ANNUAL REPORT | APRIL 2025

BOWMAN SUBBASIN (5-006.01) GROUNDWATER SUSTAINABILITY PLAN ANNUAL REPORT – 2024

SUBMITTED BY

TEHAMA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT GROUNDWATER SUSTAINABILITY AGENCY

PREPARED BY

Prepared by Luhdorff and Scalmanini Consulting Engineers and Davids Engineering on behalf of the Tehama County Flood Control and Water Conservation District GSA for the Bowman Subbasin.

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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 County 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
GPS	global positioning 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 Bowman Subbasin (Subbasin) (5-006.01) 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 Bowman Subbasin, located within Tehama County, as 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 a 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(s) (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 objectives (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.

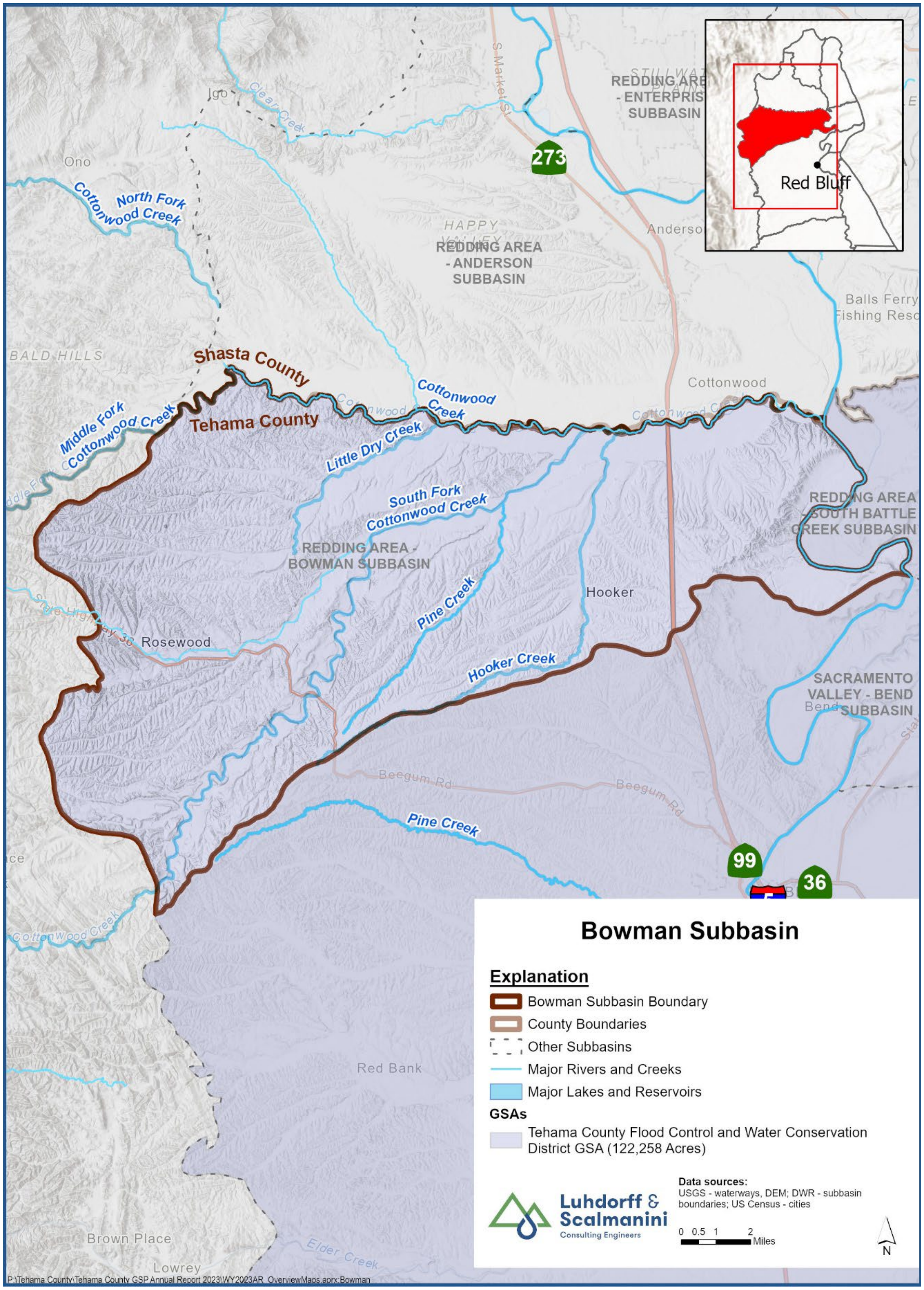

Figure ES-1. Bowman Subbasin and Groundwater Sustainability Agency Boundaries

Table ES-1. Bowman Subbasin Sustainability Indicator Summary			
2024 Status	**Undesirable Result Identification**	**MO Definition**	**MT Definition**
Chronic Lowering of Groundwater Levels			
No indication of undesirable results There were no RMS wells with spring or fall 2024 groundwater level measurements below the MT.	25% of groundwater elevations measured at same RMS wells exceed the associated MT for two consecutive measurements.	**Upper & Lower Aquifer:** Spring 2015 groundwater elevation minus five feet (ft) (for wells with increasing or no groundwater trends) or projected spring 2042 groundwater elevation minus five ft for wells with declining groundwater elevations.	**Upper Aquifer:** Spring groundwater elevation where less than 10% or less than 20% of domestic wells could potentially be impacted. **Lower Aquifer:** Spring groundwater elevation minus 20 to 120 ft.
Reduction of Groundwater Storage			
No indication of undesirable results There were no RMS wells with spring or fall 2024 groundwater level measurements below the MT.	Same as the chronic lowering of groundwater levels.	**Upper & Lower Aquifer:** Amount of groundwater storage when groundwater elevations are at their MO.	**Upper & Lower Aquifer:** Amount of groundwater in storage when groundwater elevations are at their MT.
Degraded Water Quality			
No indication of undesirable results There were no RMS wells with spring or fall 2024 TDS measurements above the MO or MT.	At least 25% of RMS exceed the MT for water quality for two consecutive years at each well where it can be established that GSP implementation is the cause of the exceedance.	**Upper & Lower Aquifer:** California lower limit secondary MCL concentration for TDS of 500 mg/L measured at RMS wells.	**Upper & Lower Aquifer:** TDS concentration of 750 mg/L at all RMS wells.

Table ES-1. Bowman 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 of 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 wells with spring or fall 2024 groundwater level measurements below the MT.	25% of groundwater elevations measured at RMS wells dropped below the associated threshold during two consecutive years in the Upper Aquifer.	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; MCL = Maximum Contaminant Level; SMCL = Secondary Maximum Contaminant Level.

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 the spring of 2024, with only one well that fell below the MO in the fall of 2024. 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, 69 ft above the MT throughout the Subbasin and, on average, 7 ft above the MO in spring 2024 and 2 ft 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 and decreased groundwater extractions, which contributed to the recovery of groundwater conditions relative to the dry period from WY 2020 to WY 2022.

The balance between aquifer recharge and extraction influences fluctuations in groundwater levels and storage within the Subbasin. 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 12,200 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 -47,000 AF, and the highest increase was estimated to be 54,000 AF. **Figure ES-2** shows groundwater pumping, as well as annual and cumulative changes in groundwater storage from WY 1990 to WY 2024.

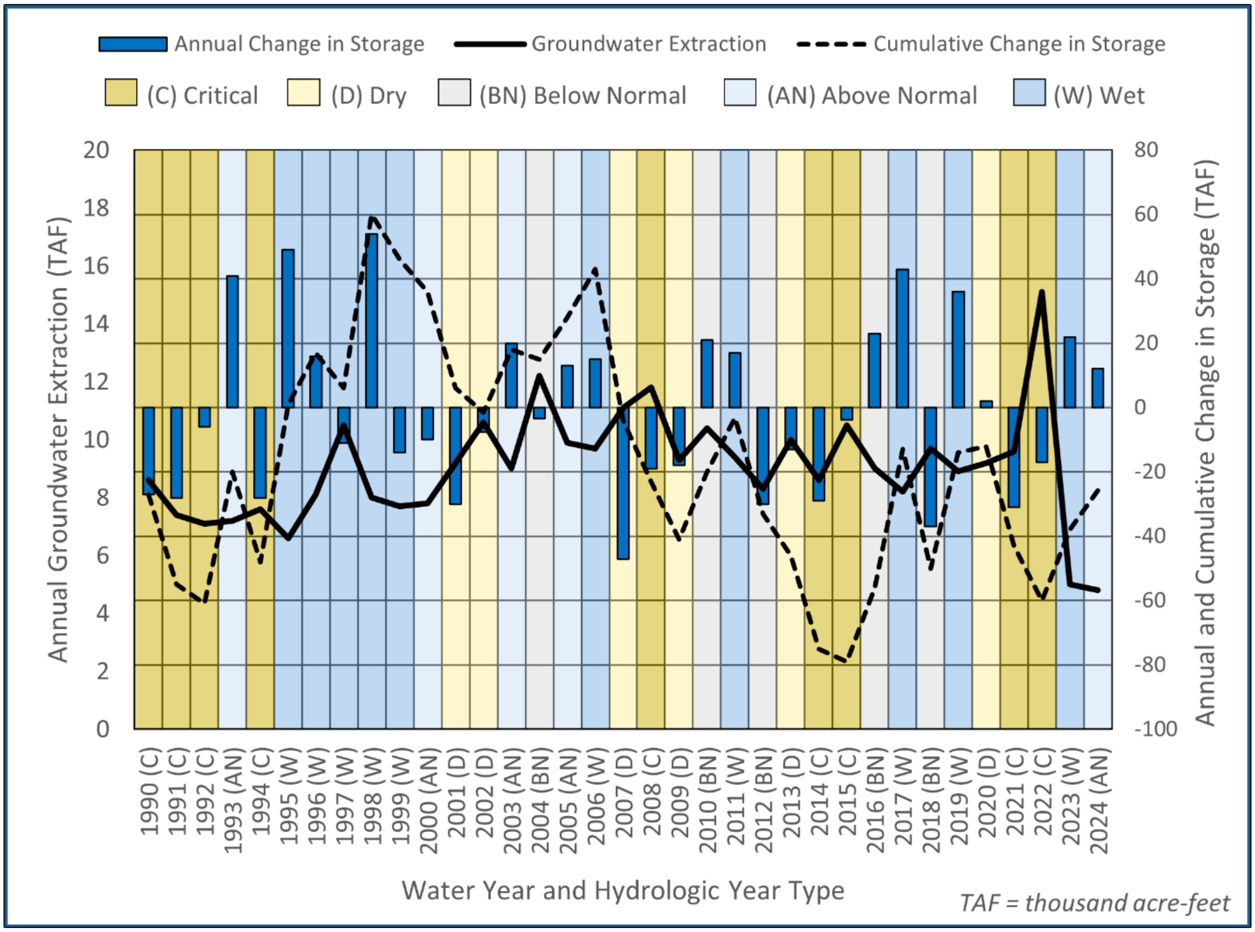

Figure ES-2. Bowman Subbasin Groundwater Pumping, Annual and Cumulative Change in Storage from WY 1990 to WY 2024

Water Use

Groundwater extraction was approximately 4,900 AF in WY 2024, lower than the 5,000 AF extracted in WY 2023. The annual volume of surface water delivered to the Subbasin from surface water features such as Little Dry Creek, South Fork Cottonwood Creek, Pine Creek, and Hooker Creek was about 15,200 AF in WY 2024, higher than the 10,000 AF delivered in WY 2023. The decrease in groundwater estimates in WY 2024 compared to WY 2023 was influenced by a variety of factors, including increased surface water and effective precipitation in WY 2024 (relative to WY 2023).

Surface water provides the majority (84%) of the water for agriculture in the Subbasin, and groundwater water is the source for the remainder (15%). 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. Bowman Subbasin Total Water Use by Water Use Sector				
Sector	WY 2024 (AF)			
	Groundwater	Surface Water	Total	Total Irrigated Area (acres)
Agricultural	2,800	15,200	**18,000**	**3,900**
Municipal	600	0	**600**	**0**
Rural Residential	1,500	0	**1,500**	**0**
Total	**4,900**	**15,200**	**20,100**	**3,900**

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 **Section 5.3**.
- 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 1 PMA 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 of Subbasin conditions and submission to DWR as required by SGMA.
- Ongoing intra- and inter-basin coordination.

Since 2023, the Tehama County GSA in the Subbasin 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)

The Annual Report for the Bowman Subbasin (Subbasin) (5-006.01) was prepared on behalf of the Tehama Flood Control and Water Conservation District and the Tehama County Groundwater Sustainability Agency (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 Bowman Subbasin and GSP Implementation, Technical Advisory Committee meeting schedules and recordings, and other resources should visit the **(https://tehamacountywater.org/gsa/)** website.

1.1 Report Contents

This report is the fourth annual report prepared for the Bowman Subbasin GSP submitted in January 2022. 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, the 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 192 square mile (122,500 acre) area in the Redding Area Groundwater Basin in northern 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 Redding Area Groundwater Subbasin, **Figure 1-1**. The Subbasin's northern boundary is the Anderson Subbasin, the southern boundary is the Red Bluff Subbasin, the eastern boundary is the South Battle Creek Subbasin, and the western boundary is the Northern Coast Mountain Ranges (DWR, 2018), **Figure 1-2**. Several surface water features are located in the Subbasin, including Cottonwood Creek and the Sacramento River. Smaller local streams entering and traversing the Subbasin include Little Dry Creek, Pine Creek, and Hooker Creek. Groundwater generally flows from west/northwest to east/southeast.

The Bowman GSP estimates the sustainable yield of the Subbasin to be 10,000 acre-feet (AF) based on projected long-term groundwater pumping averages of 6,200 acre-feet per year AFY and an annual decrease in storage of 122,425 AFY (Tehama County GSA 2021). Water use in the Subbasin is dominated (90%) by agricultural uses; the remaining uses (10%) include municipal and household water uses. Surface water constitutes the majority (76%) of the Subbasin's water supplies, with groundwater comprising the remaining portion (24%).

