevations mostly near those observed in recent years (**Appendix A**). This positive trend in recent years is attributed to the ongoing recovery in groundwater conditions facilitated by increased precipitation to meet evapotranspiration demands in WY 2024. Spring 2024 groundwater elevations were above the MOs, although the fall 2024 groundwater elevation in one well was below the MOs (**Table 5-2**).

Table 5-1. Antelope Subbasin Sustainability Indicator Summary			
2024 Status	Undesirable Result Identification	MO Definition	MT Definition
Chronic Lowering of Groundwater Levels			
<p>No indication of undesirable results There were no RMS with spring or fall 2024 groundwater level measurements below the MT.</p>	<p>10 supply wells become dry (after the GSP revision) within a tessellation hexagon or when water levels at any RMP in the future decline 7.5 ft or more over a five (5) year period.</p>	<p>Upper & Lower Aquifer: Spring 2015 groundwater elevation minus five ft (for wells with increasing or no groundwater trends) or projected spring 2042 groundwater elevation minus five ft for wells with declining groundwater elevations.</p>	<p>Focus Areas: 2020-2022 groundwater lows Outside Focus Areas: 2020-2022 lows minus 20 ft</p>
Reduction of Groundwater Storage			
<p>No indication of undesirable results There were no RMS with spring or fall 2024 groundwater level measurements below the MT.</p>	<p>25% of groundwater elevations measured at same RMS wells exceed the associated MT for two consecutive fall measurements.</p>	<p>Upper & Lower Aquifer: Amount of groundwater storage when groundwater elevations are at their MO.</p>	<p>Upper & Lower Aquifer: Amount of groundwater in storage when groundwater elevations are at their MT.</p>
Degraded Water Quality			
<p>No indication of undesirable results There were no RMS with TDS levels above their MTs. There were two wells with Nitrate as N concentrations above their MO, but not above their MT.</p>	<p>TDS: At least 25% of RMS exceed the MT for water quality for 2 consecutive years at each RMS well Or Nitrate: one RMS exceeds the MT for water quality once. With the stipulation for both TDS and nitrate as N that GSP implementation is the cause of the exceedance.</p>	<p>Upper & Lower Aquifer: California lower limit secondary MCL concentration for TDS of 500 mg/L measured at RMS wells. Nitrate: concentration of 5 mg/L nitrate as N at all RMS wells.</p>	<p>Upper & Lower Aquifer: TDS concentration of 750 mg/L at all RMS wells. Nitrate: concentration of 10 mg/L nitrate as N at all RMS wells.</p>

Table 5-1. Antelope Subbasin Sustainability Indicator Summary			
2024 Status	Undesirable Result Identification	MO Definition	MT Definition
Land Subsidence			
No indication of undesirable results No InSAR pixel exceeded MT in WY 2024.	50% of RMS exceed the MT over a 5-year period that is irreversible and is caused by lowering groundwater elevations.	One foot over 20 years (Zero inelastic subsidence, in addition to any measurement error). If InSAR data are used, the measurement error is 0.1 ft, and any measurement 0.1 ft or less would not be considered inelastic subsidence.	Two feet over 20 years (i.e., no more than 0.5 ft of cumulative subsidence over a five-year period (beyond the measurement error), solely due to lowering of groundwater elevations.
Depletion of Interconnected Surface Water			
No indication of undesirable results There were no RMS with spring or fall 2024 groundwater level measurements below the MT.	25% of groundwater elevations measured at RMS wells drop below the associated threshold during two consecutive fall measurements.	Same as the chronic lowering of groundwater levels.	Same as the chronic lowering of groundwater levels.

Notes:

TDS is the primary water quality constituent of concern.

MO = Measurable Objective; MT = Minimum Threshold; RMS = representative monitoring site; mg/L = milligrams per liter

5.2.1 Chronic Lowering of Groundwater Levels and Reduction in Groundwater Storage SMC

The reduction in groundwater storage SMC utilizes the chronic lowering of groundwater levels SMC as a proxy (**Table 5-1**). Thus, groundwater conditions related to storage and chronic lowering of groundwater levels are discussed together. Groundwater conditions in the Subbasin are on track to meet the first 5-year 2027 interim milestones for groundwater levels at each of the RMS wells. In WY 2024, all groundwater elevations were above the established MTs (as indicated in **Table 5-2**). **Table 5-2** shows measurements from WY 2024 for spring seasonal highs and fall seasonal lows, along with MOs and MTs. It also compares the WY 2024 measurements to those from WY 2023 and to the MOs. Higher water levels were observed in spring 2024 compared to spring 2023 due to above normal conditions, which has helped to increase recharge and offset extraction, bolstering groundwater storage in the Subbasin.

Table 5-2. Antelope Subbasin Measurable Objectives, Minimum Thresholds, and Seasonal Groundwater Elevations of Representative Monitoring Site Wells								
Representative Monitoring Site (RMS) ID	Groundwater Elevation (feet above mean sea level)				Spring 2024 vs. MO	Fall 2024 vs. MO	Spring 2024 vs. Spring 2023 (seasonal high)	Fall 2024 vs. Fall 2023 (seasonal low)
	2024 Measurements		MO	MT				
	Spring (seasonal high)	Fall (seasonal low)						
Upper Aquifer								
Ant-1U	243.3	228.83	231.10	214.00	12.2	-2.27	1.17	-0.1
Ant-2U	--	231.43	231.20	214.00	--	0.23	--	2.8
Ant-3U	--	--	231.10	210.00	--	--	--	--
Ant-4U	--	--	NA	NA	--	--	--	--
Lower Aquifer								
Ant-5L	243.67	219.48	NA	NA	--	--	1.94	-6.69

MO = Measurable Objective, MT = Minimum Threshold, -- = Indicates Missing or Questionable Measurement, NA = Indicates non-determined MO, MT due to insufficient history

5.2.2 Degraded Water Quality SMC

The degraded water quality MT and MO are summarized in **Table 5-1**. TDS and nitrate as N are the main constituents of concern in the Subbasin. For WY 2024, one (Ant-2U) of the five RMS wells were not available for monitoring, but no alternate was identified for sampling. TDS is measured at RMS wells throughout the Subbasin, and data was collected by the Tehama County GSA in 2024. TDS results ranged from 210 mg/L to 380 mg/L. Nitrate as N concentrations ranged from ND to 9.6 mg/L. None of the wells exceeded MO or MT for TDS in 2024; however, two of the four wells sampled for Nitrate as N exceeded

their MOs in 2024. A summary of groundwater quality monitoring data is available in **Appendix F**. Groundwater conditions are on track to avoid results related to water quality.

5.2.3 Land Subsidence SMC

The land subsidence MT and MO are summarized in **Table 5-1**. Interferometric Synthetic Aperture Radar (InSAR) data provided by DWR (DWR, 2024) was analyzed from October 2023 to October 2024 to track annual changes and from October 2019 to October 2024 to track net changes 5-year net changes. A positive change corresponds to a higher land surface elevation, and a negative change corresponds to a lower land surface elevation relative to a reference elevation. In this subbasin, the MT is reached if subsidence rates exceed 0.5 ft beyond the measurement error over a 5-year period. Subsidence measured by InSAR in WY 2024 (**Figure 5-1**) ranged from -0.015 feet of subsidence to 0.012 feet of uplift. Subsidence measured by InSAR for WY 2019 to WY 2024 (**Figure 5-2**) ranged from -0.211 ft of subsidence to 0.06 ft of uplift. Groundwater conditions in the Subbasin are on track to meet the first 5-year 2027 IMs and avoid URs for land subsidence. Conditions indicate that there has not been any inelastic land subsidence during the reporting periods.

