Wyandotte Creek WY 2023 Annual Report Update

Kelly Peterson, Butte County Water and Resource Conservation Department

May 23, 2024

Butte County
WATER & RESOURCE CONSERVATION

Luhdorff & Scalmanini
Consulting Engineers

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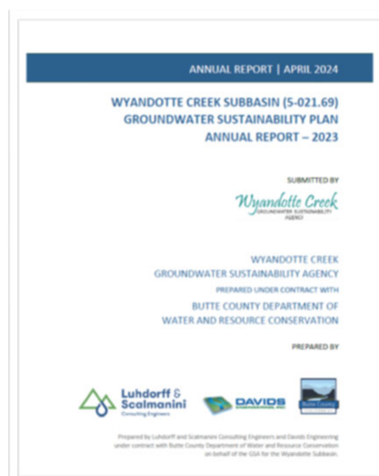
Where are We Headed Today?

- **Overview / Hydrological and Water Supply Conditions**
- **Groundwater Conditions**
- **Water Supply and Water Use (Water Budget)**
- **Progress Towards GSP Implementation**


ANNUAL REPORT | APRIL 2024

WYANDOTTE CREEK SUBBASIN (5-021.69)
GROUNDWATER SUSTAINABILITY PLAN
ANNUAL REPORT – 2023

SUBMITTED BY

WYANDOTTE CREEK
GROUNDWATER SUSTAINABILITY AGENCY
PREPARED UNDER CONTRACT WITH
BUTTE COUNTY DEPARTMENT OF
WATER AND RESOURCE CONSERVATION

PREPARED BY

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Annual Report Requirements

- **Updates on Groundwater Conditions**
  - **Elevations (Hydrographs, Contour Maps)**
  - **Change in Storage**
- **Water Supply and Water Use**
  - **Groundwater Extraction**
  - **Surface Water Supplies**
  - **Total Water Use**
- **Progress Toward Plan Implementation**

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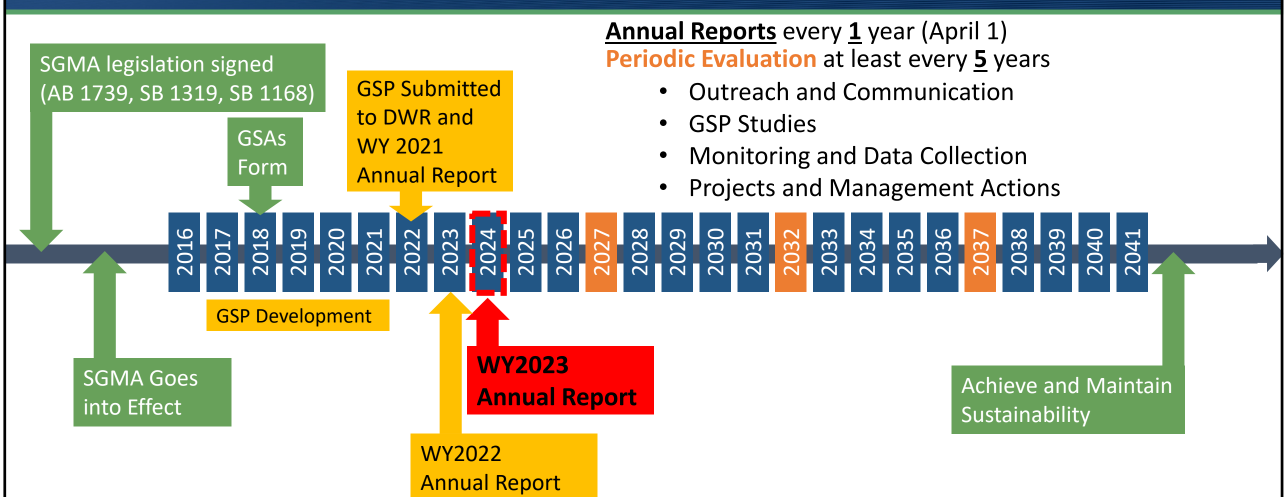
Overview – SGMA Implementation Timeline



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Annual Report Summary – Water Year 2023

- **Above average precipitation, streamflow and full surface water supply allocations contributed to groundwater conditions rebounding from last year**
- **Groundwater levels**
  - **↑ vs. Spring and Fall 2022**
  - **Spring all above MOs**
  - **Fall most were above MOs**
- **Groundwater extraction – ~35 TAF for the year**
  - **Less than 23-year pumping average (2000-2022)**
  - **Above average of last 4 wet years**
  - **Less than last years pumping**

Lake Oroville June 2023 Source: DWR

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Annual Report Summary – Water Year 2023

- **Groundwater Storage**
  - **↑ from 2022**
  - **Cumulative storage has ↑ also**
- **Sustainability Indicators (SI)**
  - **On track to meet Interim Milestones for Sustainable Management Criteria**
  - **No indications of undesirable results for any SI**
  - **Two exceedances of water quality SI**