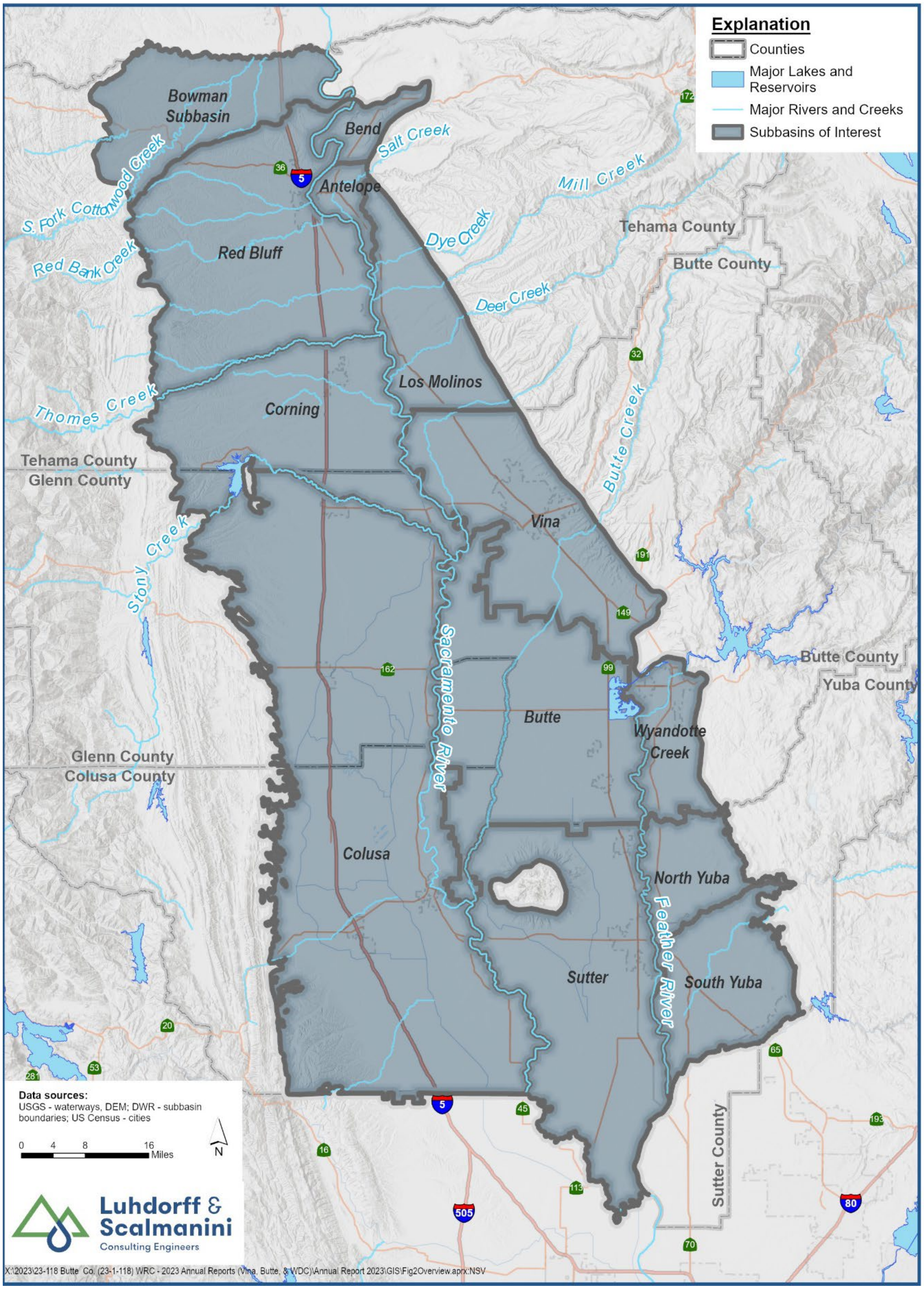

Figure 1-1. Subbasins in the North Sacramento Valley

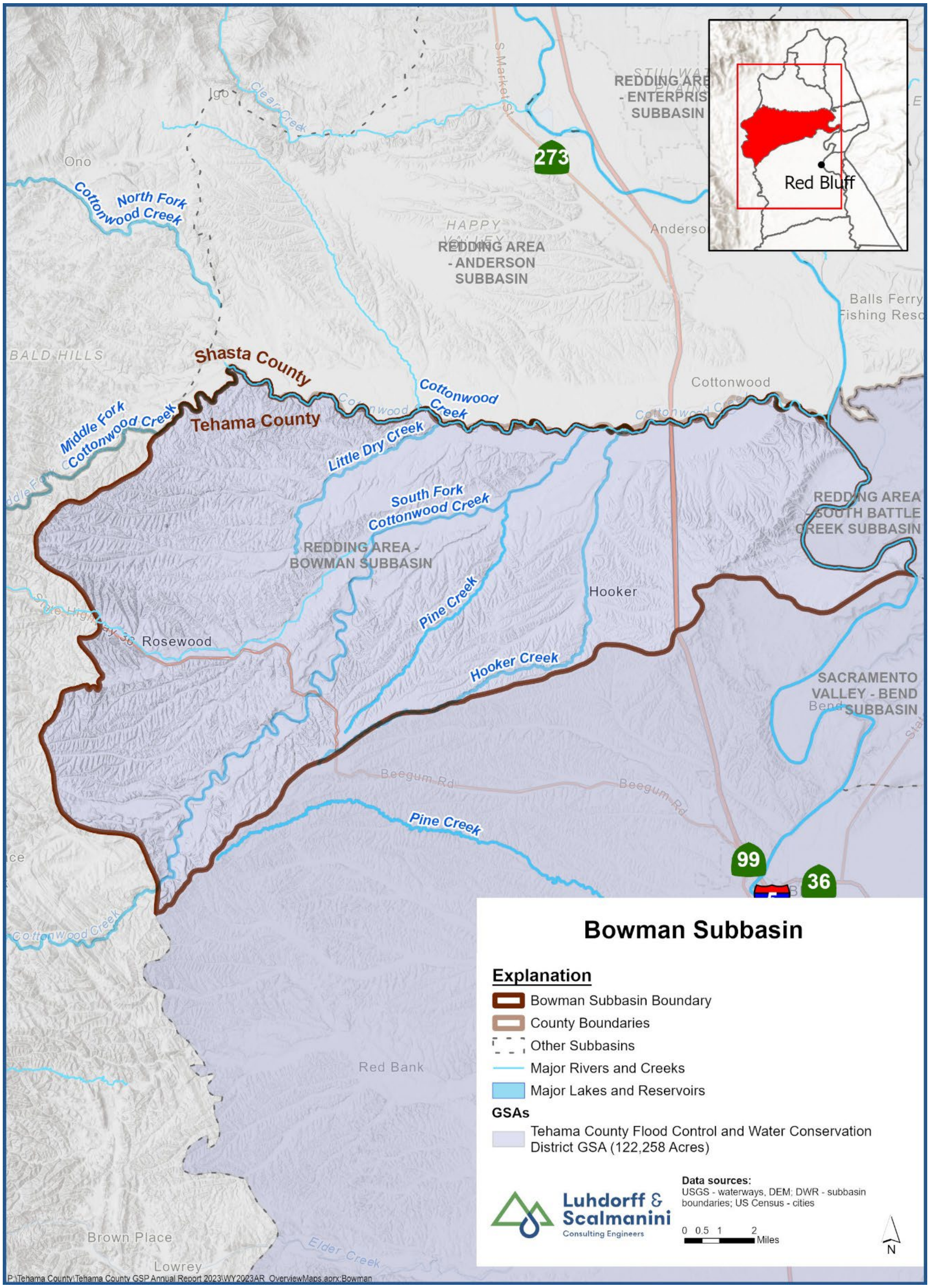

Figure 1-2. Bowman Subbasin and Groundwater Sustainability Agency Boundaries

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) provide an indication of 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 seven (7) RMS wells used to monitor conditions in the Upper and Lower Aquifer. RMS wells are identified in **Table 5-2**. **Appendix A** includes hydrographs depicting 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 is 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 and Lower Aquifer systems are summarized in **Table 5-2**. The groundwater level monitoring methods are consistent with the protocols described in the Bowman 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 ft or 0.1 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 and Lower Aquifer, as shown in **Figures 2-1** through **2-4**. Spring contours are intended to generally represent seasonal high groundwater elevations (shallower depth to water), while 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. Water level measurements for fall 2024 in the lower aquifer were only available for one well; therefore, water level elevation contours were not prepared (**Figure 2-4**).

The contour maps of the Upper Aquifer and Lower Aquifer (**Figures 2-1 through 2-4**) each show that groundwater elevations are generally higher in the western areas of the Subbasin versus the eastern areas, indicating a general gradient – and thus groundwater flow – from the west/northwest to the east/southeast. The contour maps illustrate several general features of the groundwater flow system in the Bowman Subbasin, including:

- Overall, west/northwest to east/southeast groundwater flow is consistent with recharge from the Northern Coastal Mountain Ranges.
- Movement of water towards the Sacramento River in both the fall and the spring.
- The higher concentration of contours in the 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 Northern Coastal Mountain Ranges foothills. New sources of information and data may improve understanding of this area.

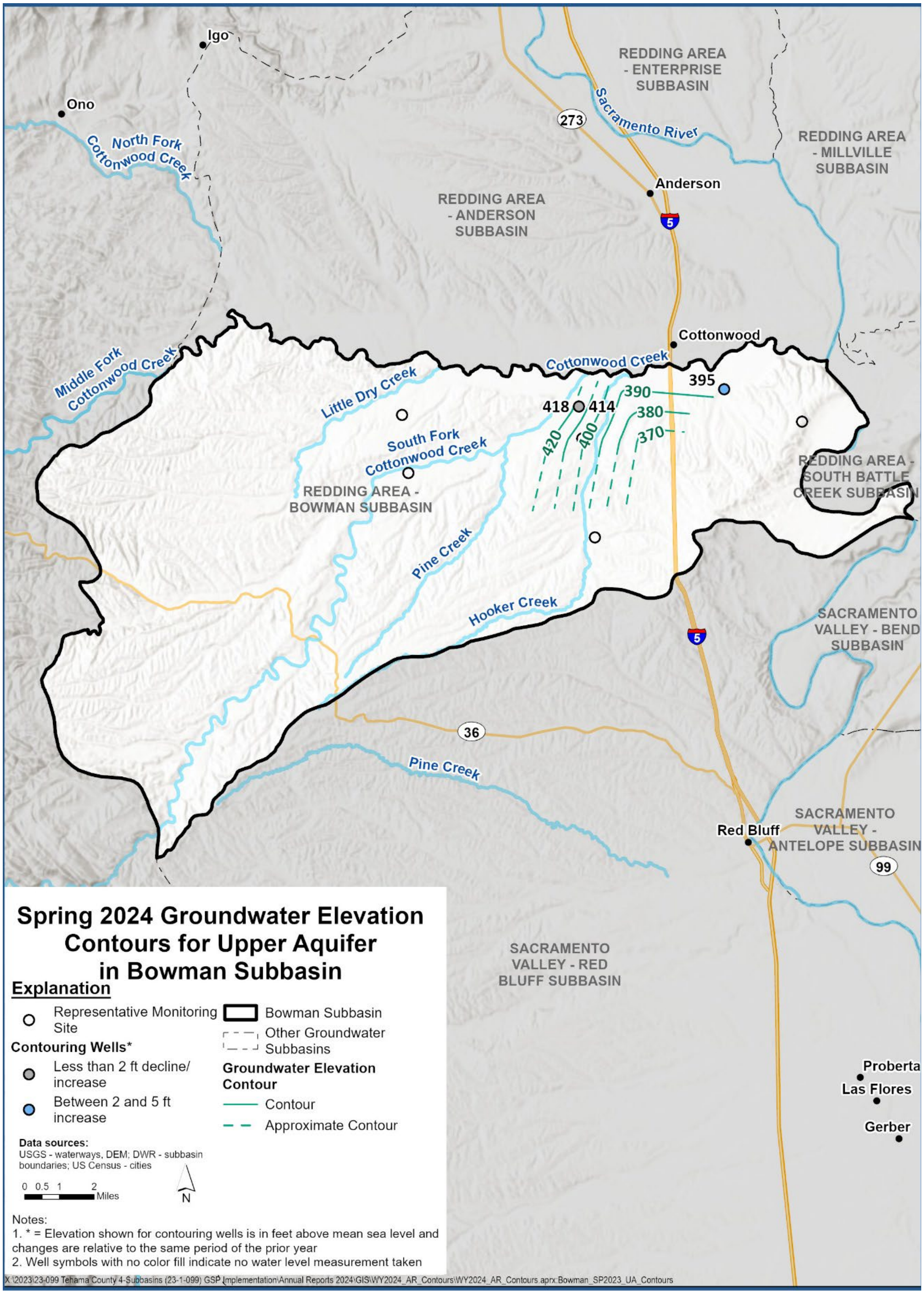

Figure 2-1. Bowman Subbasin Contours of Equal Groundwater Elevation for the Upper Aquifer, Spring 2024 (Seasonal High)

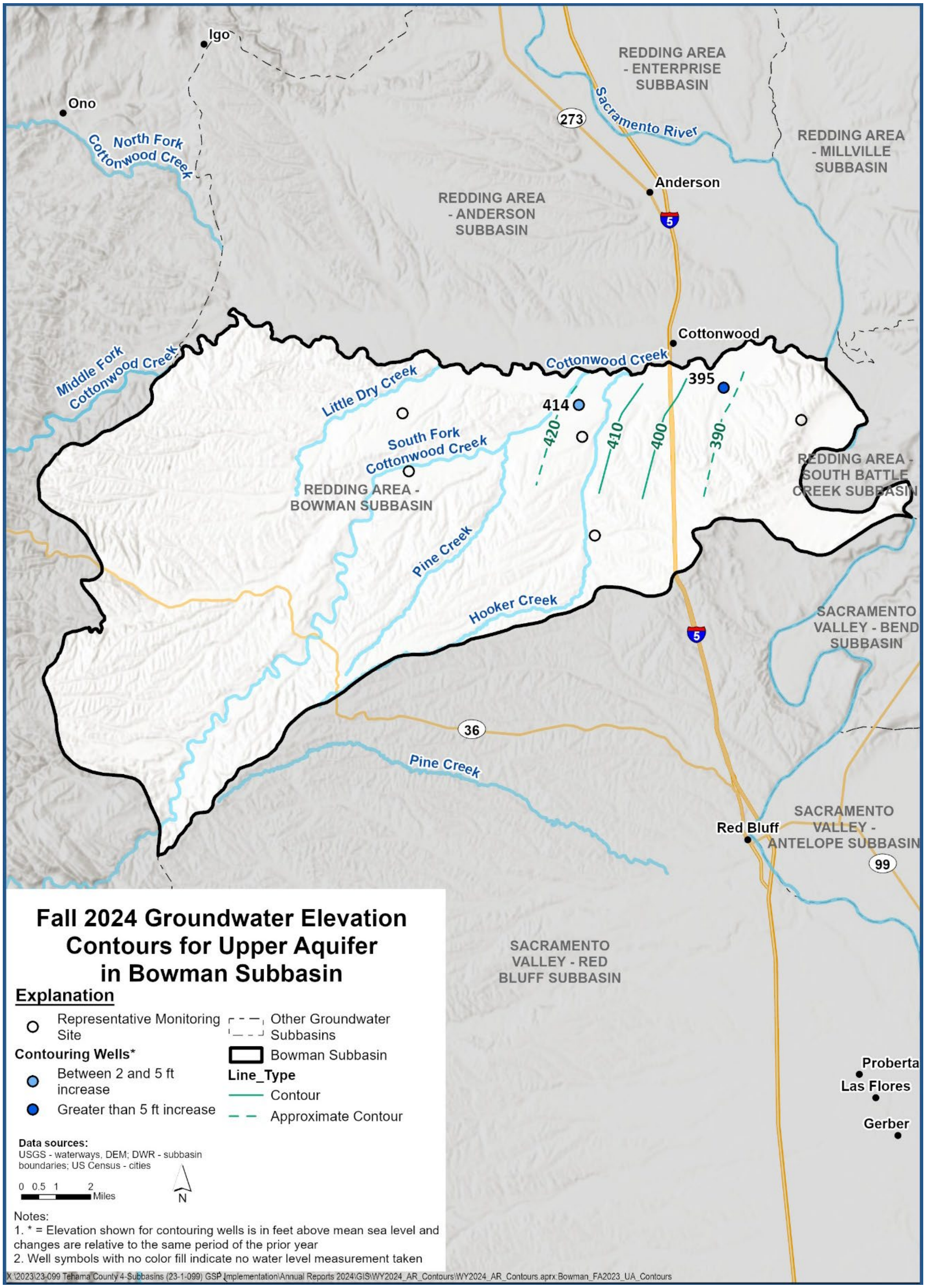

Figure 2-2. Bowman Subbasin Contours of Equal Groundwater Elevation for the Upper Aquifer, Fall 2024 (Seasonal Low)