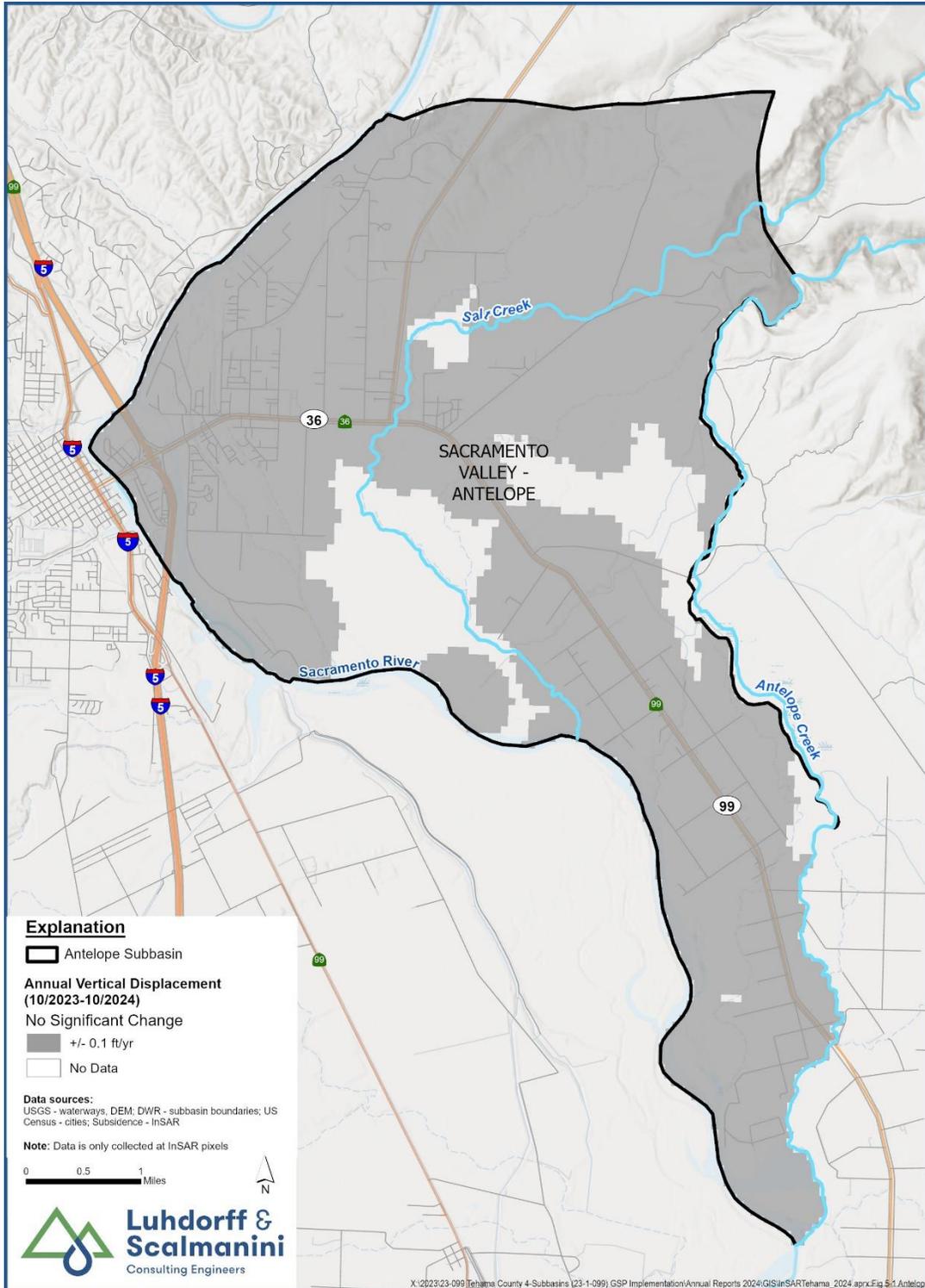


Figure 5-1. Antelope Subbasin Change in Subsidence from 10/2023 to 10/2024

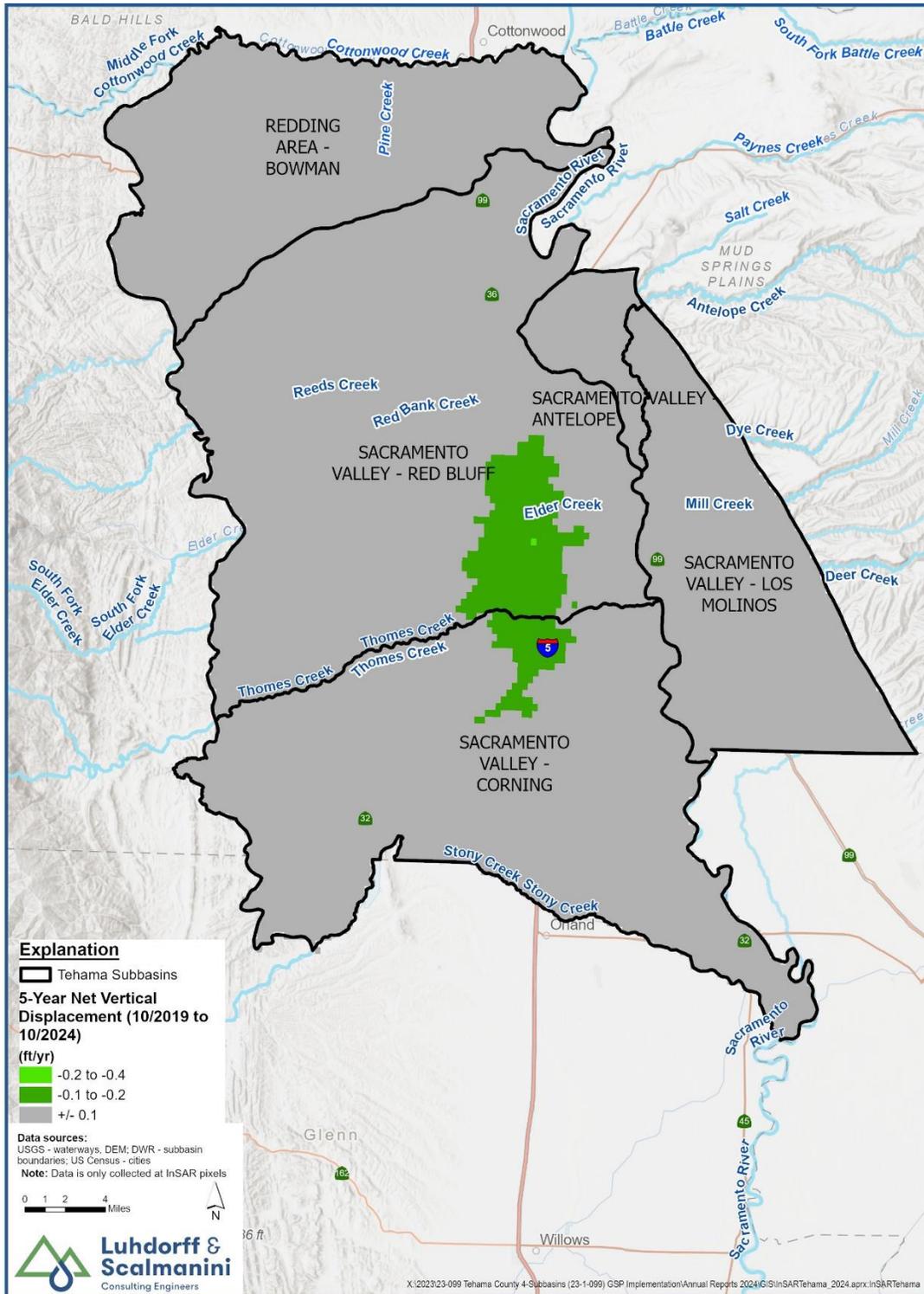


Figure 5-2. Antelope Subbasin Change in Subsidence from 10/2019 to 10/2024

5.2.4 Depletion of Interconnected Surface Water SMC

The depletion of interconnected surface water (ISW) SMC utilizes the chronic lowering of groundwater levels SMC as a proxy (Table 5-1). A subset of groundwater levels SMC RMS is used for this SMC (Table 5-3), and all groundwater elevations were above the established MTs. Groundwater conditions in the Subbasin are on track to meet the first 5-year 2027 IMs and to avoid URs for groundwater levels at each RMS.

Table 5-3. Antelope Subbasin Measurable Objectives, Minimum Thresholds, Undesirable Results for Depletion of Interconnected Surface Water						
State Well Number /Representative Monitoring Site (RMS) ID	Groundwater Elevation (feet above mean sea level)				Spring 2024 vs. MO	Fall 2024 vs. MO
	2024 Measurements		MO	MT		
	Spring (Seasonal High)	Fall (Seasonal Low)				
Ant-1U	243.3	228.83	231.10	214.00	12.2	-2.27
Ant-2U	--	231.43	231.20	214.00	--	0.23
Ant-3U	--	--	231.10	210.00	--	--
Ant-4U	--	--	NA	NA	--	--

MO = Measurable Objective, MT = Minimum Threshold, -- = Indicates Missing or Questionable Measurement, NA = Indicates non-determined MO, MT due to insufficient history

5.3 Progress Toward PMA Implementation

The following sections summarize the Tehama County GSA’s progress towards implementing PMAs that were developed to manage groundwater conditions in the Subbasin and achieve the groundwater sustainability objectives described in the GSP. Projects as outlined in the GSP are provided below and summarized in Table 5-4. Updates on the status of management actions are described below and summarized below in Section 5-4 and Table 5-5.

Groundwater users in the Subbasin benefit from generally stable groundwater levels in the Subbasin. Surface water supplies available to diverters in the Subbasin are used, when available, for irrigation and for the benefit of other recharge efforts and projects described in the GSP. Ongoing access to surface water supplies is crucial to preserving the sustainability of the Subbasin.

Table 5-4. Antelope Subbasin Summary of Project Implementation Status			
GSP Section Reference	Project Name	Current Status	Notable Progress Since Last Annual Report
4.2.1	Ongoing Monitoring, Data Gaps, and Enhancements	In Progress	Advancements have been made in multi-completion monitoring wells, ISW site identification, domestic monitoring, synoptic gaging, and Groundwater Dependent Ecosystems (GDE) surveys.

Table 5-5. Antelope Subbasin Summary of Management Actions			
GSP Section Reference	Management Action	Current Status	Notable Progress Since Last Annual Report
4.5.2.6	Well Management Program	In Progress	Program is in its third year; well inventory is in progress.

5.4 GSP Project Implementation Progress

5.4.1 Ongoing Monitoring, Data Gaps, and Enhancements (GSP Section 4.2.1)

Monitoring, data gaps, and enhancements have been advanced since the 2023 annual report. Advancements have included:

- Sites for five (5) new multi-completion monitoring wells were identified, and construction began with anticipated completion in early 2025.
- Five (5) new potential interconnected surface water (ISW) monitoring well locations have been identified. Construction specifications for nested wells at these locations have been drafted and construction is anticipated to begin in Spring 2025.
- Public outreach for participation in a community led domestic well monitoring program has been conducted. This outreach was intended to collect contact information for parties interested in having telemetered acoustic sounders installed on their domestic wells. Contact information for these interested parties for community domestic monitoring has been collected, and the monitoring equipment has been selected and tested. Selection of the participants and installation of the equipment is anticipated to occur in early 2025.
- A draft work plan for synoptic stream gaging has been developed, and initial stream measurements have been collected. Additional stream gaging measurements will be collected in 2025 during both high and low flow conditions.
- Initial GDE field surveys have been conducted at one (1) site. Access is being pursued for an additional site to be surveyed in 2025. Additional analyses to identify GDE are anticipated to be added to the surveys in 2025 including isotope sampling of plant water and high-resolution aerial imagery mapping.

- Development of an isotopic sampling plan for the expansion of water quality data and to assess the vertical connectivity of the aquifer material in the Subbasin began in 2024. Implementation of this plan is anticipated after the new multi-completion wells have been installed in early 2025.

5.5 GSP Management Action Implementation Progress

Below are management action updates and their progress in implementation since the last annual report.

5.5.1 Well Management Program (GSP Section 4.5.2.6)

Tehama County GSA is in its third year of administering a well registration program that provides information about the location, number, and construction of wells. It will also eventually provide a source of funding for GSP implementation and a future well mitigation program.

6 CONCLUSIONS

The Tehama County GSA adopted and submitted the GSP to DWR in January 2022, with a revised GSP submitted in April 2024. Following the analysis of historical and current hydrogeological conditions presented in the GSP, the Tehama County GSA has been actively working on sustainable groundwater management in the Subbasin. As presented in **Section 5** of this report, recent progress made on activities applicable to the Tehama County GSA demonstrates the commitment of the Tehama County GSA to implement the GSP by allocating the necessary time and resources to achieve long-term sustainable management of the groundwater resources in the Antelope Subbasin.

7 REFERENCES

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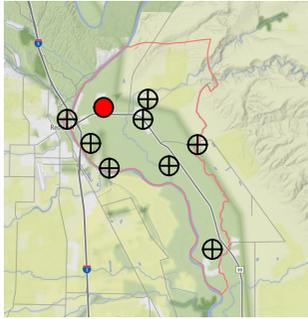
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Appendix A

Characteristics and Hydrographs of Representative
Monitoring Site (RMS) Wells

Antelope Subbasin – State Well Number (SWN) 27N03W16K003M (Ant-1U)