State / Regional Water Supplies at End of 2023 WY

Statewide conditions at end of WY

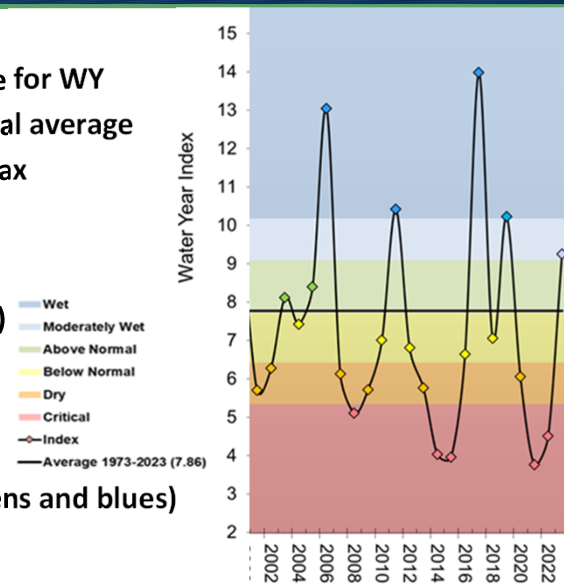
- **Precipitation:~ 34" or 141% of historical average for WY**
- **Reservoir Storage: 27.4 MAF or 128% of historical average**
- **Snowpack: 247% of historical average annual max**

Sacramento River Region

- **Runoff, 136% of average (24.1 million acre-feet)**

Classified a "Wet Year"

- **Since 2000 or last 24 years**
  - **Only 8 (30%) Above Normal / Wet years (greens and blues)**
  - **Only 5 (20%) Wet years (blues)**



2023 Water Year Conditions

Classified a "Wet Year"

<u>N. Sierra 8-station Index Precipitation</u>

- **~ 67'' or 125% of average**
- **~ 155% or 24'' more than last WY 3rd year of severe drought**

<u>Local Precipitation</u>

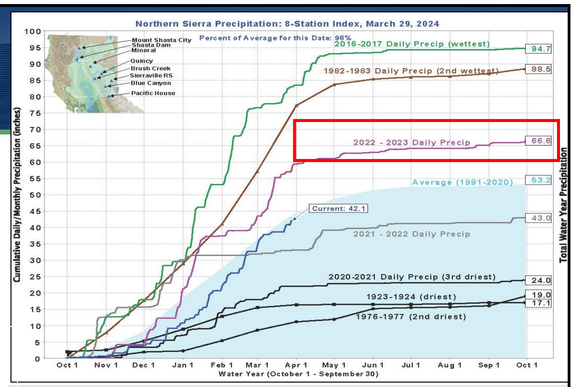
- **Biggs ~ 21 inches or 141% of 2016-2022 average**
- **Durham ~ 23 inches or 117% of 2000-2022 average**

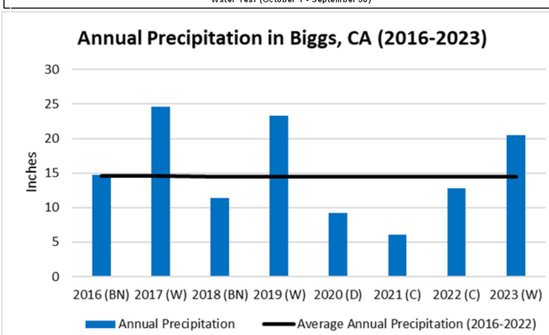
<u>Surface Water Supplies</u>

Wet climate conditions

<u>+ increased stream flows</u>

= groundwater recharge, ↓groundwater extraction volumes vs. 2022, ↑ in storage

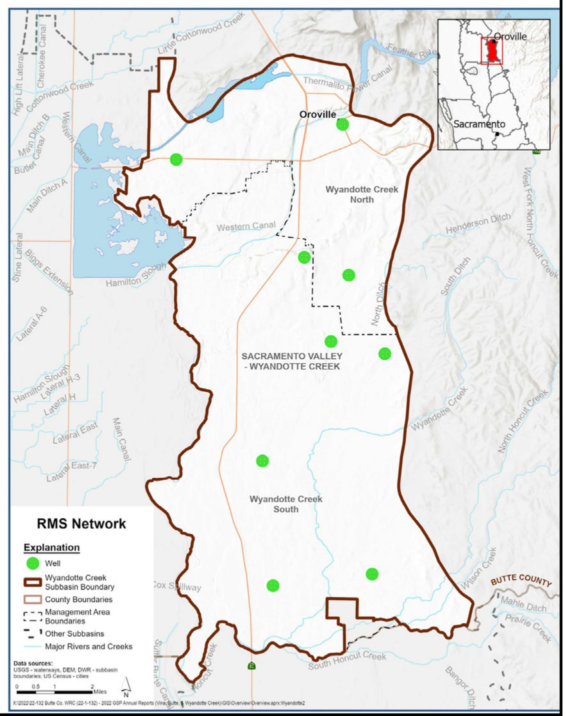




Groundwater Conditions – Groundwater Elevations

Groundwater Levels

- **Compared to 2022**
  - **Spring ↑ ~ 3 feet**
  - **Fall ↑ ~ 3 feet**
- **Spring 2023 all above MOs**
  - **~18 feet above on average**
- **Fall 2023 mostly above MOs**
  - **~ 10 feet above MOs on average**
  - **~ 35 feet above MTs**