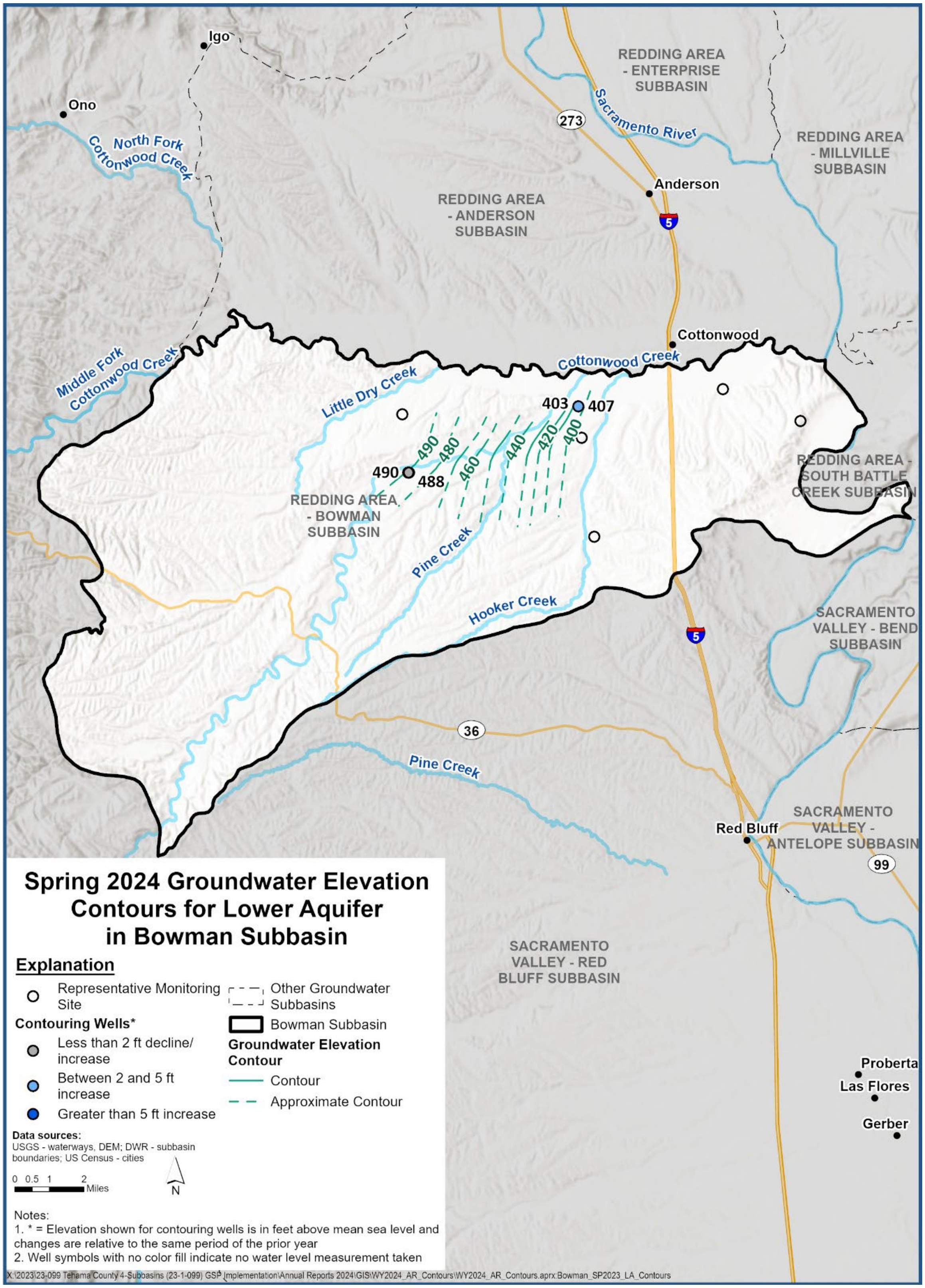

Figure 2-3. Bowman Subbasin Contours of Equal Groundwater Elevation for the Lower Aquifer, Spring 2024 (Seasonal High)

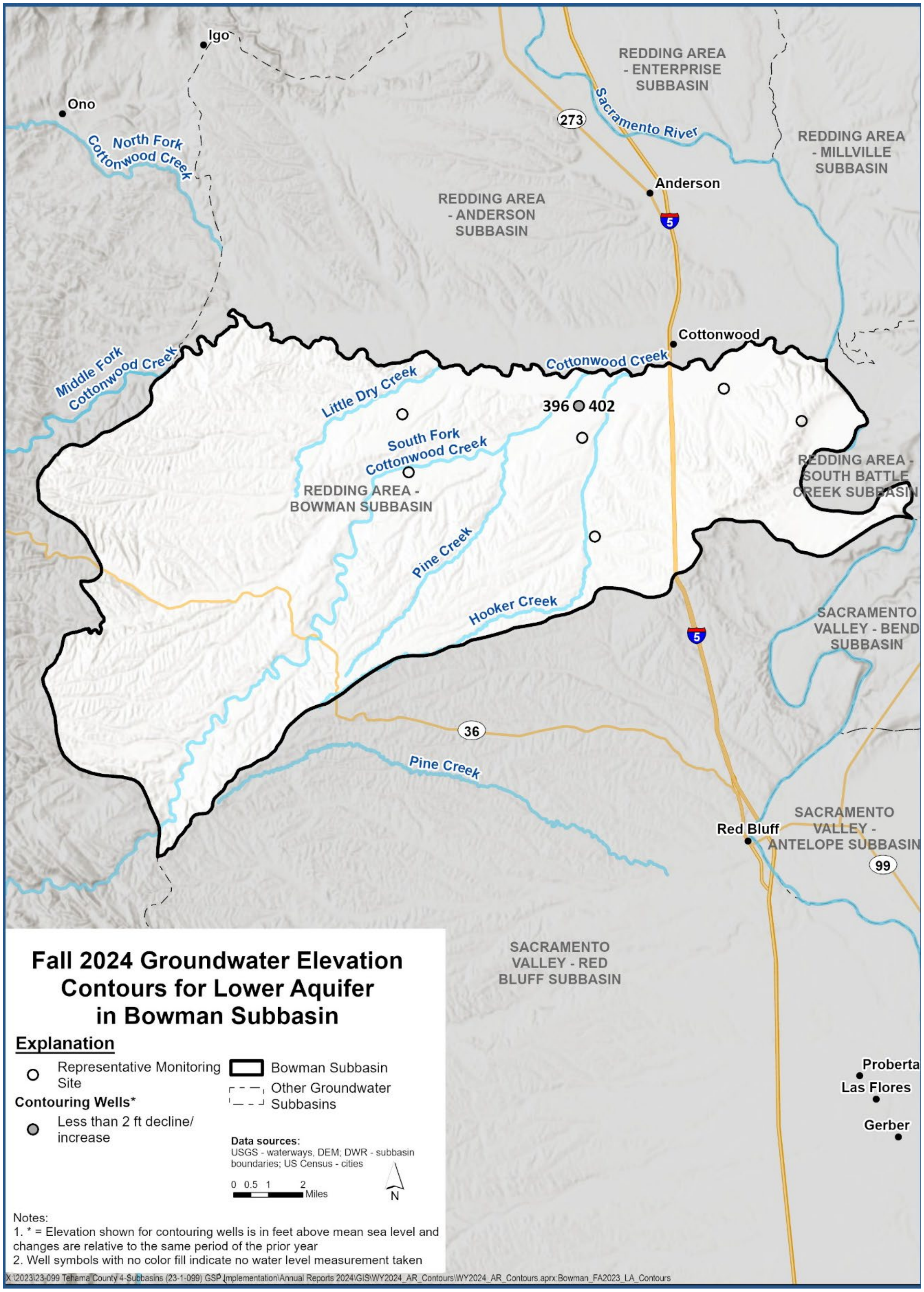

Figure 2-4. Bowman Subbasin Contours of Equal Groundwater Elevation for the Lower Aquifer, Fall 2024 (Seasonal Low)

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** provides an explanation of 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 WY 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 in the Upper Aquifer was 426.30 feet above mean sea level (AMSL), and the average seasonal low was 399.85 feet AMSL. In WY 2024, the average seasonal high in the Lower Aquifer was 449.27 feet AMSL, and the average seasonal low was 396.49 feet AMSL. In WY 2022, the average seasonal high was 409 feet AMSL, and in WY 2023, the average seasonal high was 423.71 feet AMSL. Increases in groundwater level elevations are generally expected to result from decreased groundwater extraction in WY 2024 relative to WY 2023, as well as increased recharge due to above normal climate conditions.

All wells remained above the MO as of spring 2024, and only one well (Bow-6L) fell below the MO in fall 2024 by 0.11 feet. All measured groundwater elevations remained above the corresponding MT of that RMS well, avoiding undesirable results related to groundwater levels as defined in the GSP in WY 2024. On average, groundwater levels in RMS wells were roughly 82 feet higher than MT elevations in spring 2024 and 42 feet higher than MT elevations in fall 2024. All measured groundwater levels remained within the Subbasin's margin of operational flexibility and above the MT's.

3 WATER SUPPLY AND USE

As required by §356.2, this section summarizes water supply and use in the Subbasin, categorized by groundwater extraction volume, 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 is presented in **Appendix D**. The water use analysis methodology is discussed in **Appendix E**. Surface water use was estimated from historic deliveries when records were not available.

Table 3-1. Bowman Subbasin Groundwater Use by Water Use Sector	
Sector	**WY 2024 (AF)**
Agricultural	2,800
Municipal	600
Rural Residential	1,500
Total	**4,900**

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

Groundwater extraction in the Subbasin is summarized in **Table 3-1**. Groundwater extraction is obtained from pumping records where available, with the remaining groundwater extraction 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, diminished 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, substantial surface water supplies help to increase recharge and offset extraction, bolstering groundwater storage.

Municipal water users extracted approximately 600 AF in the Subbasin in WY 2024. Municipal water supplies are measured and provided by the Rio Alto Water District. 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 4,900 AF in WY 2024. The total groundwater extraction is about 4,300 AF less than the historical groundwater pumping average (9,200 AFY; **Table 4-1**) and less than 8,500 AF, which was the average annual extraction of the last four above-normal WYs on record (1993, 2000, 2003, and 2005). **Figure 3-1** shows the general areas where groundwater is applied in the Subbasin. About 57% of the total groundwater extraction was used by the agricultural sector, while the remaining 43% was used for municipal and rural residential water needs.

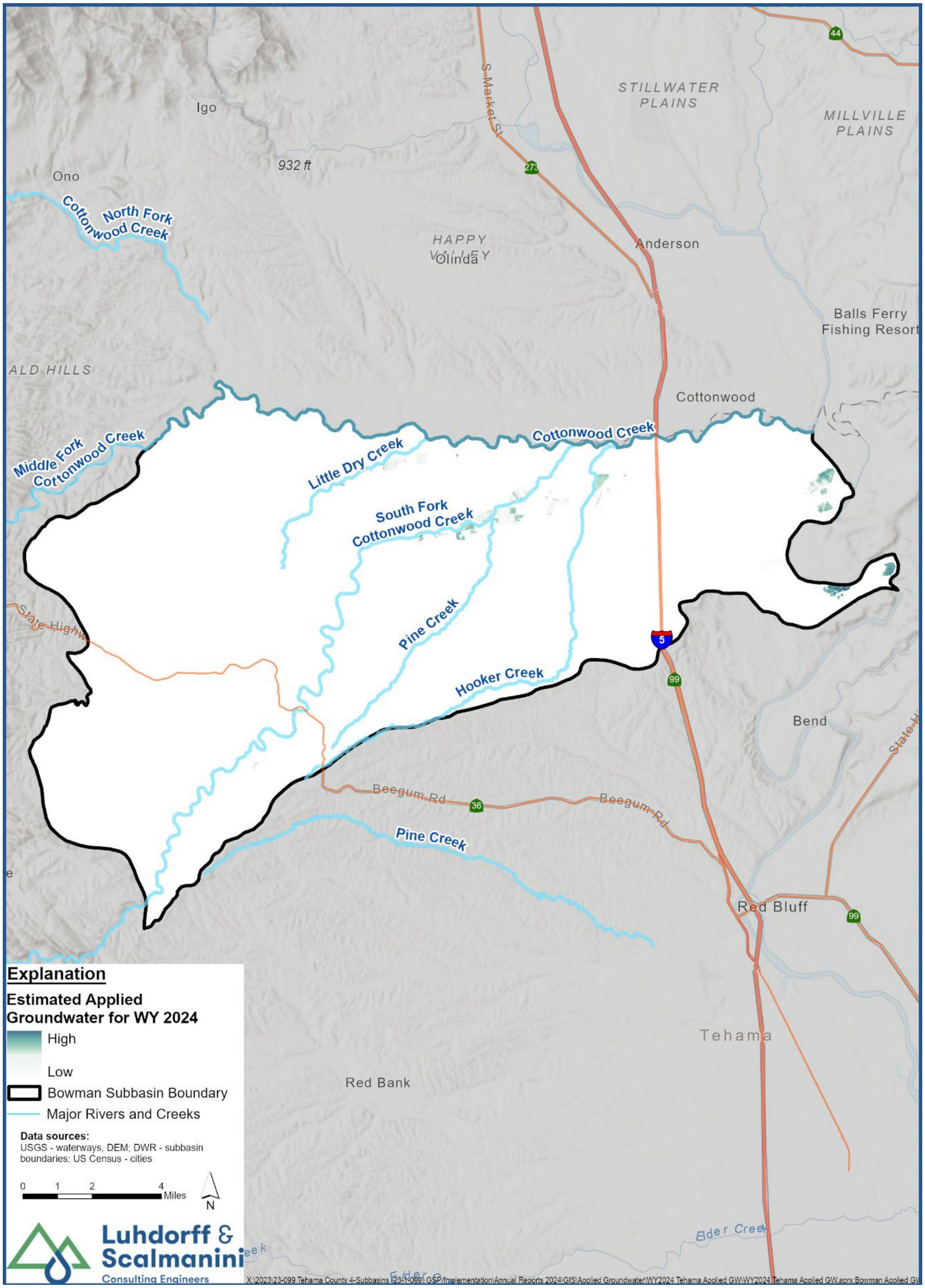

Figure 3-1. Bowman Subbasin Estimated Applied Groundwater – WY 2024

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 84% of the agricultural water demand in the Subbasin for WY 2024. Diversions from surface water features such as the Sacramento River and Cottonwood Creek were accessed from the State Water Resource Control Board's (SWRCB) Electronic Water Rights Information Management System (eWRIMS; SWRCB, 2023). 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 Bowman Subbasin. Total surface water diversions and deliveries for the Bowman Subbasin are estimated to be about 25,100 AF and 15,200 AF, respectively.

WY 2024 was an above normal WY, indicating less overall precipitation than the wet hydrologic conditions in WY 2023. Despite receiving less precipitation in WY 2024, surface water use increased in WY 2024 compared to WY 2023.

Table 3-2. Bowman Subbasin Surface Water Use by Water Use Sector for WY 2024

Sector	Diverted (AF)	Applied (AF)
Agricultural	25,100	15,200
Total	**25,100**	**15,200**

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 (76%) and groundwater (24%). 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.

Table 3-3. Bowman Subbasin Total Water Use by Water Use Sector

Sector	WY 2024 (AF)			
	Groundwater	Surface Water	Total	Total Irrigated Area (acres)
Agricultural	2,800	15,200	**18,000**	**3,900**
Municipal	600	0	**600**	**0**
Rural Residential	1,500	0	**1,500**	**0**
Total	**4,900**	**15,200**	**20,100**	**3,900**

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. Bowman 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 (despite recent positive trends in the past couple of water years). 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 12,200 AF. Decreased groundwater extraction in WY 2024 relative to WY 2023 contributed to the increase in groundwater storage, as well as increased recharge due to above normal climate conditions. These and related factors, such as increased 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 12,200 AF in the Upper and Lower Aquifer. For context, in the past 34 years, the largest decrease in groundwater storage is estimated to be -47,000 AF, and the highest increase was estimated to be 54,000 AF.