Upper Aquifer Well Depth: 137 ft. Perforation top & bottom: 117 – 137 ft bgs

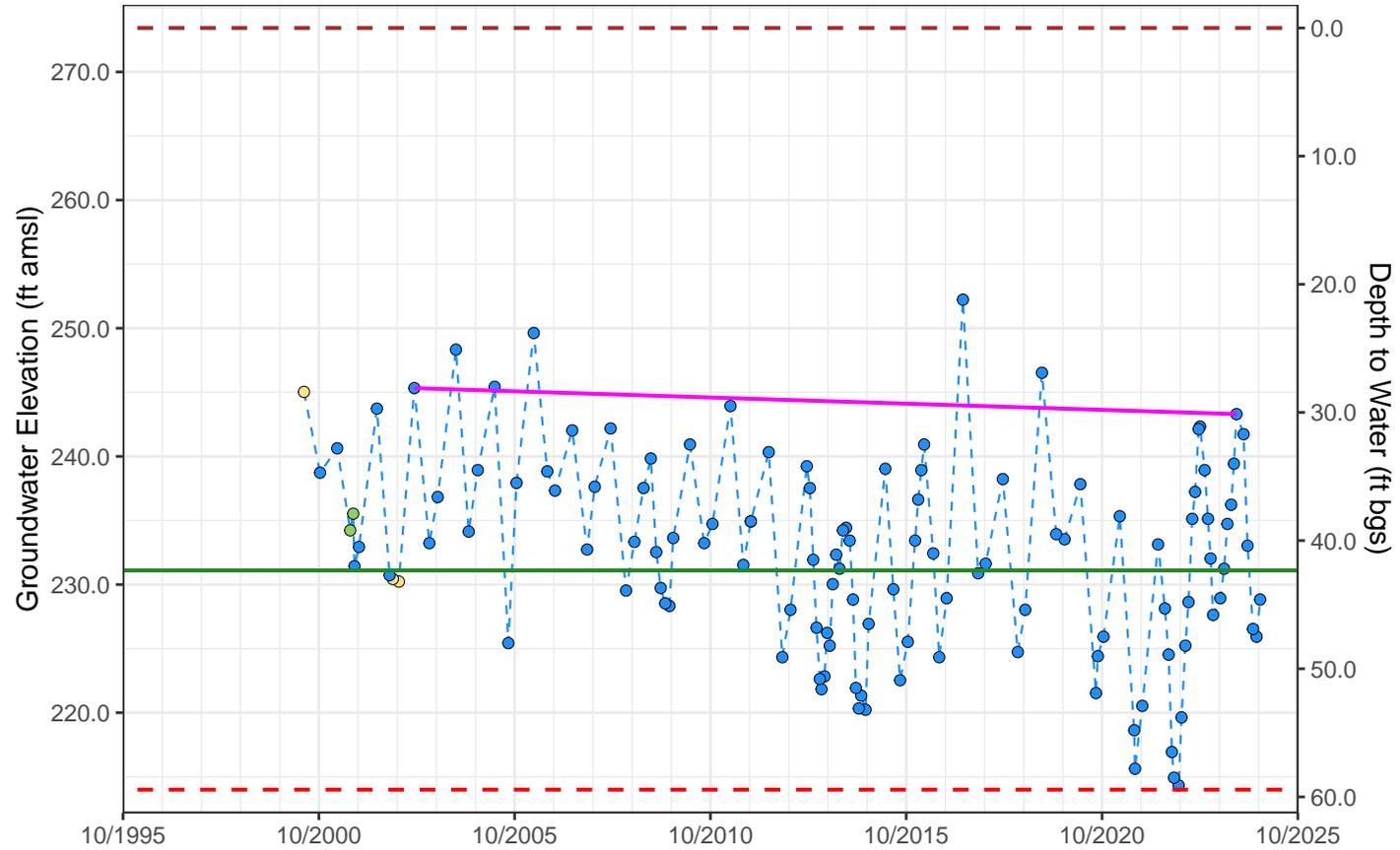


- Graphed Well
- ⊕ Other Well

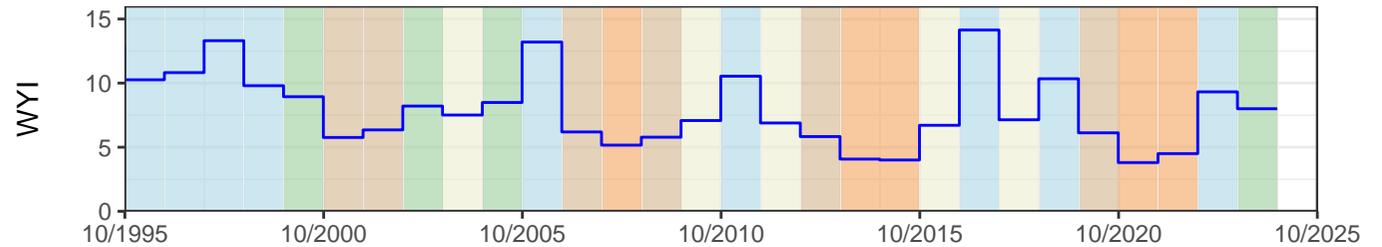
MO GWE: 231.1 ft amsl
 MT GWE: 214 ft amsl

Area: Within Special Zone
 (Reference: GSP, 2024)

Statistics of spring water levels for
 past 21 years (2003 to 2024):
 Change = -2.03 ft
 Avg. rate of change = -0.1 ft/yr
 Avg. water level = 241.87 ft amsl



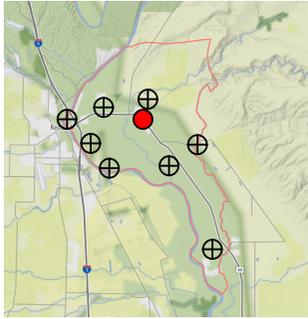
- Good measurement
- Affected by other conditions
- GSE
- Recent spring water level trend
- Pumped recently
- MO
- MT



- WY Type: ■ Wet ■ Above Normal ■ Below Normal ■ Dry ■ Critical — Sacramento Valley Water Year Index

Antelope Subbasin – State Well Number (SWN) 27N03W23D001M (Ant-2U)

Upper Aquifer Well Depth: 250 ft. Perforation top & bottom: 30 – 155 ft bgs

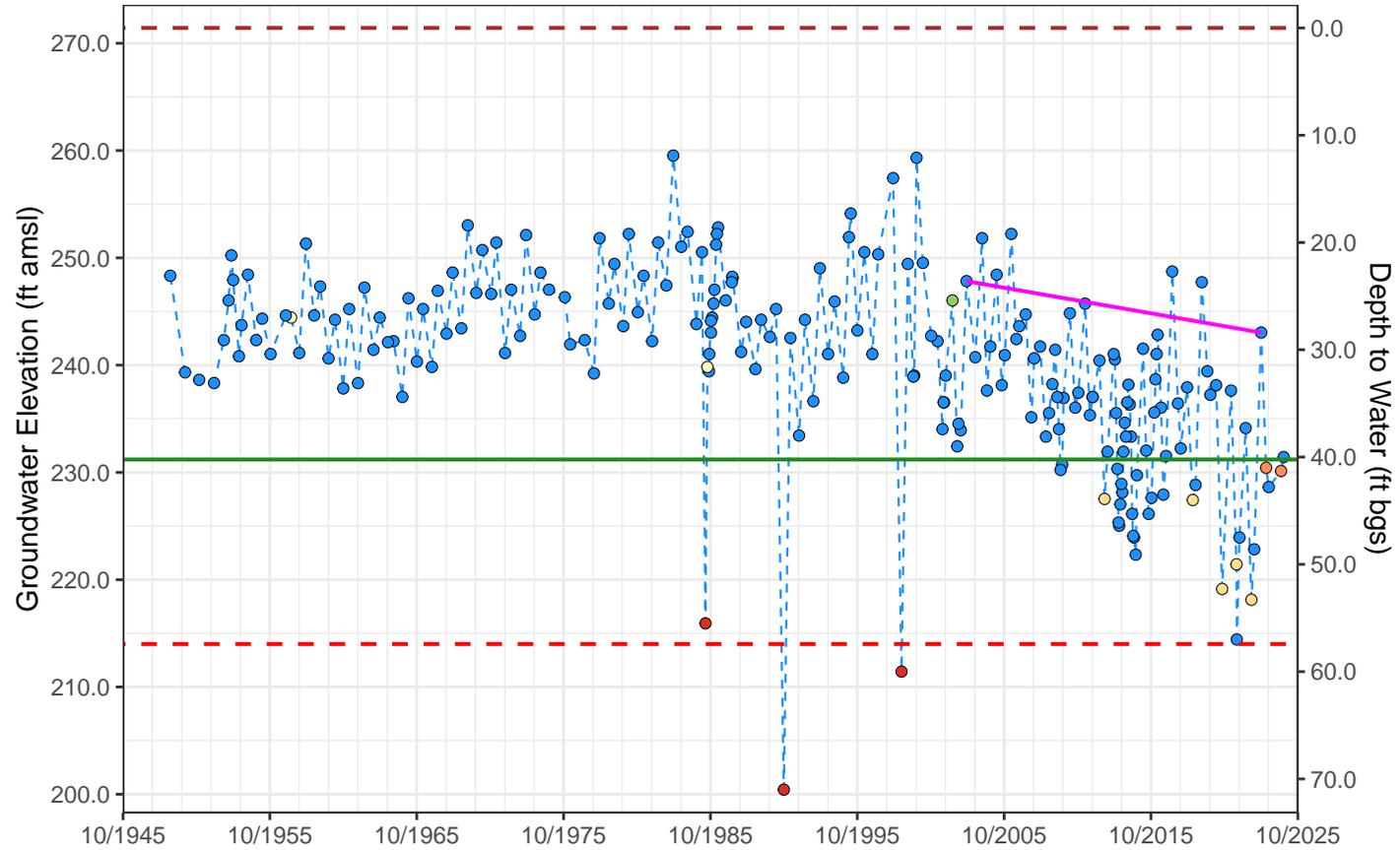


- Graphed Well
- ⊕ Other Well

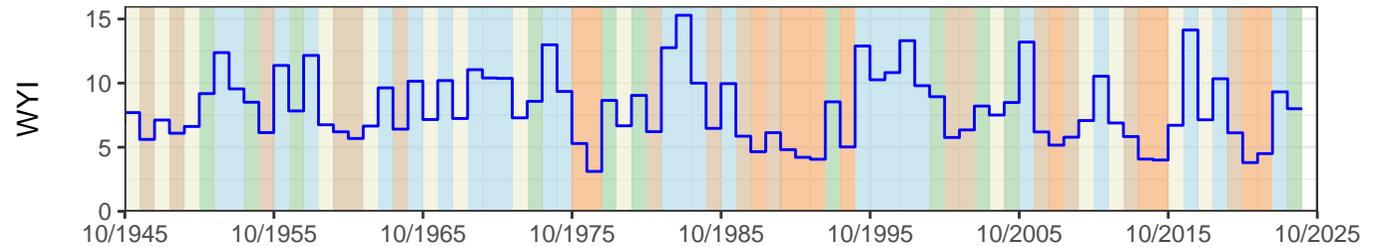
MO GWE: 231.2 ft amsl
MT GWE: 214 ft amsl

Area: Within Special Zone
(Reference: GSP, 2024)

Statistics of spring water levels for past 20 years (2003 to 2023):
Change = -4.8 ft
Avg. rate of change = -0.24 ft/yr
Avg. water level = 246.75 ft amsl



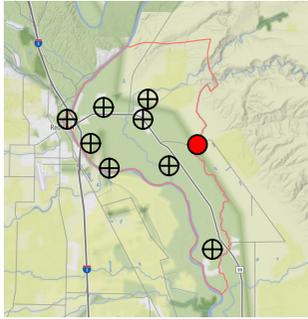
- Good measurement
- Pumped recently
- GSE
- Recent spring water level trend
- Pumping
- Oil or foreign substance in casing
- MO
- Nearby pump operating
- Affected by other conditions
- MT



- WY Type: ■ Wet ■ Above Normal ■ Below Normal ■ Dry ■ Critical — Sacramento Valley Water Year Index

Antelope Subbasin – State Well Number (SWN) 27N02W30C003M (Ant-3U)