The Tehama Integrated Hydrogeologic Model (TIHM; Tehama County, 2021) was used to estimate groundwater pumping, groundwater uptake, change in storage, and cumulative change in storage for WY 1990 through WY 2019. 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 2020-2024 was estimated based on the methods described in **Section 4.2**. Groundwater extractions for the entire period include 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 below 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. Bowman Subbasin Annual Groundwater Extraction and Change in Storage			
Water Year (Hydrologic Year Type)	Groundwater Extraction[1] (AF)	Annual Change in Storage (AF)	Cumulative Change in Storage (AF)
1990 (C)	8,600	-27,000	-27,000
1991 (C)	7,400	-28,000	-55,000
1992 (C)	7,100	-6,000	-61,000
1993 (AN)	7,200	41,000	-20,000
1994 (C)	7,600	-28,000	-48,000
1995 (W)	6,600	49,000	1,000
1996 (W)	8,100	16,000	17,000
1997 (W)	10,500	-11,000	6,000
1998 (W)	8,000	54,000	60,000
1999 (W)	7,700	-14,000	46,000
2000 (AN)	7,800	-10,000	36,000
2001 (D)	9,200	-30,000	6,000
2002 (D)	10,600	-7,600	-1,600
2003 (AN)	9,000	20,000	18,000
2004 (BN)	12,200	-3,500	15,000
2005 (AN)	9,900	13,000	28,000
2006 (W)	9,700	15,000	43,000
2007 (D)	11,100	-47,000	-4,100
2008 (C)	11,800	-19,000	-23,000
2009 (D)	9,300	-18,000	-41,000
2010 (BN)	10,400	21,000	-20,000
2011 (W)	9,400	17,000	-3,100
2012 (BN)	8,300	-30,000	-33,000
2013 (D)	10,000	-13,000	-46,000
2014 (C)	8,600	-29,000	-75,000
2015 (C)[2]	10,500	-3,800	-79,000
2016 (BN)	9,000	23,000	-56,000
2017 (W)	8,200	43,000	-13,000
2018 (BN)	9,700	-37,000	-50,000
2019 (W)	8,900	36,000	-14,000
2020 (D)	9,200	2,000	-12,000
2021 (C)[2]	9,600	-31,000	-43,000

Table 4-1. Bowman Subbasin Annual Groundwater Extraction and Change in Storage			
Water Year (Hydrologic Year Type)	Groundwater Extraction[1] (AF)	Annual Change in Storage (AF)	Cumulative Change in Storage (AF)
2022 (C) [2]	15,100	-17,000	-60,000
2023 (W)	5,000	22,000	-38,000
2024 (AN)	4,900	12,200	-25,800
Historic Averages (1990-2023) [3]			
1990-2023 (33 years)	9,200	-1,100	
W (9 years)	8,200	23,000	
AN (4 years)	8,500	16,000	
BN (5 years)	9,900	-5,300	
D (6 years)	9,900	-19,000	
C (9 years)	10,000	-21,000	

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 2021; groundwater extraction values for WY 2023 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.*

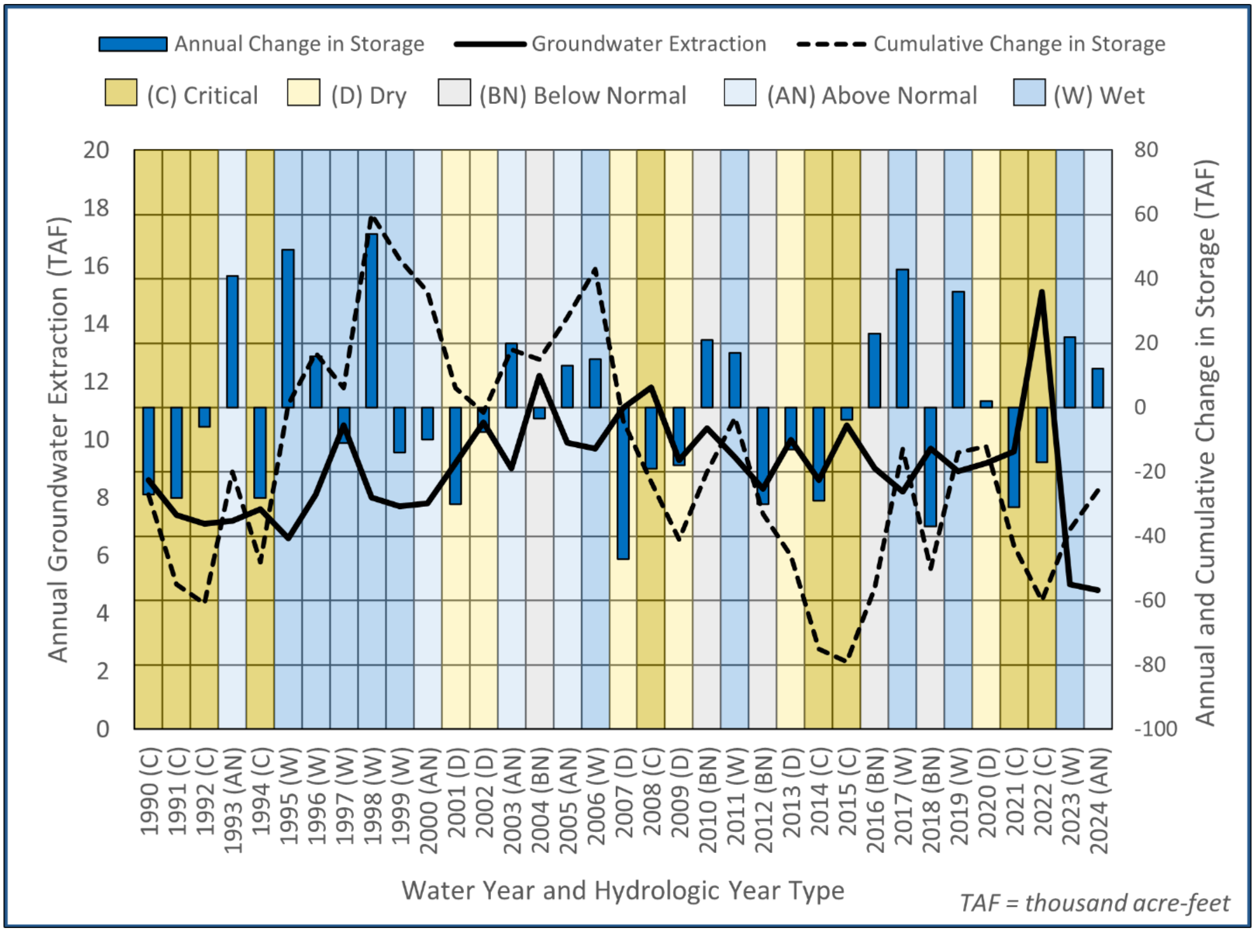

Figure 4-1. Bowman Subbasin Groundwater Extraction and Change in Groundwater Storage from WY 1990 to WY 2024

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. 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 -14 and 2,600 AF. The western portion of the Subbasin had a larger positive change in storage. Total groundwater storage change in the Upper Aquifer was estimated to be approximately 4,500 AF between spring 2023 and spring 2024. As shown in **Figure 4-3**, the change in storage within the Lower Aquifer from spring 2023 to spring 2024 was between 1,900 and 3,400 AF. Total groundwater storage change in the Lower Aquifer was estimated to be approximately 7,700 AF between spring 2023 and spring 2024.

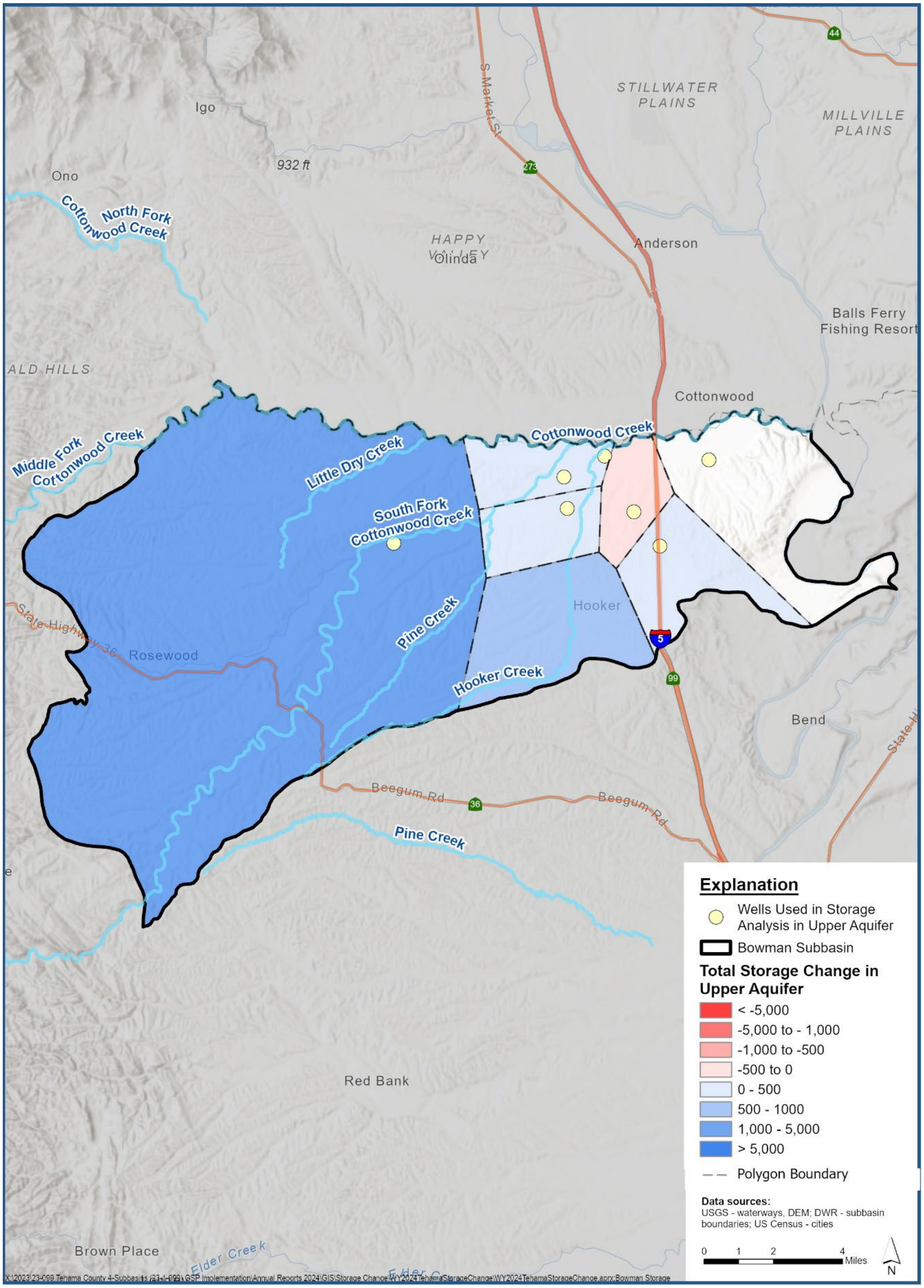

Figure 4-2. Bowman Subbasin Change in Groundwater Storage from Spring 2023 to Spring 2024 in the Upper Aquifer

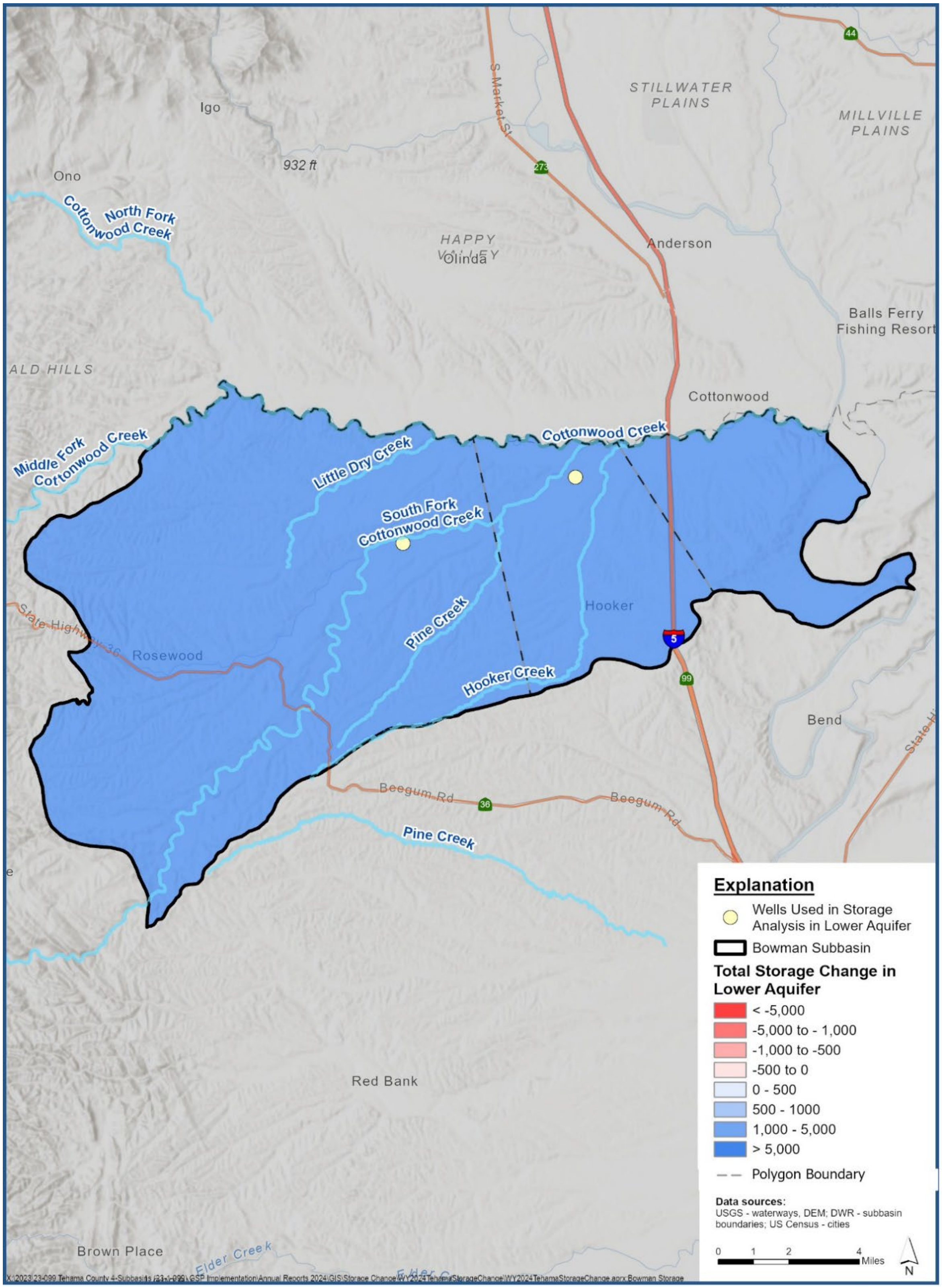

Figure 4-3. Bowman Subbasin Change in Groundwater Storage from Spring 2023 to Spring 2024 in the Lower Aquifer

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 (0.007 – 0.0259) from the TIHM was used to calculate the change in storage. 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 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 **Section 5.3**.
- 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 1 PMA 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.

5.2 Progress Toward Achieving Interim Milestones

All SIs are in compliance with their MTs (see summary **Table 5-1**). A 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 an 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 SMC, as the value of total dissolved solids (TDS) increases 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 near the MOs in spring and fall of 2024; and avoided URs since less than 25% of wells fell below their MTs for two consecutive years, hence avoiding undesirable results as defined in the GSP.

Overall, groundwater conditions in the Subbasin are on track to meet the first 5-year 2027 IMs 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 is attributed to the ongoing recovery in groundwater conditions facilitated by increased surface water supplies in WY 2024 following two recent years of cutbacks in WY 2021 and WY 2022. Spring 2024 groundwater elevations were above the established MOs; one well fell below MO in fall 2024 (**Table 5-2**).

Table 5-1. Bowman Subbasin Sustainability Indicator Summary			
2024 Status	**Undesirable Result Identification**	**MO Definition**	**MT Definition**
Chronic Lowering of Groundwater Levels			
No indication of undesirable results There were no RMS wells with spring or fall 2024 groundwater level measurements below the MT.	25% of groundwater elevations measured at same RMS wells exceed the associated MT for two consecutive measurements.	**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.	**Upper Aquifer:** Spring groundwater elevation where less than 10% or less than 20% of domestic wells could potentially be impacted. **Lower Aquifer:** Spring groundwater elevation minus 20 to 120 feet.
Reduction of Groundwater Storage			
No indication of undesirable results There were no RMS wells with spring or fall 2024 groundwater level measurements below the MT.	Same as the chronic lowering of groundwater levels.	**Upper & Lower Aquifer:** Amount of groundwater storage when groundwater elevations are at their MO.	**Upper & Lower Aquifer:** Amount of groundwater in storage when groundwater elevations are at their MT.
Degraded Water Quality			
No indication of undesirable results There were no RMS wells with spring or fall 2024 TDS measurements above the MO or MT.	At least 25% of RMS exceed the MT for water quality for two consecutive years at each well where it can be established that GSP implementation is the cause of the exceedance.	**Upper & Lower Aquifer:** California lower limit secondary MCL concentration for TDS of 500 mg/L measured at RMS wells.	**Upper & Lower Aquifer:** TDS concentration of 750 mg/L at all RMS wells.

Table 5-1. Bowman 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 of 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 wells with spring or fall 2024 groundwater level measurements below the MT.	25% of groundwater elevations measured at RMS wells dropped below the associated threshold during two consecutive years in the Upper Aquifer.	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; MCL = Maximum Contaminant Level; SMCL = Secondary Maximum Contaminant Level.

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 IMs 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. Bowman 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								
Bow-1U	394.62	390.84	386.30	318.50	8.32	4.54	3.68	5.1
Bow-2U	401.54	--	395.10	372.50	6.44	--	1.0	--
Bow-2UR	413.81	408.87	NA	NA	--	--	4.72	3.66
Bow-3U	495.26	--	484.90	419.60	--	--	0.98	--
Bow-4U	--	--	404.80	377.50	--	--	--	--
Lower Aquifer								
Bow-5L	--	--	338.50	294.00	--	--	--	--
Bow-6L	402.90	396.49	396.60	351.80	6.3	-0.11	2.96	-0.29
Bow-7LR	495.64	--	NA	NA	--	--	12.78	--

MO = Measurable Objective, MT = Minimum Threshold, -- = Indicates Missing or Questionable Measurement, NA = Indicates non-determined MO, MT due to insufficient history; [1] No longer monitored by DWR. Well has been removed from the groundwater monitoring network.

5.2.2 Degraded Water Quality SMC

The degraded water quality MT and MO are summarized in **Table 5-1**. TDS is the main constituent of concern in the Subbasin. TDS is measured at RMS wells throughout the Subbasin, and data was collected by the Tehama County GSA in 2024. For WY 2024, four (Bow-2U, Bow-3U, Bow-4U, and Bow-7L) of the seven RMS wells were not available for monitoring, and alternates were identified for sampling (Bow-

2UR). TDS ranged from 150 mg/L to 200 mg/L. None of the wells exceeded MO or MT for TDS 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 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 over a 5-year period. Subsidence measured by InSAR in WY 2024 (**Figure 5-1)** ranged from -0.036 feet of subsidence to 0.03 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 undesirable results for land subsidence. Conditions indicate that there has not been any inelastic land subsidence during the reporting periods.

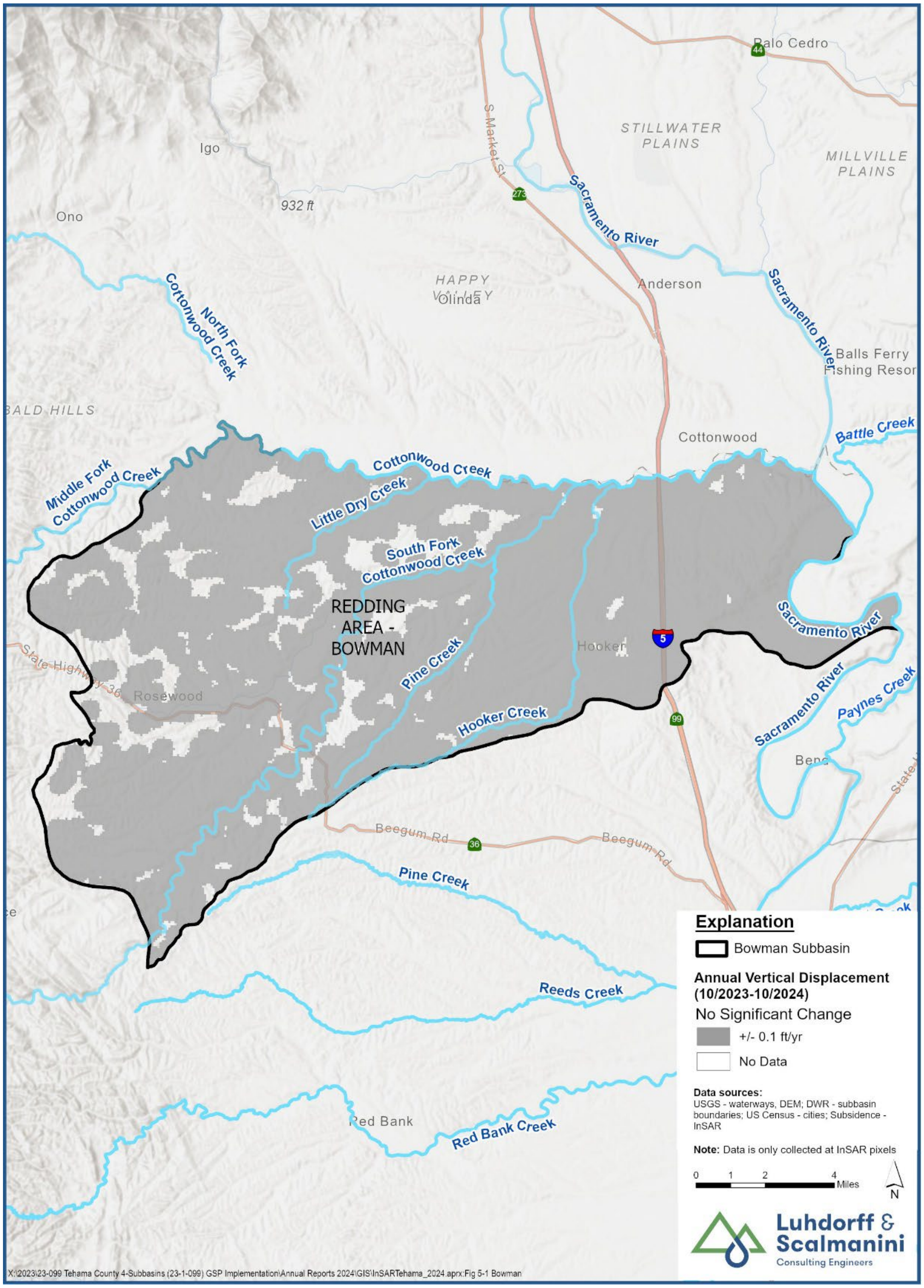

Figure 5-1. Bowman Change in Subsidence from 10/2023 to 10/2024

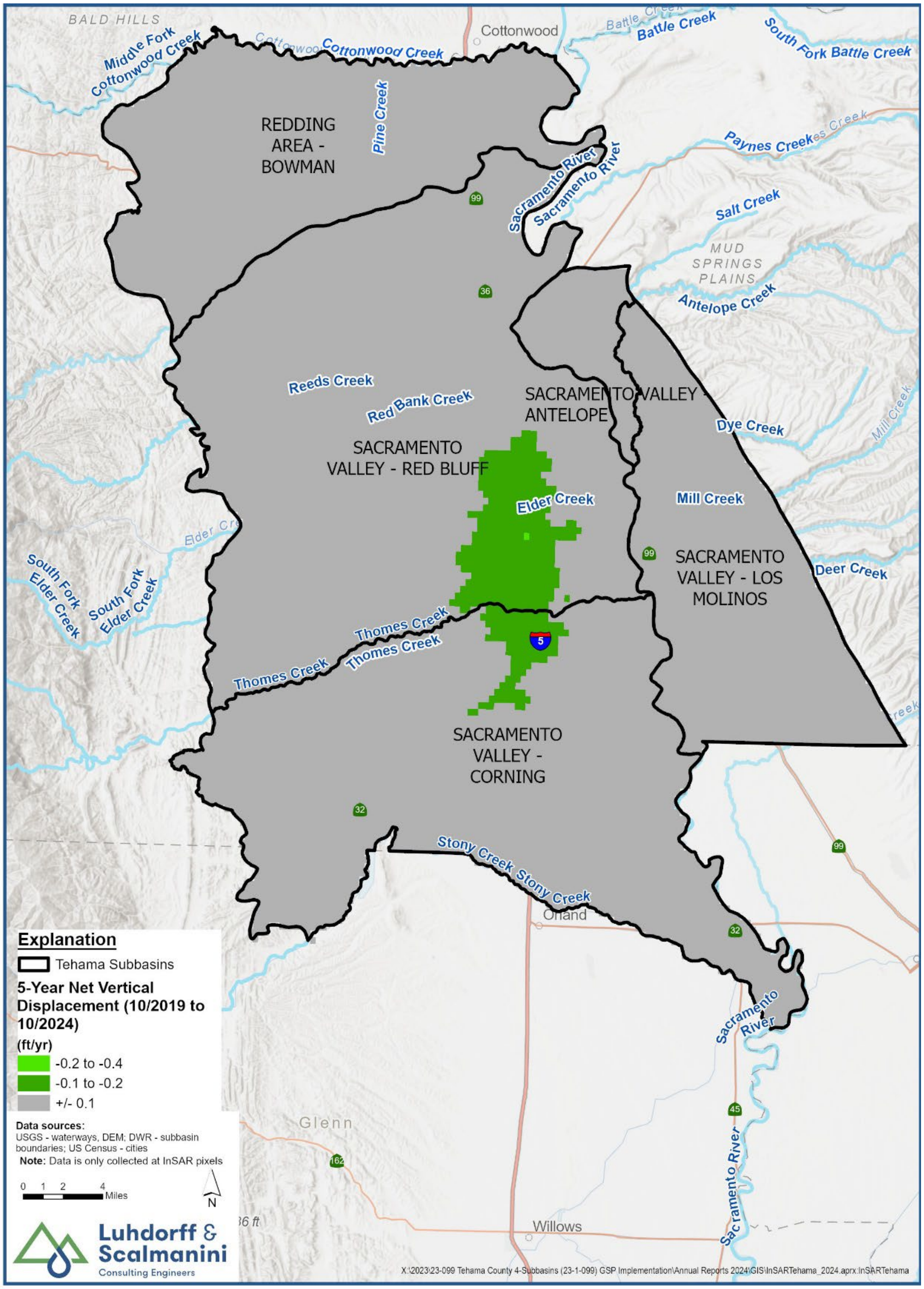

Figure 5-2. Bowman Change in Subsidence from 10/2019 to 10/2024

5.2.4 Depletion of Interconnected Surface Water SMC

The depletion of interconnected surface water 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. The Groundwater conditions in the Subbasin are on track to meet the first 5-year 2027 IMs for groundwater levels at each of the RMS wells.

Table 5-3. Bowman 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)				
Bow-1U	394.62	390.84	386.3	318.5	8.32	4.54
Bow-2U	401.54	--	395.1	372.5	6.44	--
Bow-2UR	413.81	408.87	--	--	--	--
Bow-3U	495.26	--	484.9	419.6	--	--
Bow-4U	--	--	404.8	377.5	--	--

MO = Measurable Objective, MT = Minimum Threshold, -- = Indicates missing or questionable measurements

5.3 Progress Toward PMA Implementation

The Tehama County GSA worked to secure funding through the SGM Grant Program. Their efforts involved planning, project evaluation, and the submission of a grant application in December 2022. Unfortunately, the results announced in September 2023 indicated that the Bowman Subbasin would not receive funding. However, neighboring subbasins within the county secured resources, and any data acquired regionally will benefit from these resources.

Table 5-4. Bowman Subbasin Summary of Management Actions

GSP Section Reference	Project (Proponent)	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 Management Action Implementation Progress

Below are management action updates and their progress in implementation since the last annual report (**Table 5-4).**

5.4.1 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. 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 Bowman Subbasin.

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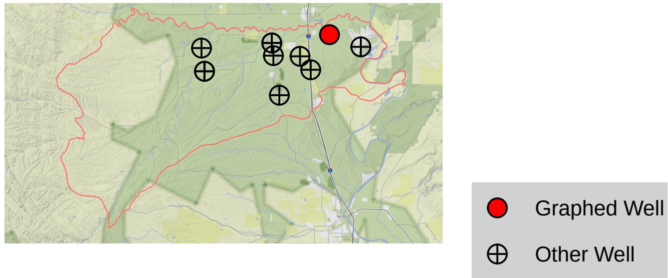
Water Year 2024 Annual Report

Appendix A

Characteristics and Hydrographs of Representative Monitoring Site (RMS) Wells

Bowman Subbasin – State Well Number (SWN) 29N03W18M001M (Bow−1U)

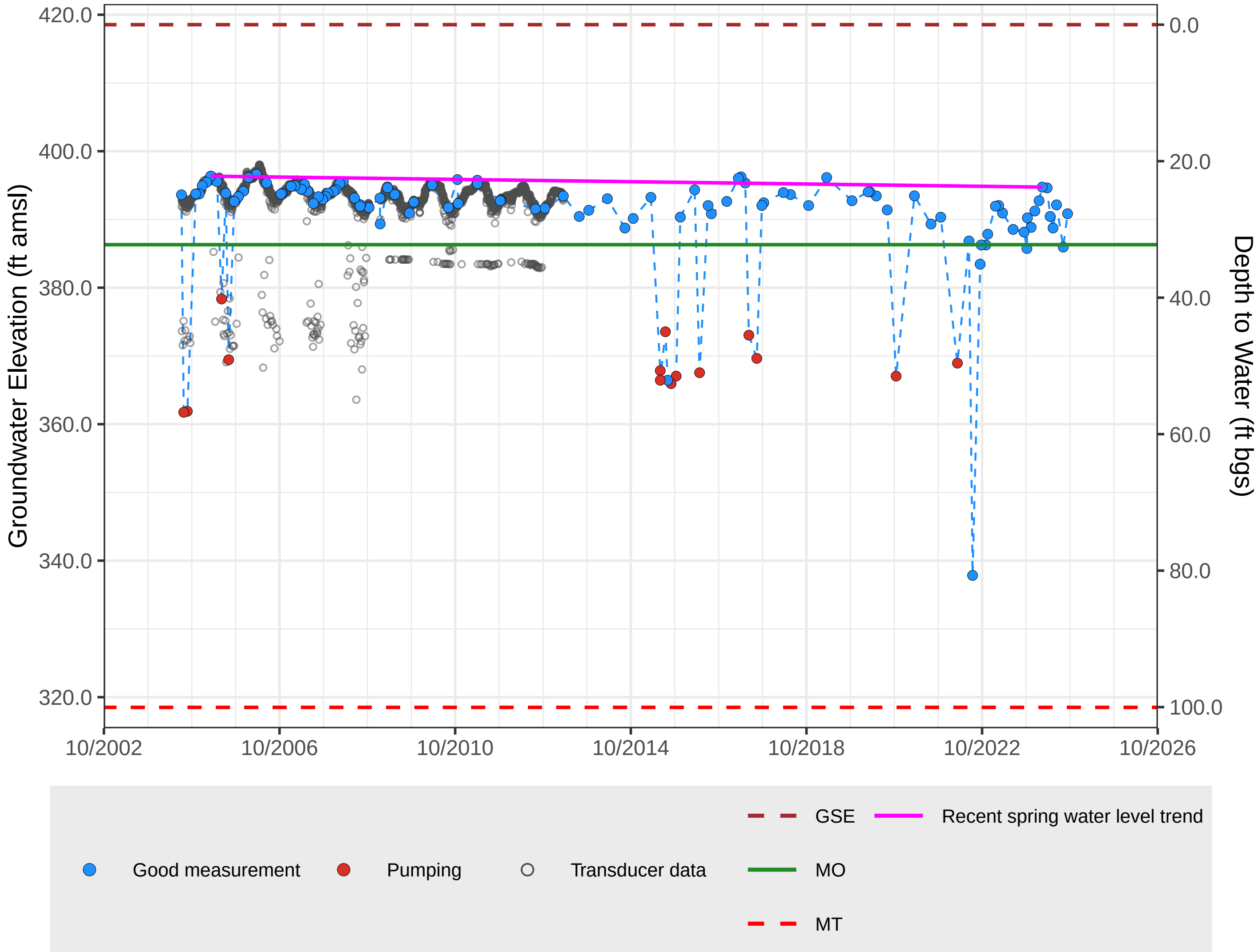
Upper Aquifer   Well Depth: 234 ft. Perforation top & bottom: Unknown

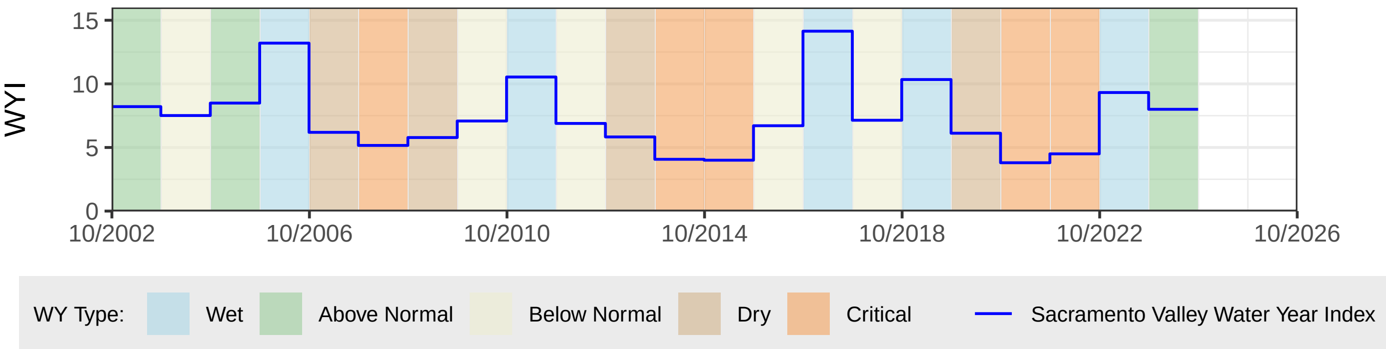


MO GWE: 386.3 ft amsl
MO DTW: 32.24 ft bgs

MT GWE: 318.5 ft amsl
MT DTW: 100 ft bgs

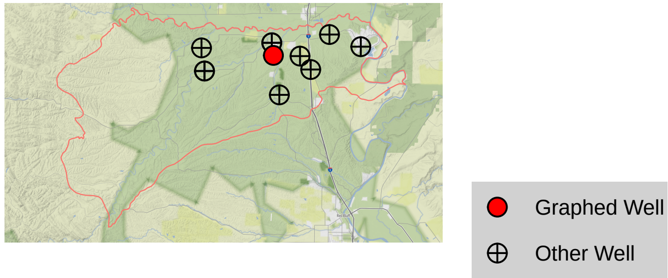
Statistics of spring water levels for past 19 years (2005 to 2024):
Change = −1.6 ft
Avg. rate of change = −0.08 ft/yr
Avg. water level = 394.65 ft amsl