Upper Aquifer Well Depth: 170 ft. Perforation top & bottom: 157 – 170 ft bgs

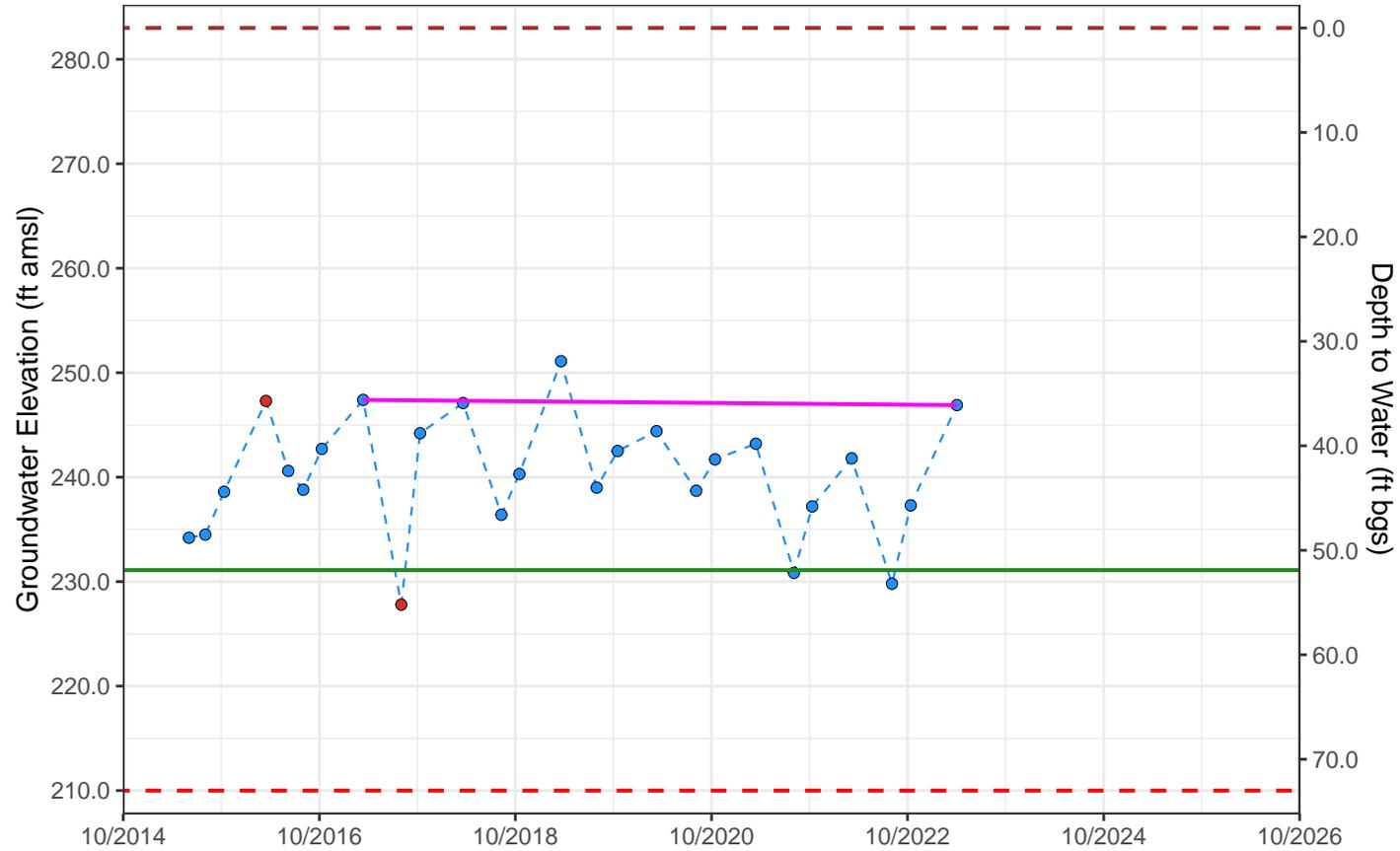


- Graphed Well
- ⊕ Other Well

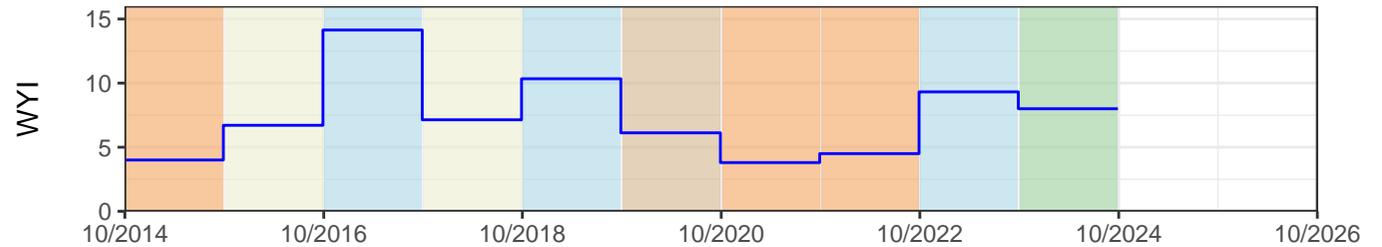
MO GWE: 231.1 ft amsl
 MT GWE: 210 ft amsl

Area: Outside of Special Zone
 (Reference: GSP, 2024)

Statistics of spring water levels for
 past 6 years (2017 to 2023):
 Change = -0.5 ft
 Avg. rate of change = -0.08 ft/yr
 Avg. water level = 245.99 ft amsl



- GSE
- Recent spring water level trend
- Good measurement
- Pumping
- MO
- MT



- WY Type: ■ Wet ■ Above Normal ■ Below Normal ■ Dry ■ Critical — Sacramento Valley Water Year Index

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Appendix B

Explanation of Sustainable Management Criteria

Appendix B: Explanation of Sustainable Management Criteria

The Sustainable Groundwater Management Act (SGMA) requires a Groundwater Sustainability Plan (GSP) to define Sustainable Management Criteria (SMC) for the groundwater subbasin. The SMC offer guideposts and guardrails for groundwater managers seeking to achieve sustainable groundwater management. SGMA defines sustainable groundwater management as “the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results,” where the planning and implementation horizon is 50 years with the first 20 years spent working toward achieving sustainable groundwater management and the following 30 years (and beyond) spent maintaining it (California Water Code §10721).

“Undesirable Results” are associated with up to six Sustainability Indicators (SI), including groundwater levels, groundwater storage, water quality, seawater intrusion, land subsidence, and interconnected surface water. SGMA defines undesirable results as those having significant and unreasonable negative impacts. Failure to avoid undesirable results on the part of the GSAs may lead to intervention by the State. Once the sustainability goal and undesirable results have been locally identified, projects and management actions are formulated to achieve the sustainability goal and avoid undesirable results.



SI and associated undesirable results, if significant and unreasonable

The associated undesirable results for each SI have been defined similarly across the Butte Subbasin. In turn, the rationale and approach for determining Minimum Thresholds and Measurable Objectives for each SI are the same across the Butte Subbasin.

The terminology for describing SMC is defined as follows:

Undesirable Results – Significant and unreasonable negative impacts associated with each SI.

Minimum Threshold (MT) – Quantitative threshold for each SI used to define the point at which undesirable results may begin to occur.

Measurable Objective (MO) – Quantitative target that establishes a point above the MT that allows for a range of active management to prevent undesirable results.

Margin of Operational Flexibility – The range of active management between the MT and the MO.

Interim Milestones (IMs) – Targets set in increments of five years over the implementation period of the GSP offering a path to sustainability.

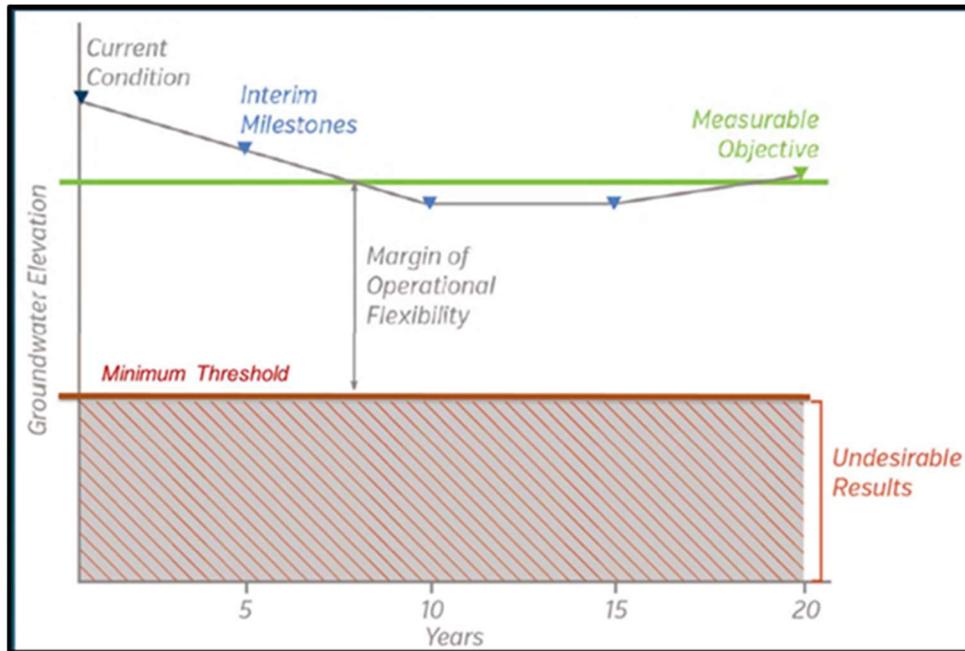


Illustration of Terms Used for Describing Sustainable Management Criteria Using the Groundwater Level SI

The Figure above illustrates these terms for the groundwater level SI.

SI are intended to be measured and compared against quantifiable SMC throughout a monitoring framework of Representative Monitoring Site (RMS) wells. Ongoing monitoring of SI can:

- Determine compliance with the adopted GSP
- Offer a means to evaluate the effectiveness of projects and management actions over time
- Allow for course correction and adaptation in five-year updates
- Facilitate understanding among diverse stakeholders
- Support decision-making on the part of the GSAs into the future

The SMC for the Antelope Subbasin is fully explained and defined in Section 3 of the GSP available here: <https://sgma.water.ca.gov/portal/gsp/preview/134>