Bowman Subbasin − State Well Number (SWN) 29N04W28D001M (Bow−2U)

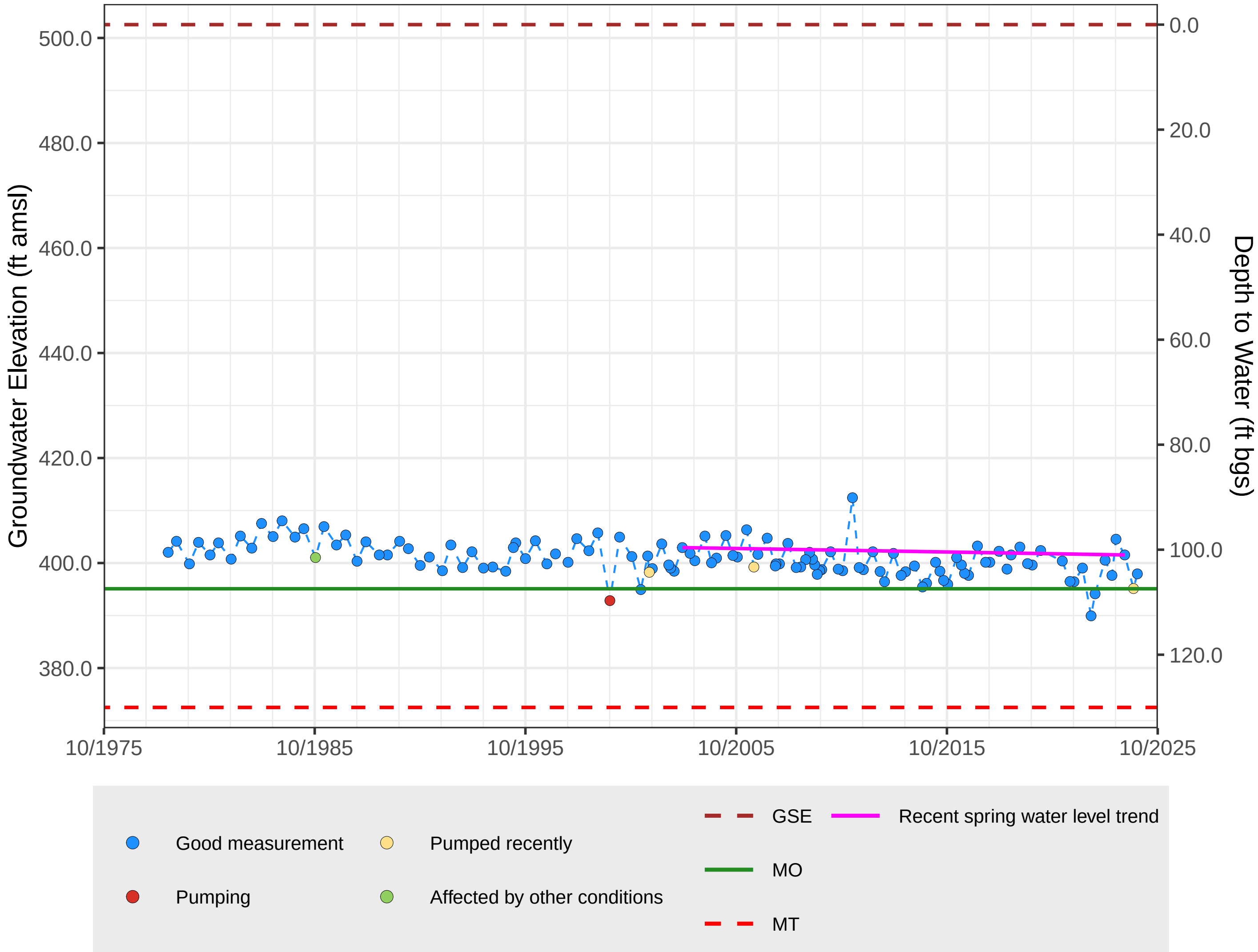
Upper Aquifer   Well Depth: 134 ft. Perforation top & bottom: 114 − 134 ft bgs

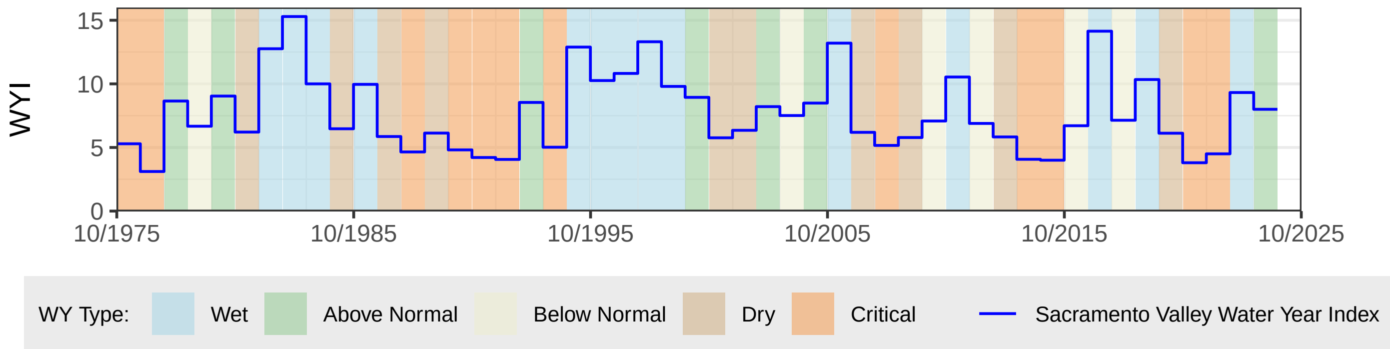


MO GWE: 395.1 ft amsl
MO DTW: 107.44 ft bgs

MT GWE: 372.5 ft amsl
MT DTW: 130 ft bgs

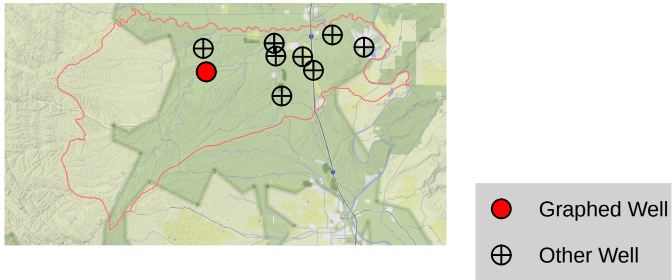
Statistics of spring water levels for past 21 years (2003 to 2024):
Change = −1.4 ft
Avg. rate of change = −0.07 ft/yr
Avg. water level = 403.29 ft amsl





Bowman Subbasin – State Well Number (SWN) 29N05W33A004M (Bow−3U)

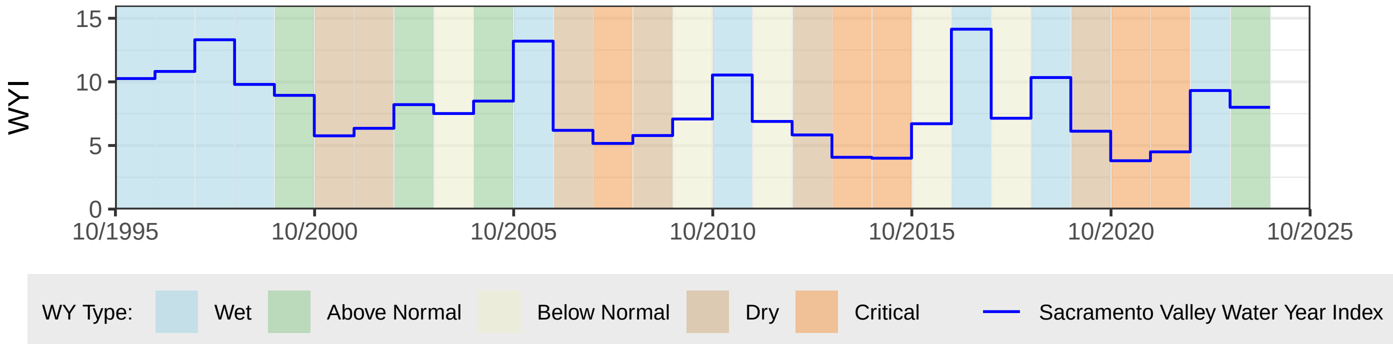
Upper Aquifer Well Depth: 210 ft. Perforation top & bottom: 110 − 210 ft bgs



MO GWE: 484.9 ft amsl
MO DTW: 49.66 ft bgs

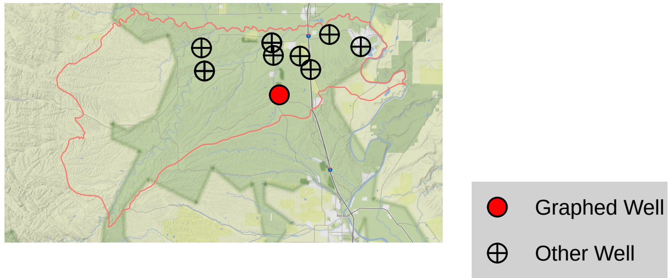
MT GWE: 419.6 ft amsl
MT DTW: 115 ft bgs

Statistics of spring water levels for past 21 years (2003 to 2024):
Change = −0.9 ft
Avg. rate of change = −0.04 ft/yr
Avg. water level = 495.13 ft amsl



Bowman Subbasin – State Well Number (SWN) 28N04W04P001M (Bow−4U)

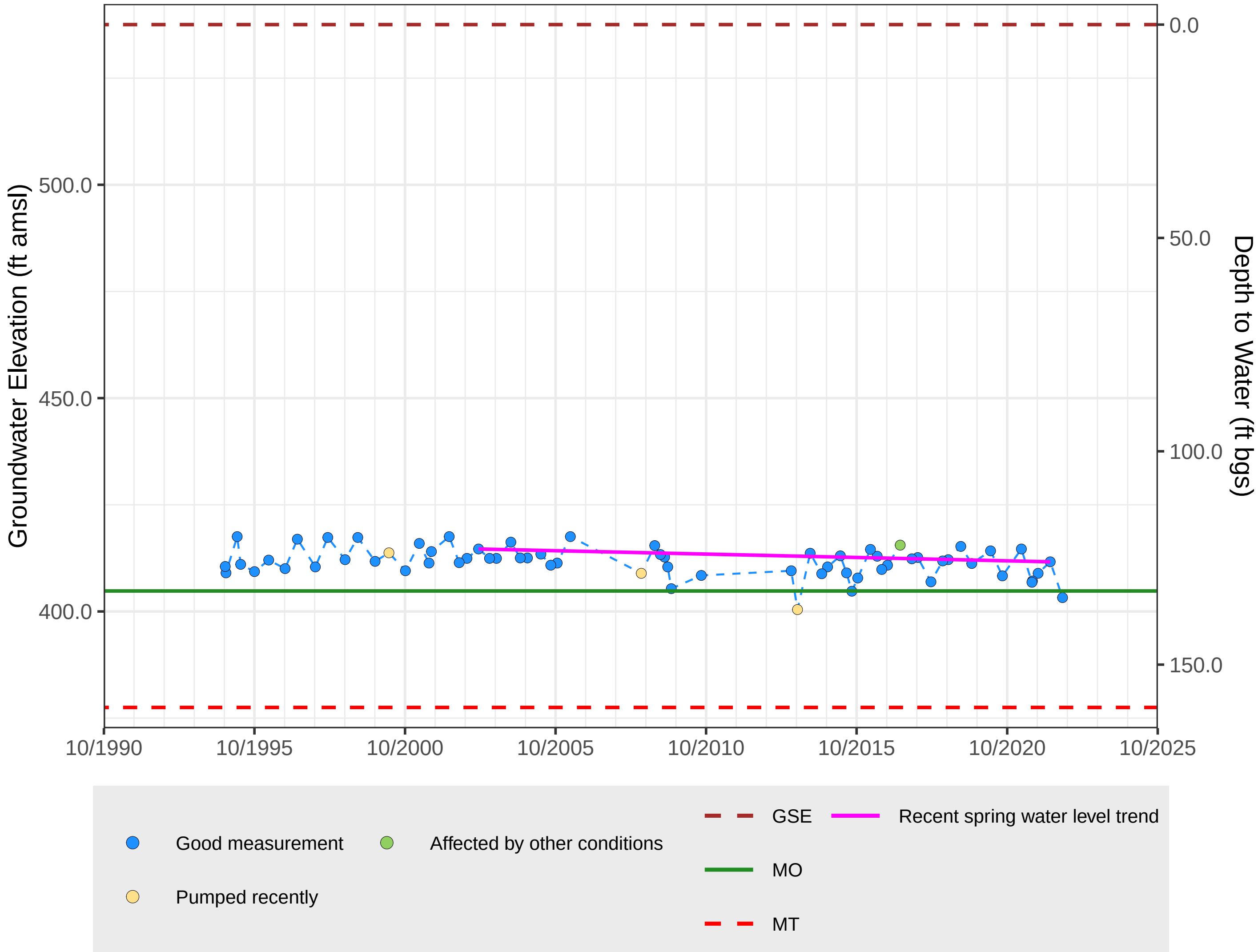
Upper Aquifer   Well Depth: 270 ft. Perforation top & bottom: Unknown

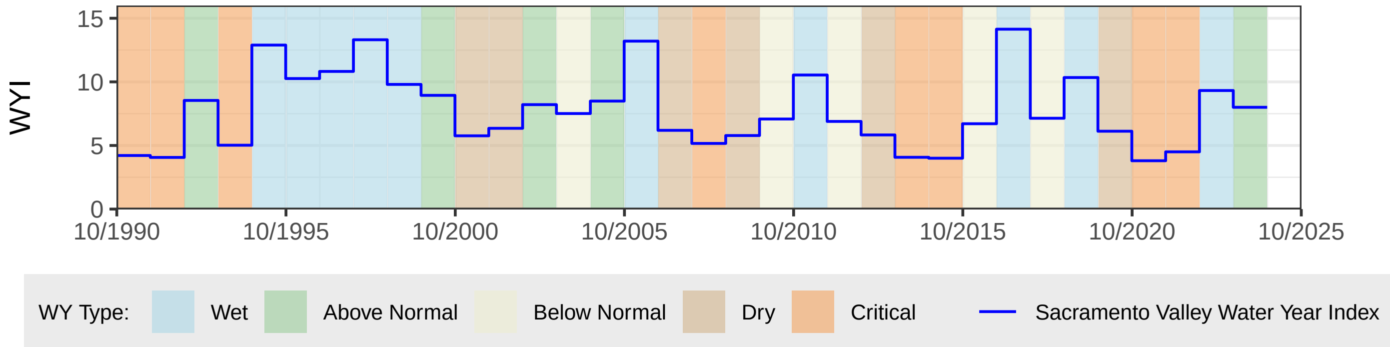


MO GWE: 404.8 ft amsl
MO DTW: 132.74 ft bgs

MT GWE: 377.5 ft amsl
MT DTW: 160 ft bgs

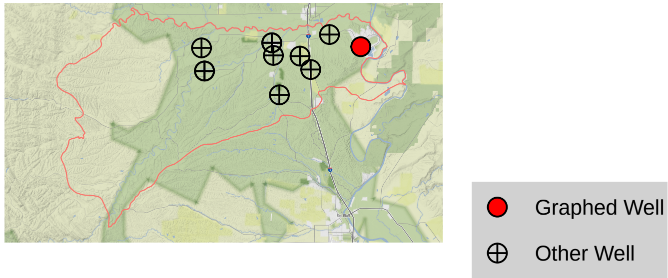
Statistics of spring water levels for past 19 years (2003 to 2022):
Change = −3 ft
Avg. rate of change = −0.16 ft/yr
Avg. water level = 414.83 ft amsl