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Appendix C

GSP Annual Reporting Elements Guide

Groundwater Sustainability Plan Annual Report Elements Guide

Basin Name	Antelope Subbasin		
GSP Local ID	5-0.21.54		
California Code of Regulations - GSP Regulation Sections	Groundwater Sustainability Plan Elements	Document page number(s) that address the applicable GSP element.	Notes: Briefly describe the GSP element does not apply.
Article 5	Plan Contents		
Subarticle 4	Monitoring Networks		
§ 354.40	Reporting Monitoring Data to the Department		
	Monitoring data shall be stored in the data management system developed pursuant to Section 352.6. A copy of the monitoring data shall be included in the Annual Report and submitted electronically on forms provided by the Department.	36-40; 65-76	
	Note: Authority cited: Section 10733.2, Water Code. Reference: Sections 10728, 10728.2, 10733.2 and 10733.8, Water Code.		
Article 7	Annual Reports and Periodic Evaluations by the Agency		
§ 356.2	Annual Reports		
	Each Agency shall submit an annual report to the Department by April 1 of each year following the adoption of the Plan. The annual report shall include the following components for the preceding water year:		
	(a) General information, including an executive summary and a location map depicting the basin covered by the report.	5-12	
	(b) A detailed description and graphical representation of the following conditions of the basin managed in the Plan:		
	(1) Groundwater elevation data from monitoring wells identified in the monitoring network shall be analyzed and displayed as follows:		
	(A) Groundwater elevation contour maps for each principal aquifer in the basin illustrating, at a minimum, the seasonal high and seasonal low groundwater conditions.	16-19	
	(B) Hydrographs of groundwater elevations and water year type using historical data to the greatest extent available, including from January 1, 2015, to current reporting year.	20; 44-47	
	(2) Groundwater extraction for the preceding water year. Data shall be collected using the best available measurement methods and shall be presented in a table that summarizes groundwater extractions by water use sector, and identifies the method of measurement (direct or estimate) and accuracy of measurements, and a map that illustrates the general location and volume of groundwater extractions.	21-23	
	(3) Surface water supply used or available for use, for groundwater recharge or in-lieu use shall be reported based on quantitative data that describes the annual volume and sources for the preceding water year.	24	
	(4) Total water use shall be collected using the best available measurement methods and shall be reported in a table that summarizes total water use by water use sector, water source type, and identifies the method of measurement (direct or estimate) and accuracy of measurements. Existing water use data from the most recent Urban Water Management Plans or Agricultural Water Management Plans within the basin may be used, as long as the data are reported by water year.	24-25	
	(5) Change in groundwater in storage shall include the following:		
	(A) Change in groundwater in storage maps for each principal aquifer in the basin.	29-31	
	(B) A graph depicting water year type, groundwater use, the annual change in groundwater in storage, and the cumulative change in groundwater in storage for the basin based on historical data to the greatest extent available, including from January 1, 2015, to the current reporting year.	29	
	(c) A description of progress towards implementing the Plan, including achieving interim milestones, and implementation of projects or management actions since the previous annual report.	32-42	

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Appendix D

DWR Upload Tables

A. Groundwater Extractions								
Total Groundwater Extractions (AF)	Water Use Sector Urban (AF)	Water Use Sector Industrial (AF)	Water Use Sector Agricultural (AF)	Water Use Sector Managed Wetlands (AF)	Water Use Sector Managed Recharge (AF)	Water Use Sector Native Vegetation (AF)	Water Use Sector Other (AF)	Water Use Sector Other Description
19,400	300	0	17,700		0	-	1,400	Rural Residential

B. Groundwater Extraction Methods																								
Meters Volume (AF)	Meters Description	Meters Type	Meters Accuracy (%)	Meters Accuracy Description	Electrical Records Volume (AF)	Electrical Records Description	Electrical Records Type	Electrical Records Accuracy (%)	Electrical Records Accuracy Description	Land Use Volume (AF)	Land Use Description	Land Use Type	Land Use Accuracy (%)	Land Use Accuracy Description	Groundwater Model Volume (AF)	Groundwater Model Description	Groundwater Model Type	Groundwater Model Accuracy (%)	Groundwater Model Accuracy Description	Other Method(s) Volume (AF)	Other Method(s) Description	Other Method(s) Type	Other Method(s) Accuracy (%)	Other Method(s) Accuracy Description
300	Metered Municipal Wells	Direct	5%	Metered connection maintained by City of Red Bluff and Los Molinos Mutual Water Company	0					17,700	Land use estimates were derived from crop mapping and CropScape survey results	Estimate	20%	Typical uncertainty for water balance calculation	0					1,400	Rural residential groundwater extraction is estimated based on City of Red Bluff's 2020 Urban Water Management Plan 2020 usage of an average per capita water use of 253 gallons per capita per day. Population data from the 2020 census was coupled with water district boundary data to identify total population not serviced by municipal supplies	Estimate	15%	Uncertainties are from population estimates and gallon per capita per day estimates

C. Surface Water Supply										
Total Surface Water Supply (AF)	Methods Used To Determine	Water Source Type Central Valley Project (AF)	Water Source Type State Water Project (AF)	Water Source Type Colorado River Project (AF)	Water Source Type Local Supplies (AF)	Water Source Type Local Imported Supplies (AF)	Water Source Type Recycled Water (AF)	Water Source Type Desalination (AF)	Water Source Type Other (AF)	Water Source Type Other Description
8,700	Diversions for local supplies are estimated based on historic State Water Resource Control Board eWRIMS (Electronic Water Rights Information Management System) data for total diversions. Surface water delivery estimates are based on historic deliveries in the area that have occurred in dry and critical years	0	0	0		0	0	0	0	

D. Total Water Use															
Total Water Use (AF)	Methods Used To Determine	Water Source Type Groundwater (AF)	Water Source Type Surface Water (AF)	Water Source Type Recycled Water (AF)	Water Source Type Reused Water (AF)	Water Source Type Other (AF)	Water Source Type Other Description	Water Use Sector Urban (AF)	Water Use Sector Industrial (AF)	Water Use Sector Agricultural (AF)	Water Use Sector Managed Wetlands (AF)	Water Use Sector Managed Recharge (AF)	Water Use Sector Native Vegetation (AF)	Water Use Sector Other (AF)	Water Use Sector Other Description
28,100	Methods used are a combination of estimates based on land use and population/ per capita water use, metered municipal water use, and estimates based on historic water rights data for dry and critical years	19,400	8,700	0	0	0		300	0	26,400	-	0	-	1,400	Rural Residential

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Appendix E

Water Use Analysis Methodology

TECHNICAL MEMORANDUM

To: Luhdorff and Scalmanini Consulting Engineers
From: Davids Engineering, Inc.
Date: March 3, 2025
Subject: **Water Use Analysis Methodology**

1 Introduction

Pursuant to the Groundwater Sustainability Plan (GSP) regulations (23 CCR¹ Section 356.2), the GSP Annual Report for the Antelope Subbasin (Subbasin) includes quantification of water supplies and water uses in the reporting year, including groundwater extraction by water use sector². Water supplies and water uses in the Subbasin have been quantified based on the best available data sources and information, either collected from measured records or estimated where necessary.

While some groundwater extraction in the Subbasin is measured, most groundwater extraction is unmeasured, including extraction from privately owned wells. For the Antelope Subbasin Annual Report (Annual Report), the approach used to estimate unmeasured groundwater extraction for the agricultural water use sector is referred to as the Groundwater Extraction Estimates from Earth Observations (GEEEO) process. In this approach, a spatial water use analysis is computed on a monthly basis using current land use data, climate conditions (e.g., precipitation and evapotranspiration), crop water demands, and other local information, allowing for estimation of total water use and estimated groundwater extraction, after accounting for the use of other available water supplies.

This approach differs from the water budget methodology used in GSP development, where the Tehama Integrated Hydrogeologic Model (TIHM) was used to generate historical, current, and projected water budgets for the Subbasin. The shift toward the GEEEO process is due to the time and cost constraints associated with updating the GSP groundwater model annually. Despite this change, key inputs and results from the GEEEO process have been compared with those of the GSP groundwater model to ensure consistency in the water use analyses.

This technical memorandum (TM) describes the methodology and data sources used in the GEEEO process. Results of the GEEEO process are documented in the Annual Report.

¹ California Code of Regulations, Title 23, Division 2, Chapter 1.5, Subchapter 2. Groundwater Sustainability Plans.

² Water use sectors are identified in the GSP Regulations as “categories of water demand based on the general land uses to which the water is applied, including urban, industrial, agricultural, managed wetlands, managed recharge, and native vegetation” (23 CCR Section 351(a)).

2 GEEEO Process and Computational Approach

2.1 Computational Approach

The GEEEO process utilizes available geospatial data and information to quantify water use, including groundwater extraction volumes, spatially across the Subbasin:

1. First, geospatial evapotranspiration (ET) information at a pixel-scale is used to quantify the total consumptive water use and total applied water requirements during a given time period in a given area of the Subbasin, and geospatial land use information is used to help identify where irrigation water may have been applied (i.e., whether the area in question features irrigated agricultural land, versus idled land or undeveloped vegetation).
2. After quantifying total applied water requirements, available surface water supply and groundwater extraction data is incorporated into the GEEEO process by distributing that water out to specific regions where that water is applied (e.g., irrigated lands in surface water supplier service areas).
3. The remaining groundwater extraction needed to meet applied water demands is then calculated based on the difference between total applied water requirements and available water supply information, with consideration for effective precipitation.
4. Finally, the pixel-scale results can then be aggregated to the desired spatial or temporal domains of interest.

The result is a spatially distributed water use analysis calculated with a finer spatial resolution than was possible in the GSP water budgets. The pixel-scale water budget results provide greater insight into where water use occurs in the Subbasin and are configurable to create water use summaries for any region of the Subbasin. Additional details about the GEEEO computational approach are provided in Attachment A, generally following the process described in Hessels et al. (2022).

2.2 Spatial Resolution

GEEEO quantifies water use and groundwater extraction volumes with pixel-scale resolution (30 meters (m) x 30 m), corresponding to the spatial resolution of satellite imagery used in developing many of the GEEEO inputs. For those inputs that are not available at the 30 m x 30 m resolution, available data and information is distributed as averages over the area where that information is applicable (e.g., district-reported surface water deliveries are distributed as an average acre-feet per acre (AF/ac) over irrigated lands in that district's service area³). Additional information about the spatial resolution of specific data sources is provided in Section 3.

The fine spatial resolution of the GEEEO inputs and computations allows for highly configurable GEEEO results summaries. For the Annual Report, results are summarized by subregions that are defined to roughly correspond with the boundaries of the water budget regions in the GSP groundwater model, with distinction between water districts, managed wetlands and refuge areas, and out-of-district lands.

³ Future refinements to the GEEEO process could potentially incorporate field-scale surface water delivery records to improve spatial detail of results rather than equally distributing surface water deliveries across the irrigated lands within the district's service area.

2.3 Period and Timestep

For each Annual Report, the GEEEO process operates from 2016 through the current reporting year⁴ on a monthly timestep, although only the results from the current reporting year are included in the Annual Report. The period and timestep are set according to data availability and reporting needs. However, the GEEEO process is configurable to operate on different timescales (e.g., daily or weekly). The start year is currently limited by the availability of geospatial ET information from OpenET, although further historical ET information is expected to be available in the near future.

3 Data Sources

The GEEEO process uses data sources and information that capture the unique, local conditions within the Subbasin to the extent available. Details about the data and information used in the GEEEO process are described below.

3.1 Evapotranspiration

ET, or consumptive water use, is the major driver of water use in the Subbasin, particularly agricultural use. In this context, consumptive water use is defined as *“the part of water withdrawn that is evaporated, transpired, incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the immediate water environment”* (ASCE, 2016). Unlike surface runoff or infiltration of water into the groundwater system (through seepage, deep percolation, managed recharge, or other means), ET is water that cannot be recovered or directly reused in the Subbasin.

In the GEEEO process, ET is quantified from satellite-based remote sensing analyses available from OpenET. OpenET is a multi-agency web-based geospatial information system (GIS) utility that quantifies ET over time with a spatial resolution of 30 m x 30 m (approximately 0.22 acres). OpenET information is available in raster coverages of the Subbasin on both a daily and monthly timestep from 2016 through present.⁵ The GEEEO process utilizes monthly rasters of the ensemble ET from OpenET to calculate total water use for the Annual Report.

While OpenET is a new utility, the underlying methodologies to quantify ET apply a variety of well-established modeling approaches that are widely used in government and research applications. The OpenET modeling approaches are also similar to the approaches used to quantify ET in the GSP groundwater model. Additional information about the OpenET team, data sources, and methodologies are available at: <https://openetdata.org/>.