Bowman Subbasin – State Well Number (SWN) 29N03W21–XXX (Bow–5L)

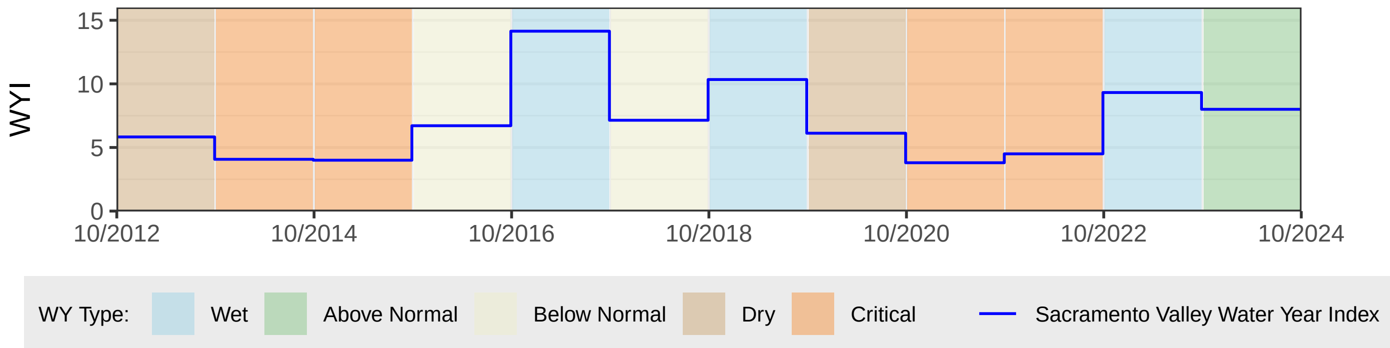
Lower Aquifer Well Depth: 760 ft. Perforation top & bottom: 390 – 750 ft bgs

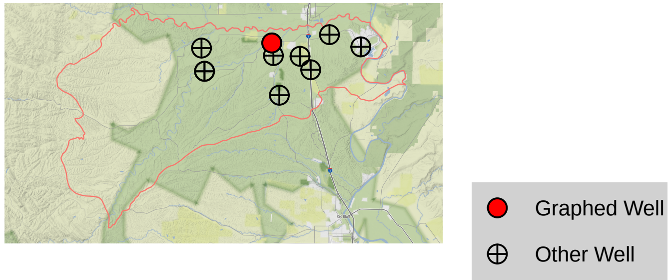


MO GWE: 338.5 ft amsl
MO DTW: 285.5 ft bgs

MT GWE: 294 ft amsl
MT DTW: 330 ft bgs

Statistics of spring water levels for past 8 years (2014 to 2022):
Change = −0.28 ft
Avg. rate of change = −0.04 ft/yr
Avg. water level = 344.68 ft amsl

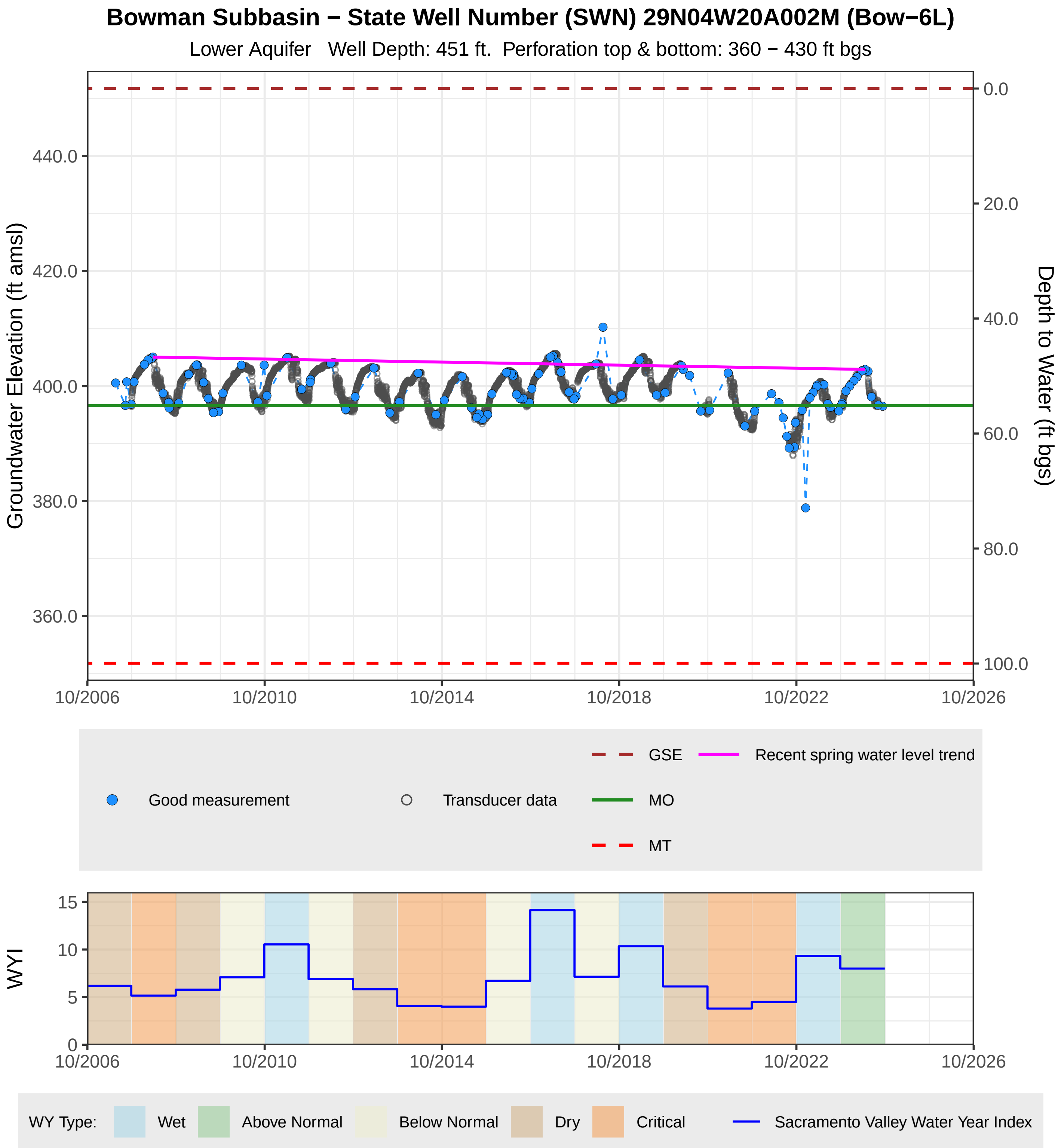




MO GWE: 396.6 ft amsl
MO DTW: 55.15 ft bgs

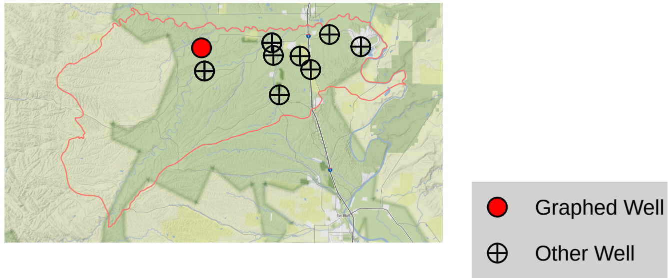
MT GWE: 351.8 ft amsl
MT DTW: 100 ft bgs

Statistics of spring water levels for past 16 years (2008 to 2024):
Change = −2.14 ft
Avg. rate of change = −0.13 ft/yr
Avg. water level = 403.04 ft amsl



Bowman Subbasin – State Well Number (SWN) 29N05W21H001M (Bow–7L)

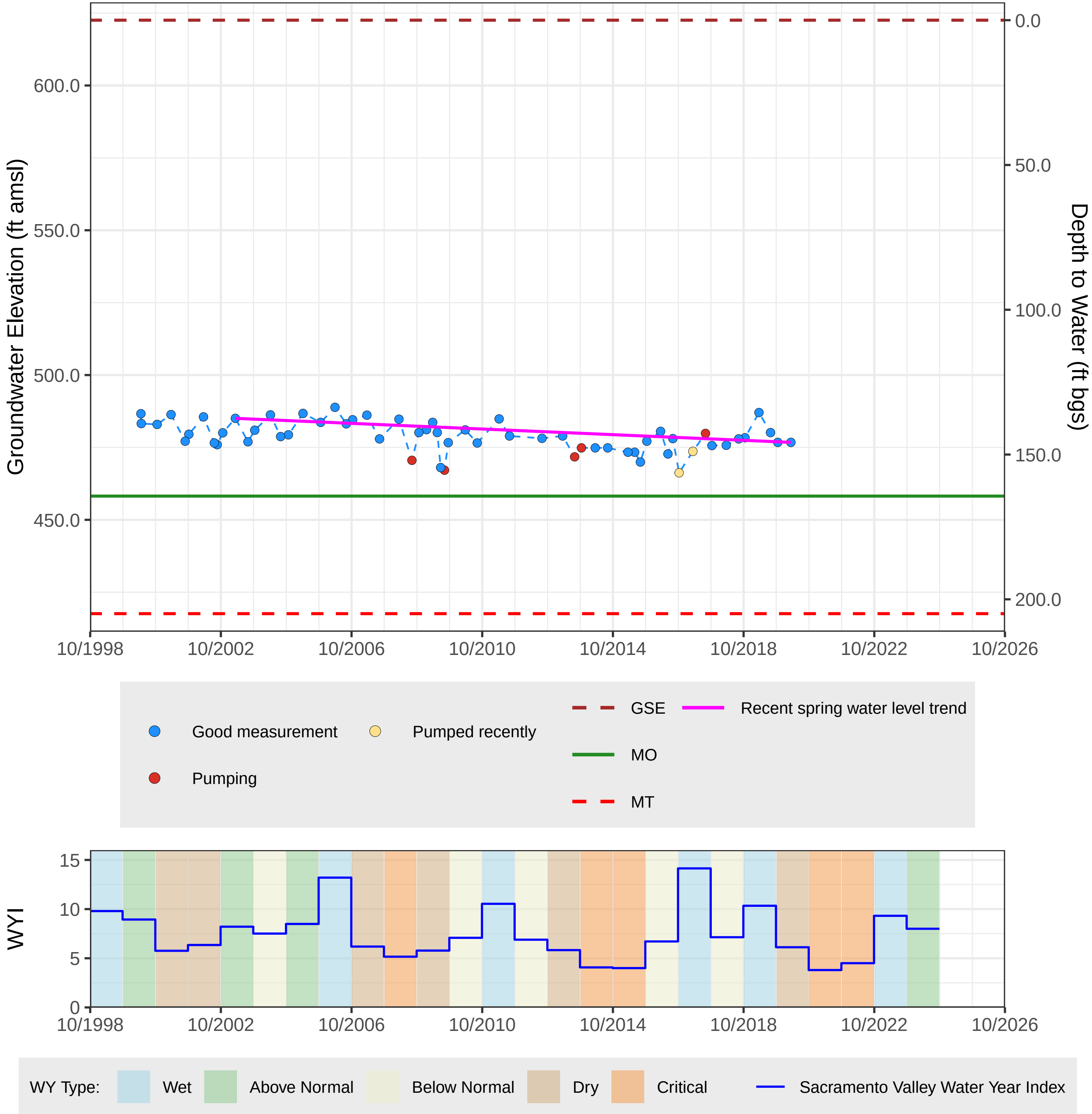
Lower Aquifer   Well Depth: 280 ft. Perforation top & bottom: 250 – 280 ft bgs



MO GWE: 458.2 ft amsl
MO DTW: 164.35 ft bgs

MT GWE: 417.6 ft amsl
MT DTW: 205 ft bgs

Statistics of spring water levels for past 17 years (2003 to 2020):
Change = −8.3 ft
Avg. rate of change = −0.49 ft/yr
Avg. water level = 482.8 ft amsl



Water Year 2024 Annual Report

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.

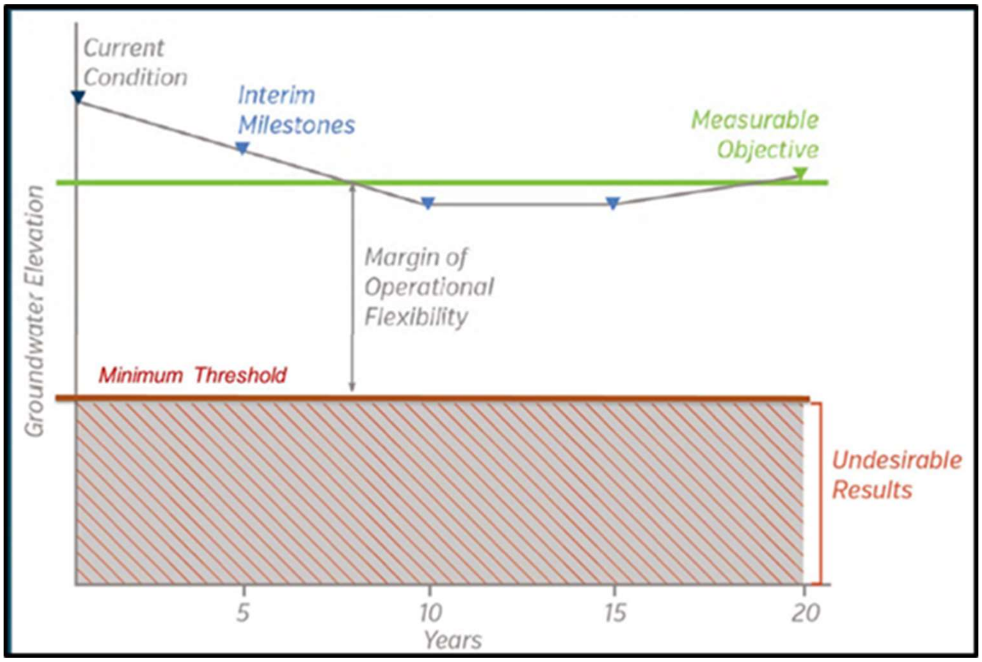


Illustration of Terms Used for Describing Sustainable Management Criteria Using the Groundwater Level SI

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 .ƻǿϒl·ƴ Subbasin is fully explained and defined in Section 3 of the

GSP available here: https://sgma.water.ca.gov/portal/gsp/preview/13т

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Appendix C

GSP Annual Reporting Elements Guide

Groundwater Sustainability Plan Annual Report Elements Guide

Basin Name	Bowman		
GSP Local ID	5-006.01		
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.	38-42; 70-79	
	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.	5-11	
	(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.	15-20	
	(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.	21; 45-52	
	(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.	22-24	
	(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.	25	
	(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.	25-26	
	(5) Change in groundwater in storage shall include the following:		
	(A) Change in groundwater in storage maps for each principal aquifer in the basin.	30-33	
	(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.	30	
	(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.	34-43	

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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
4,900	600	0	2,800		0	-	1,500	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
600	Metered Municipal Wells	Direct	5%	Metered connection maintained by Rio Alto Water District	0					2,800	Land use estimates were derived from crop mapping and CropScape survey results	Estimate	20%	Typical uncertainty for water balance calculation	0					1,500	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
15,200	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	15,200	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
20,100	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	4,900	15,200	0	0	0		600	0	18,000	-	0	-	1,500	Rural Residential

Water Year 2024 Annual Report

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 CCR[1] Section 356.2), the GSP Annual Report for the Bowman Subbasin (Subbasin) includes quantification of water supplies and water uses in the reporting year, including groundwater extraction by water use sector[2]. 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 Bowman 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(al)).

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 area[3]). 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 year[4] 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.

4 References

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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.