3.2 Land Use

Areas in each water use sector in the Subbasin were identified using the most recent and reliable spatial land use data in the region, including:

1. Statewide crop mapping, available from the California Department of Water Resources (DWR) (DWR, 2024)

⁴ Annual Reports are required to be submitted by April 1 each year following the adoption of the GSP. The current reporting year for each Annual Report is the preceding water year (i.e., October 1 through September 30)

⁵ OpenET raster information is typically available within about one month after the period has ended.

2. CropScape Cropland Data Layer coverage, available from the United States Department of Agriculture (USDA, 2024).

Land use data from these sources were compiled into 30 m x 30 m raster coverages of the Subbasin. To prepare the GEEEO process inputs, DWR data, which includes extensive ground-truthing review of results, is preferentially used to identify agricultural land (including irrigated and non-irrigated lands) and urban areas, and then USDA data is utilized to back-fill gaps of non-irrigated, idled, and non-developed land in the Subbasin. Local refinements are also applied, as needed, to account for local land use information.

These land use data sources and applications were similar to those used in development of the GSP water budgets. Comparisons were made to evaluate the consistency of the datasets and with earlier land use analyses; good correspondence was found for the major land use classes found in the Subbasin.

DWR data is typically available in provisional form approximately two years after a given year has passed. USDA data is typically available for the prior year in early- to mid-February. When data for the current reporting year is not yet available, raster coverages of the Subbasin are generally assembled utilizing land use data from the most recent, hydrologically similar year (i.e., similar water supply conditions and similar cropping patterns, to the extent possible). Idling of annual and ponded crops in a given year may also be locally refined through comparison with USDA data for the current reporting year or through an analysis of vegetation coverage in the current reporting year. However, it is noted that land use data is only used in the GEEEO process to identify areas in each water use sector where water is applied. The total water use for lands in the agricultural and managed wetlands water use sectors are determined through an analysis of OpenET data, regardless of the precise land use classification.

3.3 Precipitation

Spatial precipitation estimates were extracted from the Parameter-elevation Regressions on Independent Slopes Model (PRISM), developed by the PRISM Climate Group at Oregon State University. PRISM quantifies spatial precipitation estimates, among other climate parameters, based on available weather station data and modeled spatial relationships with topography and other factors influencing weather and climate.

PRISM data is available in raster coverages of the Subbasin on both a daily and monthly timestep, with a spatial resolution of 4 kilometer (km) x 4 km. The GEEEO process utilizes monthly rasters for the Annual Report analysis, and the precipitation results for each 4 km pixel are applied to each of the 30 m pixels within it (i.e., downscaled) for which ET and land use data are available. Additional information about the PRISM data and methodologies are available at: <https://prism.oregonstate.edu>. PRISM precipitation data is consistent with the historical precipitation inputs to the GSP groundwater model.

To calculate effective precipitation and, subsequently, evapotranspiration from precipitation (ETPR), PRISM precipitation data, estimated crop rooting depths, and soil property information are used as inputs. Estimated rooting depths are taken from the ranges listed in Appendix B of ASCE 70 (2016). For crops not listed in ASCE 70, rooting depths are based on the rooting depths of similar crops and professional judgement. Relevant soil properties include total soil depth, depth to restrictive layer, and available water holding capacity. Estimated soil properties are aggregated from the USDA soil survey geographic database (SSURGO) (Soil Survey Staff, 2025). ETPR is computed using the input parameters

(soil, precipitation, and rooting depth) and either the U.S. Bureau of Reclamation (USBR) method (Stamm, 1967) or the National Engineering Handbook Part 623 method (USDA, 1993), depending on local data availability, results, and conditions. For the USBR method, the effective precipitation bins have been modified from the original bins outlined in the USBR method documentation to match regional hydrology patterns..

3.4 Local Water Supply Data

As described in Section 2, available surface water supply and groundwater extraction data is incorporated into the GEEEO process to quantify the amount of known water supply available, prior to estimating the remaining groundwater extraction needed to meet demand. Where field-scale delivery measurements are available, the water supply volume delivered was distributed evenly across all irrigated areas of that field. Where field-scale delivery measurements are not available and only diversion volumes or aggregated delivery volumes for a larger area are available, water supply data is distributed evenly over the area where that water can be delivered for irrigation (e.g., average AF/ac over lands where that water is available for use).

Surface water supply and groundwater extraction data are collected from both publicly available and local sources. Information gathered may include, where applicable:

1. Water supply contract delivery records, from the United States Bureau of Reclamation (USBR), State Water Project (SWP), or other publicly available sources as applicable.
2. Water rights diversions records, from the State Water Resources Control Board (SWRCB) through the Electronic Water Rights Information Management System (eWRIMS)
3. Data requests to local water agencies and water users, requesting surface water diversions, surface water deliveries, surface water outflows, groundwater pumping records, or other available water use data. At the most detailed possible level, these include field-scale volumetric delivery measurements taken by Water or Irrigation District water operators, as required per the Water Conservation Act of 2009.

In cases where current surface water data is not available, general information on surface water inflows and outflows may be gathered from other local sources as available (e.g., Agricultural Water Management Plan water budgets). More information about surface water data sources is described in the Annual Report.

While groundwater extraction data is not available in many parts of the Subbasin, local data is requested each year so that new data can be incorporated into the GEEEO process as it becomes available. It is noted that while groundwater extraction for municipal water supply systems is generally reported for urban areas in the Annual Report based on SWRCB and locally provided data, groundwater extraction for municipal areas is not directly included in the GEEEO process due to underlying differences in how the majority of water is used in urban areas. This also applies to estimates of rural residential groundwater use (e.g., domestic water use pumped through private domestic wells) outside of urban areas. The data sources and approaches used to quantify municipal and rural residential groundwater extraction are described in the Annual Report.

3.5 Other Agronomic Data

Other agronomic and climate-related data that is incorporated into the GEEEO process includes:

1. Representative consumptive use fractions for crops (i.e., fraction of total applied water that is consumed through ET). Values are based on typical irrigation methods and efficiencies for crops.
2. Conveyance system fractions for subregions (i.e., fraction of diverted water that is delivered, accounting for losses).
3. Reuse fractions for subregions (i.e., fraction of delivered water that is reused).

Information gathered from local sources is used where available, otherwise representative values for agronomic practices in the region are used.

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Attachment A. GEEEO Computational Approach Details

Figures A-1 and A-2, below, present a schematic of the GEEEO computational approach as it has been developed and is being generally applied to support Annual Report Development.

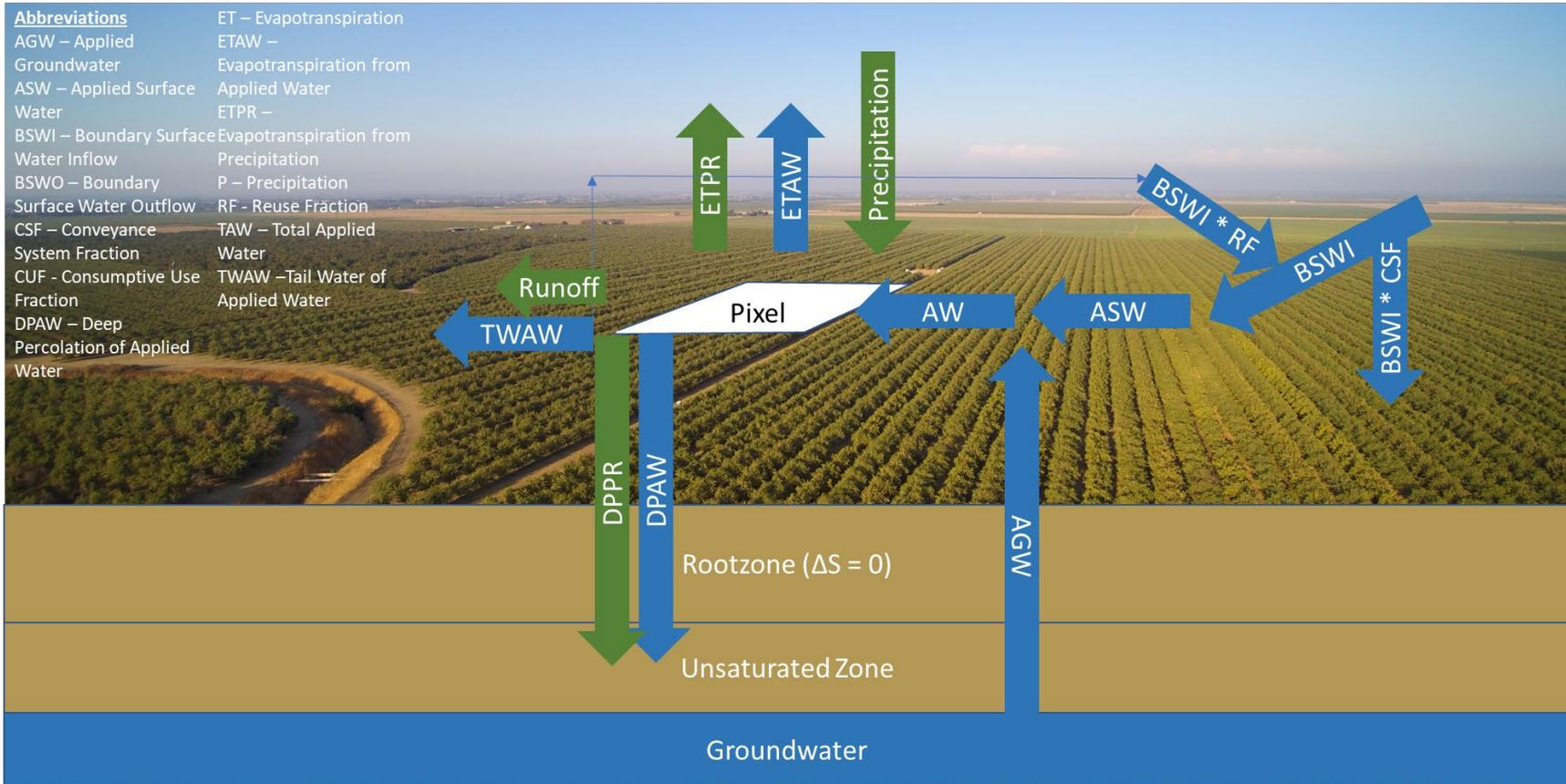


Figure A-1. Inflows and Outflows to Each 30 m x 30 m Pixel in the GEEEO Process.

Abbreviations
 AGW – Applied Groundwater
 ASW – Applied Surface Water
 AW – Total Applied Water
 BSWI – Boundary Surface Water Inflow
 BSWO – Boundary Surface Water Outflow
 CSF – Conveyance System Fraction
 CUF - Consumptive Use Fraction
 DPAW – Deep Percolation of Applied Water

ET – Evapotranspiration
 ETAW – Evapotranspiration from Applied Water
 ETPR – Evapotranspiration from Precipitation
 P – Precipitation
 RF - Reuse Fraction
 TAW – Tail Water of Applied Water

(2) Monthly effective precipitation
 SCS scientists analyzed 50 years of rainfall records at 22 locations throughout the United States to develop a technique to predict effective precipitation (USDA 1970). A daily soil moisture balance incorporating crop evapotranspiration, rainfall, and irrigation was used to determine the evapotranspiration effectiveness. The resulting equation for estimating effective precipitation is: [2-84]

$$P_e = SF \left(0.70917 P_m^{0.82424} - 0.11556 \right) \left(10^{0.02428 D} \right)$$

 where:
 P_e = average monthly effective precipitation (in)
 P_m = monthly mean precipitation (in)
 ET_c = average monthly crop evapotranspiration (in)
 SF = soil water storage factor
 The soil water storage factor was defined by: [2-85]

$$SF = (0.531747 + 0.255164 D - 0.057697 D^2 + 0.003804 D^3)$$

 where:
 D = the usable soil water storage (in)
 The term D was generally calculated as 40 to 60 percent of the available soil water capacity in the crop root zone, depending on the irrigation management practices used.
 The solution to equation 2-84 for $D = 3$ inches is given in table 2-43 and figure 2-38. For other values of D , the effective precipitation values must be multiplied by the corresponding soil water storage factor given in

The procedures used to develop equations 2-84 and 2-85 did not include two factors that affect the effectiveness of rainfall. The soil infiltration rate and rainfall intensity were not considered because sufficient data were not available or they were too complex to be readily considered. If in a specific application the infiltration rate is low and rainfall intensity is high, large amounts of rainfall may be lost to surface runoff. A sloping land surface would further reduce infiltration amounts. In these cases the effective precipitation values obtained from equations 2-84 and 2-85 need to be reduced.

A recent comparison (Patwardhan, et al. 1990) of the USDA-SCS method (USDA 1970) with a daily soil moisture balance incorporating surface runoff highlighted the need for this modification. The authors concluded that the USDA-SCS method was in fairly good agreement with the daily water balance procedure for well drained soils, but overpredicted effective precipitation for poorly drained soils.

The USDA-SCS method is generally recognized as applicable to areas receiving low intensity rainfall and to soils that have a high infiltration rate (Dastane 1974). The method averages soil type, climatic conditions, and soil-water storage to estimate effective precipitation. This provides reasonable estimates of effective precipitation, especially for project planning. Further, the procedures were designed for a monthly time step. If additional detail is needed for a more thorough project analysis or for irrigation scheduling purposes, a daily time step would be required. In this case more sophisticated techniques can be used to estimate effective precipitation. Computer-based soil

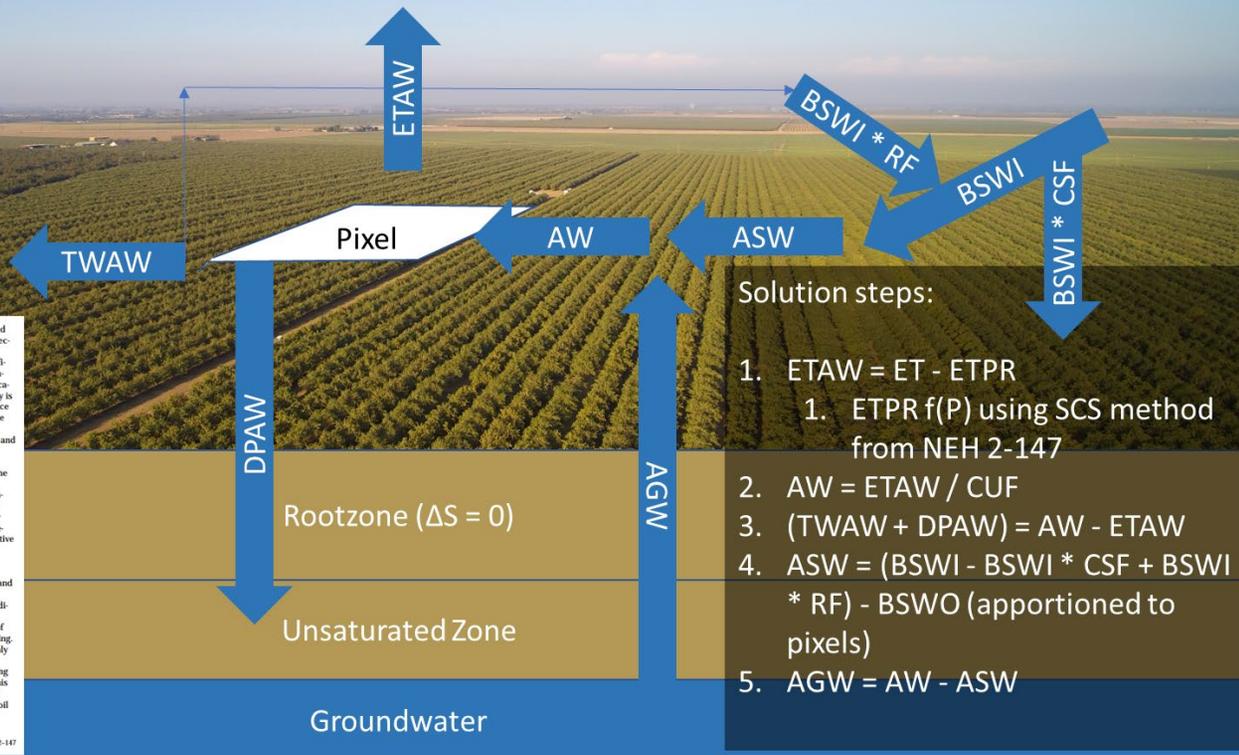


Figure A-2. Solution Steps for Calculating Applied Groundwater (AGW) in Each 30 m x 30 m Pixel in the GEEEO Process.

Water Year 2024 Annual Report

Appendix F

Water Quality

Measurable Objectives, Minimum Thresholds, and Water Quality of Representative Monitoring Site Wells

Representative Monitoring Site (RMS) ID	TDS (mg/L)				Nitrate (mg/L)			
	MO	MT	2024	Exceed MT?	MO	MT	2024	Exceed MT?
<i>Upper Aquifer</i>								
Ant-1U	500	750	290	--	5	10	9.6	--
Ant-3U	500	750	210	--	5	10	ND	--
Ant-4U	500	750	380	--	5	10	7.9	--
<i>Upper Aquifer</i>								
Ant-5L	500	750	270	--	5	10	3.5	--


 Invoice # 479967A

Remit To:
 FGL Environmental
 853 Corporation St
 Santa Paula, CA 93060

INVOICE



Luhdorff & Scalmanini Consulting
 500 First Street
 Woodland, CA 95695

Account # 7010503	
Date Billed 11/07/2024	Amount Due \$331.40
Date Due 12/07/2024	Amount Paid

To ensure that your account is properly credited, please return top portion with payment

Keep bottom portion for your records.

INVOICE



Customer Luhdorff & Scalmanini Consulting	Account # 7010503	Date Sampled 10/22/2024	Lab Number CH 2479967
Project Antelope	Invoice # 479967A	Date Billed 11/07/2024	Amount Due \$331.40
PO# / Check Number	Date Paid	Date Due 12/07/2024	Amount Paid

Description of Work	Quantity	Rate	Extended
Inorganic Analysis			
Wet Chemistry - TDS	4	34.00	136.00
Wet Chemistry - NO3+NO2 as N	4	68.00	272.00
Misc. Analysis			
Materials/Disposal For More Information http://fglinc.com/md.php	1	5.00	5.00
Discount			-\$81.60
Total			\$331.40

(GMA-L4) **For Questions about this Invoice - contact Gloria Ary at 805-392-2011**

November 4, 2024

Lab No. : CH 2479967

Customer No. : 7010503

Luhdorff & Scalmanini Consulting

Attn: Eddy Teasdale
 550 Salem Street, Suite 3
 Chico, CA 95928

Laboratory Report

Introduction: This report package contains a total of 6 pages divided into 3 sections:

- Case Narrative (1 page) : An overview of the work performed at FGL.
- Sample Results (4 pages) : Results for each sample submitted.
- Quality Control (1 page) : Supporting Quality Control (QC) results.

Case Narrative

This Case Narrative pertains to the following samples:

Sample Description	Date Sampled	Date Received	FGL Lab No.	Matrix
Ant 1U	10/22/2024	10/23/2024	CH 2479967-001	GW
Ant 3U	10/22/2024	10/23/2024	CH 2479967-002	GW
Ant 4U	10/23/2024	10/23/2024	CH 2479967-003	GW
Ant 5L	10/22/2024	10/23/2024	CH 2479967-004	GW

Sampling and Receipt Information:

All samples were received in acceptable condition and within temperature requirements, unless noted on the Condition Upon Receipt (CUR) form. All samples were received, prepared and analyzed within the method specified holding times. All samples arrived on ice. All samples were checked for pH if acid or base preservation is required (except for VOAs). For details of sample receipt information, please see the associated Chain of Custody and Condition Upon Receipt Form.

Quality Control: All samples were prepared and analyzed according to established quality control criteria. Any exceptions are noted in the Quality Control Section of this report.

Test Summary

SM 2540 C	Preparation and analysis performed by FGL-Santa Paula (FGL-SP ELAP# 1573)
SM 4500-NO3 F	Preparation and analysis performed by FGL-Santa Paula (FGL-SP ELAP# 1573)

Certification: I certify that this data package is in compliance with ELAP standards, both technically and for completeness, except for any conditions listed above and in the QC Section. Release of the data contained in this data package is authorized by the Laboratory Director or his designee, as verified by the following electronic signature. This report shall not be reproduced except in full, without the written approval of the laboratory.

KD: SMH

Approved By **Kelly A. Dunnahoo, B.S.**  Digitally signed by Kelly A. Dunnahoo, B.S.
 Title: Laboratory Director
 Date: 2024-11-05



November 4, 2024

Luhdorff & Scalmanini Consulting

Attn: Eddy Teasdale
550 Salem Street, Suite 3
Chico, CA 95928

Description : Ant 1U
Project : Antelope

Lab No. : CH 2479967-001
Customer No. : 7010503

Sampled On : October 22, 2024 at 14:07
Sampled By : Christian H./Leeah S
Received On : October 23, 2024 at 16:10
Matrix : Ground Water

Sample Results - Inorganic

Constituent	Result	RL	Units	Note	Dil.	DQF	Sample Preparation			Sample Analysis			
							Date	Time	Who	Method	Date	Time	Who
Wet Chemistry													
Nitrate + Nitrite as N	9.6	0.4	mg/L		1		10/31/2024	14:30	ilp	SM 4500-NO3 F	10/31/2024	15:42	ilp
Total Dissolved Solids (TFR)	290	20	mg/L		1		10/25/2024	15:45	ctl	SM 2540 C	10/28/2024	11:15	ctl

DQF Flags Definition:

ND=Non-Detected, RL=Reporting Level , Dil.=Dilution



November 4, 2024

Luhdorff & Scalmanini Consulting

Attn: Eddy Teasdale
550 Salem Street, Suite 3
Chico, CA 95928

Description : Ant 3U
Project : Antelope

Lab No. : CH 2479967-002

Customer No. : 7010503

Sampled On : October 22, 2024 at 14:40

Sampled By : Christian H./Leeah S

Received On : October 23, 2024 at 16:10

Matrix : Ground Water

Sample Results - Inorganic

Constituent	Result	RL	Units	Note	Dil.	DQF	Sample Preparation			Sample Analysis			
							Date	Time	Who	Method	Date	Time	Who
Wet Chemistry													
Nitrate + Nitrite as N	ND	0.4	mg/L		1	J	10/31/2024	14:30	ilp	SM 4500-NO3 F	10/31/2024	15:45	ilp
Total Dissolved Solids (TFR)	210	20	mg/L		1		10/25/2024	15:45	ctl	SM 2540 C	10/28/2024	11:15	ctl

DQF Flags Definition:

J Reported value is estimated; detected at a concentration below the RL and above the laboratory MDL.