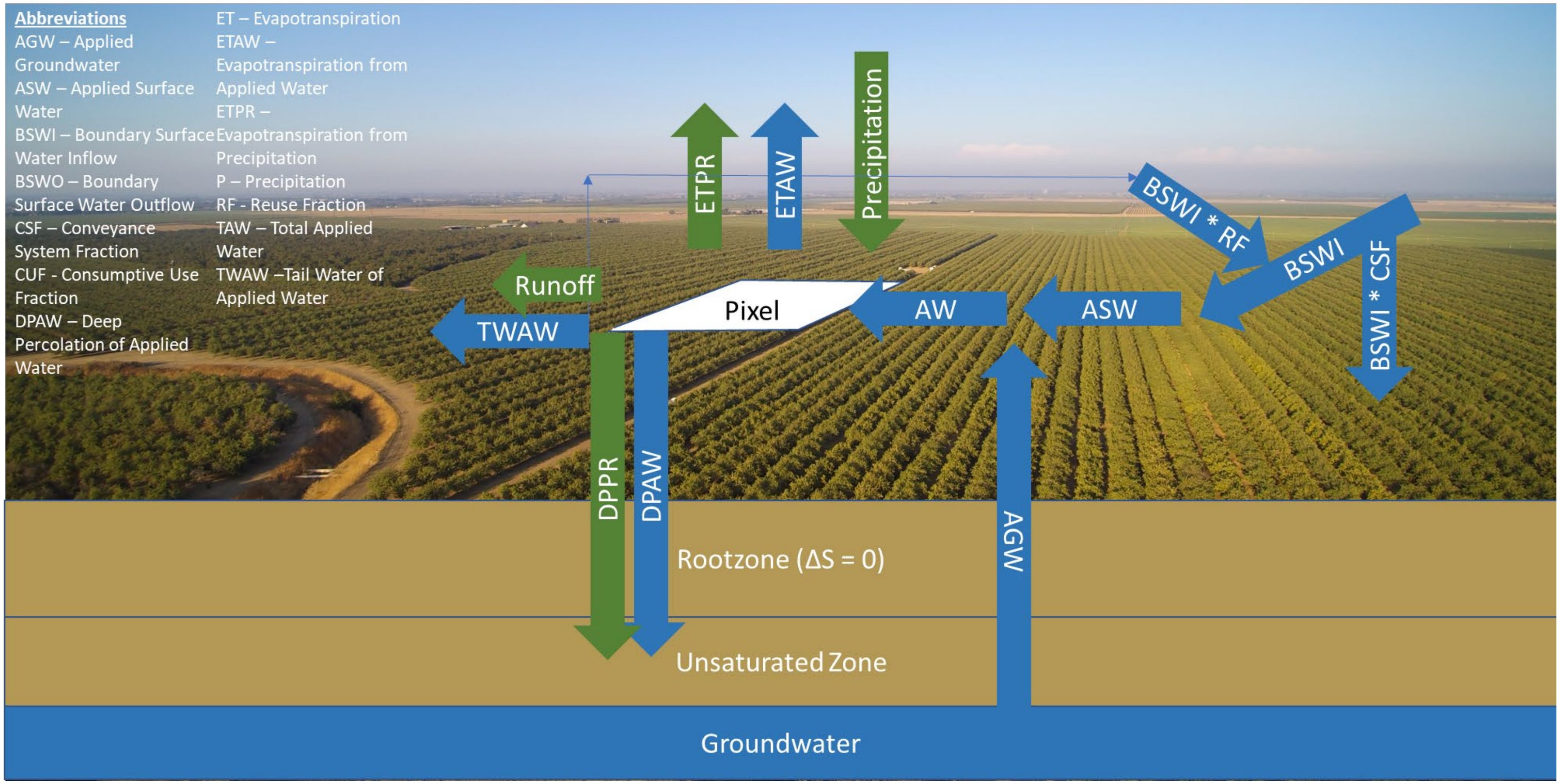

Figure A-1. Inflows and Outflows to Each 30 m x 30 m Pixel in the GEEEO Process.

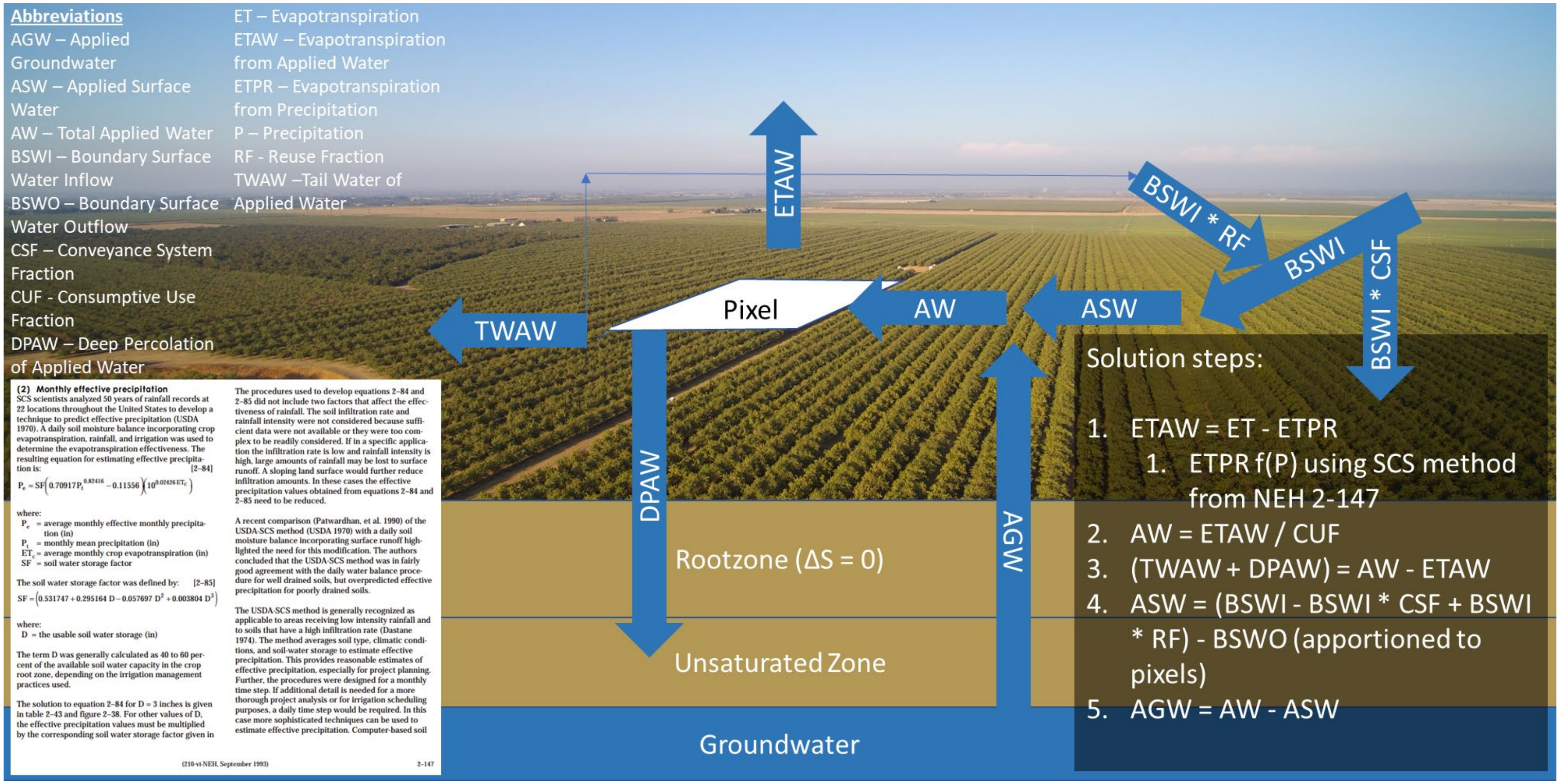

Figure A-2. Solution Steps for Calculating Applied Groundwater (AGW) in Each 30 m x 30 m Pixel in the GEEEO Process.

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)			
	MO	MT	2024	Exceed MT?
Upper Aquifer				
BOW-1U	500	750	150	--
BOW-2UR	500	750	160	--
Lower Aquifer				
BOW-5L	500	750	200	--
BOW-6L	500	750	190	--

November 12, 2024

Lab No. : CH 2479968
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

This Case Narrative pertains to the following samples:

Sample Description	Date Sampled	Date Received	FGL Lab No.	Matrix
BOW 1U	10/21/2024	10/23/2024	CH 2479968-001	GW
BOW 2UR	10/23/2024	10/23/2024	CH 2479968-002	GW
BOW 5L	10/22/2024	10/23/2024	CH 2479968-003	GW
BOW 6L	10/23/2024	10/23/2024	CH 2479968-004	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)

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: 2024-11-12

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Office & Laboratory 2500 Stagecoach Road Stockton, CA 95215 TEL: (209)942-0182 CA ELAP Certification No. 1563
Office & Laboratory 563 E. Lindo Avenue Chico, CA 95926 TEL: (530)343-5818 CA ELAP Certification No. 2670
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November 12, 2024

Luhdorff & Scalmanini Consulting
Attn: Eddy Teasdale
550 Salem Street, Suite 3
Chico, CA 95928

Description : BOW 1U
Project : Bowman

Lab No. : CH 2479968-001
Customer No. : 7010503

Sampled On : October 21, 2024 at 10:20
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			
Wet Chemistry							Date	Time	Who	Method	Date	Time	Who
Total Dissolved Solids (TFR)	150	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

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853 Corporation Street
Santa Paula, CA 93060
TEL: (805)392-2000
CA ELAP Certification No. 1573

Office & Laboratory
2500 Stagecoach Road
Stockton, CA 95215
TEL: (209)942-0182
CA ELAP Certification No. 1563

Office & Laboratory
563 E. Lindo Avenue
Chico, CA 95926
TEL: (530)343-5818
CA ELAP Certification No. 2670

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3442 Empresa Drive, Suite D
San Luis Obispo, CA 93401
TEL: (805)783-2940
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9411 W. Goshen Avenue
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November 12, 2024

Luhdorff & Scalmanini Consulting
Attn: Eddy Teasdale
550 Salem Street, Suite 3
Chico, CA 95928

Description : BOW 2UR
Project : Bowman

Lab No. : CH 2479968-002
Customer No. : 7010503

Sampled On : October 23, 2024 at 09:33
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			
Wet Chemistry							Date	Time	Who	Method	Date	Time	Who
Total Dissolved Solids (TFR)	160	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

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853 Corporation Street
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Office & Laboratory
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Stockton, CA 95215
TEL: (209)942-0182
CA ELAP Certification No. 1563

Office & Laboratory
563 E. Lindo Avenue
Chico, CA 95926
TEL: (530)343-5818
CA ELAP Certification No. 2670

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3442 Empresa Drive, Suite D
San Luis Obispo, CA 93401
TEL: (805)783-2940
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TEL: (559)734-9473
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November 12, 2024

Luhdorff & Scalmanini Consulting
Attn: Eddy Teasdale
550 Salem Street, Suite 3
Chico, CA 95928

Description : BOW 5L
Project : Bowman

Lab No. : CH 2479968-003
Customer No. : 7010503

Sampled On : October 22, 2024 at 11:15
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			
Wet Chemistry							Date	Time	Who	Method	Date	Time	Who
Total Dissolved Solids (TFR)	200	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

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853 Corporation Street
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TEL: (805)392-2000
CA ELAP Certification No. 1573

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2500 Stagecoach Road
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TEL: (209)942-0182
CA ELAP Certification No. 1563

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Chico, CA 95926
TEL: (530)343-5818
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3442 Empresa Drive, Suite D
San Luis Obispo, CA 93401
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9411 W. Goshen Avenue
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November 12, 2024

Luhdorff & Scalmanini Consulting
Attn: Eddy Teasdale
550 Salem Street, Suite 3
Chico, CA 95928

Description : BOW 6L
Project : Bowman

Lab No. : CH 2479968-004
Customer No. : 7010503

Sampled On : October 23, 2024 at 09:37
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			
Wet Chemistry							Date	Time	Who	Method	Date	Time	Who
Total Dissolved Solids (TFR)	190	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

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2500 Stagecoach Road
Stockton, CA 95215
TEL: (209)942-0182
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563 E. Lindo Avenue
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November 12, 2024
Luhdorff & Scalmanini Consulting

Lab No. : CH 2479968
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	Blank	mg/L		ND	<20	
			LCS	mg/L	991.1	97.1%	90-110	
		(CH 2479969-008)	Dup	mg/L		2.02%	5	
		(CH 2479969-008)	Dup	mg/L		0.4%	5	
			Blank	mg/L		ND	<20	
			LCS	mg/L	991.1	102%	90-110	
		(CC 2484133-002)	Dup	mg/L		0.8%	5	
		(CC 2484133-002)	Dup	mg/L		1.20%	5	

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.

ND : Non-detect - Result was below the DQO listed for the analyte.

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TEL: (209)942-0182
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San Luis Obispo, CA 93401
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FGL ENVIRONMENTAL AGRICULTURAL Analytical Chemists

www.fglinc.com

CHAIN OF CUSTODY
AND ANALYSIS REQUEST DOCUMENT

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: Bowman
Purchase Order Number:
Quote Number:

Rush Analysis: ☐ 5 Day ☐ 4 Day ☐ 3 Day ☐ 2 Day ☐ 24 hour
Rush pre-approval by lab (initals): ____
Electronic Data Transfer: ☐ No ☐ State ☐ Client Other: ____

Sampler(s): Leeah Schultz
Christian Hoover

Sampling Fee: ____ Pickup Fee: ____
Compositor Setup Date: ____ Time: ____

Lab Number: 2479968

TEST DESCRIPTION AND ANALYSES REQUESTED

Samp Num	Location Description	Date Sampled	Time Sampled	Method of Sampling: Composite (C) Grab (G)	Number of Containers	Type of Containers: (G)Glass (P)Plastic (V)VOA (MT)Metal Tube	Potable (P) Non-Potable (NP) Ag Water (AgW)	(SW) Surface Water (MW) Monitoring Well (GW) Ground Water (TB) Travel Blank (WW) Waste Water (DW) Drinking Water	(S) Soil (SLG) Sludge (SLD) Solid (O) Oil	BacT: (Sys) System (SRC) Source (W) Waste	BacT: (ROUT)Routine (RPT)Repeat (OTH)Other (RPL)Replace	(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
1	BOW 1U	10/21	10:20am	G	1	P	NP	GW						X
2	BOW 2UR	10/23	9:33am	↓	1	↓	↓	GW						↓
3	BOW 5L	10/22	11:15am		1			GW						
4	BOW 6L	10/23	9:37am		1			GW						

Remarks

Relinquished	Date:	Time:	Relinquished	Date:	Time:	Relinquished	Date:	Time:
[signature]	10/23/24	16:10	HOO	10/24/24	1700	GLS	10/25/24	1340
Received By:	**Date:**	**Time:**	**Received By:**	**Date:**	**Time:**	**Received By:**	**Date:**	**Time:**
HOO	10/23/24	16:10	GLS	10/24/24	1700	JAW	10/25/24	1340

2479968

Inter-Laboratory Condition Upon Receipt (Attach to COC)Sample Receipt at:
CC (CH) STK VI

1. Number of ice chests/packages received: OTC Shipping tracking #(s):________
2. Temp IR Gun ID #: [handwritten]
3. Were samples received on ice? (Yes) No Temps: 5.3°C / ___ / ___ / ___ / ___
   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.
4. Do the number of bottles received agree with the COC? (Yes) No N/A
5. Were samples received intact? (i.e. no broken bottles, leaks etc.) (Yes) No
6. VOAs checked for Headspace? Yes No (N/A)
7. Were all analyses within holding times at time of receipt? (Yes) No
8. 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): KDV

Sample Receipt at SP:

1. Number of ice chests/packages received: 3 Shipping tracking #(s): 562171895, 562171904, 562171891
2. Temp IR Gun ID #: TH 209
3. 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/
4. Do the number of bottles received agree with the COC? (Yes) No N/A
5. 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:

1. Were all requested analyses understood and acceptable? (Yes) No
2. Did bottle labels correspond with the client's ID's? (Yes) No
3. Were all bottles requiring sample preservation properly preserved? Yes No (N/A) FGL
   [Exception: Oil & Grease, VOA and CrVI verified in lab]
4. VOAs checked for Headspace? Yes No (N/A)
5. Have rush or project due dates been checked and accepted? Yes No (N/A)
6. 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): YW

Discrepancy Documentation:

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

1. Person Contacted:________ Phone Number:________
   Initiated By:________ Date:________
   Problem:
   Resolution:
2. Person Contacted:________ Phone Number:________
   Initiated By:________
   Problem:
   Resolution:

(7010503)
Luhdorff & Scalmanini Consulting
CH 2479968
iv 10/25/2024 07:47:17
CH 2479968

(Please use the back of this sheet for additional comments or cont