ND=Non-Detected, RL=Reporting Level , Dil.=Dilution



November 4, 2024

Luhdorff & Scalmanini Consulting

Attn: Eddy Teasdale
550 Salem Street, Suite 3
Chico, CA 95928

Description : Ant 4U
Project : Antelope

Lab No. : CH 2479967-003
Customer No. : 7010503

Sampled On : October 23, 2024 at 13:02
Sampled By : Christian H./Leeah S
Received On : October 23, 2024 at 16:10
Matrix : Ground Water

Sample Results - Inorganic

Constituent	Result	RL	Units	Note	Dil.	DQF	Sample Preparation			Sample Analysis			
							Date	Time	Who	Method	Date	Time	Who
Wet Chemistry													
Nitrate + Nitrite as N	7.9	0.4	mg/L		1		10/31/2024	14:30	ilp	SM 4500-NO3 F	10/31/2024	15:58	ilp
Total Dissolved Solids (TFR)	380	20	mg/L		1		10/25/2024	17:00	ctl	SM 2540 C	10/28/2024	11:15	ctl

DQF Flags Definition:

ND=Non-Detected, RL=Reporting Level , Dil.=Dilution



November 4, 2024

Luhdorff & Scalmanini Consulting

Attn: Eddy Teasdale
550 Salem Street, Suite 3
Chico, CA 95928

Description : Ant 5L
Project : Antelope

Lab No. : CH 2479967-004
Customer No. : 7010503

Sampled On : October 22, 2024 at 13:02
Sampled By : Christian H./Leeah S
Received On : October 23, 2024 at 16:10
Matrix : Ground Water

Sample Results - Inorganic

Constituent	Result	RL	Units	Note	Dil.	DQF	Sample Preparation			Sample Analysis			
							Date	Time	Who	Method	Date	Time	Who
Wet Chemistry													
Nitrate + Nitrite as N	3.5	0.4	mg/L		1		10/31/2024	14:30	ilp	SM 4500-NO3 F	10/31/2024	16:00	ilp
Total Dissolved Solids (TFR)	270	20	mg/L		1		10/25/2024	15:45	ctl	SM 2540 C	10/28/2024	11:15	ctl

DQF Flags Definition:

ND=Non-Detected, RL=Reporting Level , Dil.=Dilution

November 4, 2024

Luhdorff & Scalmanini Consulting

Lab No. : CH 2479967

Customer No. : 7010503

Quality Control - Wet Chem

Constituent	Method	Date/ID	Type	Units	Conc.	QC Data	DQO	Note
Wet Chem								
Solids, Total Dissolved	2540CE	10/25/2024:212117CTL (CH 2479969-008) (CH 2479969-008)	Blank	mg/L		ND	<20	
			LCS	mg/L	991.1	97.1%	90-110	
			Dup	mg/L		2.02%	5	
			Dup	mg/L		0.4%	5	
		(CC 2484133-002) (CC 2484133-002)	Blank	mg/L		ND	<20	
			LCS	mg/L	991.1	102%	90-110	
			Dup	mg/L		0.8%	5	
			Dup	mg/L		1.20%	5	
Nitrate + Nitrite as N	4500NO3F	10/31/2024:212346ILP (VI 2448661-001)	Blank	mg/L		ND	<0.4	
			LCS	mg/L	11.22	100%	80-120	
			MS	mg/L	5.609	100%	66-125	
			MSD	mg/L	5.609	97.3%	66-125	
			MSRPD	mg/L		1.8%	≤30.4	

Definition

- Blank : Method Blank - Prepared to verify that the preparation process is not contributing contamination to the samples.
- DQO : Data Quality Objective - This is the criteria against which the quality control data is compared.
- Dup : Duplicate Sample - A random sample with each batch is prepared and analyzed in duplicate. The relative percent difference is an indication of precision for the preparation and analysis.
- LCS : Laboratory Control Standard/Sample - Prepared to verify that the preparation process is not affecting analyte recovery.
- MS : Matrix Spikes - A random sample is spiked with a known amount of analyte. The recoveries are an indication of how that sample matrix affects analyte recovery.
- MSD : Matrix Spike Duplicate of MS/MSD pair - A random sample duplicate is spiked with a known amount of analyte. The recoveries are an indication of how that sample matrix affects analyte recovery.
- MSRPD : MS/MSD Relative Percent Difference (RPD) - The MS relative percent difference is an indication of precision for the preparation and analysis.
- ND : Non-detect - Result was below the DQO listed for the analyte.

Client: Luhdorff & Scalmanini Consulting Customer Number: 7010503 Address: Attn: Eddy Teasdale 550 Salem Street, Suite 3 Chico, CA 95928 Phone: (530)661-0109 Fax: Email Address: eteasdale@lsce.com Contact Person: Eddy Teasdale Project Name: Antelope Purchase Order Number: Quote Number:				Lab Number: 2479967				TEST DESCRIPTION AND ANALYSES REQUESTED																	
Rush Analysis: <input type="checkbox"/> 5 Day <input type="checkbox"/> 4 Day <input type="checkbox"/> 3 Day <input type="checkbox"/> 2 Day <input type="checkbox"/> 24 hour Rush pre-approval by lab (initials): _____ Electronic Data Transfer: <input type="checkbox"/> No <input type="checkbox"/> State <input type="checkbox"/> Client Other: _____				Method of Sampling: Composita (C) Grab (G)	Number of Containers	Type of Containers: (G) Glass (P) Plastic (M) Metal Tube	Potable (P) <input type="checkbox"/> Non-Potable (NP) <input type="checkbox"/> Ag Water (AW) <input type="checkbox"/>	(SW) Surface Water (MW) Monitoring Well (GW) Ground Water (TB) Travel Blank (WW) Waste Water (S) Soil (SLG) Sludge (SLD) Sediment (C) Oil	Bact. (Sye) System (SRC) Source (W) Waste	Bact. (ROUT) Routine (RPT) Repeat (OTT) Other (RPL) Replaces	(LT) Leaf Tissue (PET) Petiole Tissue (PRD) Produce	Preservative: (1) NaOH + ZnAc. (2) NaOH. (3) HCl (4) H2SO4. (5) HNO3. (6) Na2S2O3. (7) Other	Total Dissolved Solids	Nitrate + Nitrite as N											
Sampler(s): Christian Hoover Leech Schultz Sampling Fee: _____ Pickup Fee: _____ Compositor Setup Date: _____ Time: _____				Method of Sampling: Composita (C) Grab (G)	Number of Containers	Type of Containers: (G) Glass (P) Plastic (M) Metal Tube	Potable (P) <input type="checkbox"/> Non-Potable (NP) <input type="checkbox"/> Ag Water (AW) <input type="checkbox"/>	(SW) Surface Water (MW) Monitoring Well (GW) Ground Water (TB) Travel Blank (WW) Waste Water (S) Soil (SLG) Sludge (SLD) Sediment (C) Oil	Bact. (Sye) System (SRC) Source (W) Waste	Bact. (ROUT) Routine (RPT) Repeat (OTT) Other (RPL) Replaces	(LT) Leaf Tissue (PET) Petiole Tissue (PRD) Produce	Preservative: (1) NaOH + ZnAc. (2) NaOH. (3) HCl (4) H2SO4. (5) HNO3. (6) Na2S2O3. (7) Other	Total Dissolved Solids	Nitrate + Nitrite as N											
Samp Num	Location Description	Date Sampled	Time Sampled	Method of Sampling	Number of Containers	Type of Containers	Potable	Water Type	Bact. System	Bact. Routine	Leaf Tissue	Preservative	Total Dissolved Solids	Nitrate + Nitrite as N											
1	Ant 1u	10/22/24	14:07	G	2	P	NP	GW					X	X											
2	Ant 3u	10/22/24	14:40	G	2	P	NP	GW					X	X											
3	Ant 4u	10/23/24	13:02	G	2	P	NP	GW					X	X											
4	Ant 5L	10/23/24	13:02	G	2	P	NP	GW					X	X											
Remarks				Relinquished Date: Time: 10/23/24 16:10				Relinquished Date: Time: MDJ 10/24 1700				Relinquished Date: Time: GLS 10/25/24 1340													
				Received By: Date: Time: MDJ 10/23/24 16:10				Received By: Date: Time: GLS 10/24 1700				Received By: Date: Time: JAW 10/25/24 1340													

2479967

Inter-Laboratory Condition Upon Receipt (Attach to COC) Sample Receipt at:

CC CH STK VI

- Number of ice chests/packages received: 07C Shipping tracking #(s): _____
- Temp IR Gun ID #: 2431c
- Were samples received on ice? Yes No Temps: 5.3 / _____ / _____ / _____
Surface water SWTR bact samples: A sample that has a temperature upon receipt of >10° C, whether iced or not, should be flagged unless the time since sample collection has been less than two hours.
- Do the number of bottles received agree with the COC? Yes No N/A
- Were samples received intact? (i.e. no broken bottles, leaks etc.) Yes No
- VOAs checked for Headspace? Yes No N/A
- Were all analyses within holding times at time of receipt? Yes No
- Verify sample date, time and sampler name Yes No

Sign and date the COC, place in a ziplock and put in the same ice chest as the samples.

Sample Receipt Review completed by (initials): MDU

Sample Receipt at SP:

- Number of ice chests/packages received: 3 Shipping tracking #(s): 502171895
502171904
502171891
- Temp IR Gun ID #: TH 719A
- Were samples received on ice? Yes No Temps: 2c / _____ / _____ / _____
Acceptable is above freezing to 6°C. If many packages are received at one time check for tests/H.T.'s/rushes/
- Do the number of bottles received agree with the COC? Yes No N/A
- Were samples received intact? (i.e. no broken bottles, leaks etc.) Yes No

Sign and date the COC, obtain LIMS sample numbers, select methods/tests and print labels.

Sample Verification, Labeling and Distribution:

- Were all requested analyses understood and acceptable? Yes No
- Did bottle labels correspond with the client's ID's? Yes No
- Were all bottles requiring sample preservation properly preserved? Yes No N/A FGL
[Exception: Oil & Grease, VOA and CrVI verified in lab]
- VOAs checked for Headspace? Yes No N/A
- Have rush or project due dates been checked and accepted? Yes No N/A
- Were all analyses within holding times at time of receipt? Yes No

Attach labels to the containers and include a copy of the COC for lab delivery.

Sample Receipt, Login and Verification completed by (initials): MDU

Discrepancy Documentation:

Any items above which are "No" or do not meet specifications (i.e. temps) must be resolved.

- Person Contacted: Christian Hoover Phone Number: In Person
Initiated By: MDU Date: 10/23/24
Problem: -4 16oz less than 1/2 filled, -3 containers less than 1/2 filled
Resolution: Analyze as received if possible.
- Person Contacted: _____ Phone Number: _____
Initiated By: _____
Problem: _____
Resolution: _____

(7010503)
Luhdorff & Scalmanini Consulting
CH 2479967

iv 10/25/2024 07:47:13



CH 2479967