Groundwater Conditions

Groundwater Elevations

- **9 Representative Monitoring Site (RMS) Wells in the Aquifer**
- **Domestic, irrigation, and observation wells**

Groundwater Storage

- **Calculated utilizing groundwater levels in RMS wells**

Lowering Groundwater Levels

Reduction of Storage

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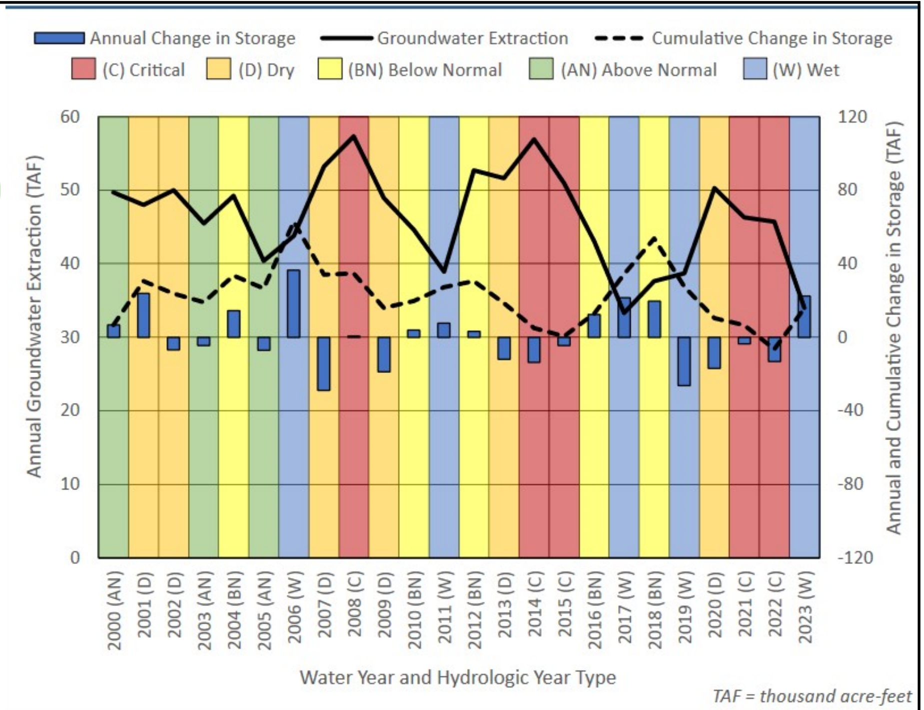
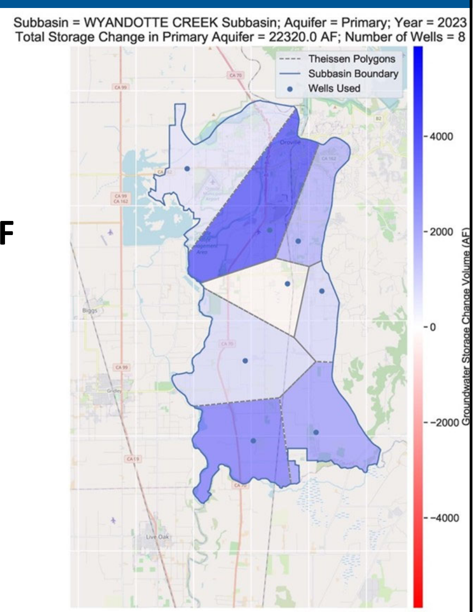
Groundwater Conditions – Groundwater Storage



Groundwater Storage

- **Increased from 2022**
  - **~ 22 TAF**
  - **Cumulative storage is ~16 TAF since 2000**
  - **Up from ~ - 7 TAF last year**



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Map shows groundwater storage change from Spring 2022 to Spring 2023.

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Water Supply and Water Use

Table 3-3. Total Water Use by Water Use Sector				
Sector	WY 2023 (AF)			
	Groundwater	Surface Water	Total	Total Area (acres)
Agricultural	32,900	17,400	50,300	13,700 (irrigated acreage)
Municipal	600	5,000	5,600	5,800
Rural Residential	1,000	0	1,000	--
Total	34,500	22,400	56,900	19,500

61% Groundwater Dependent in 2023

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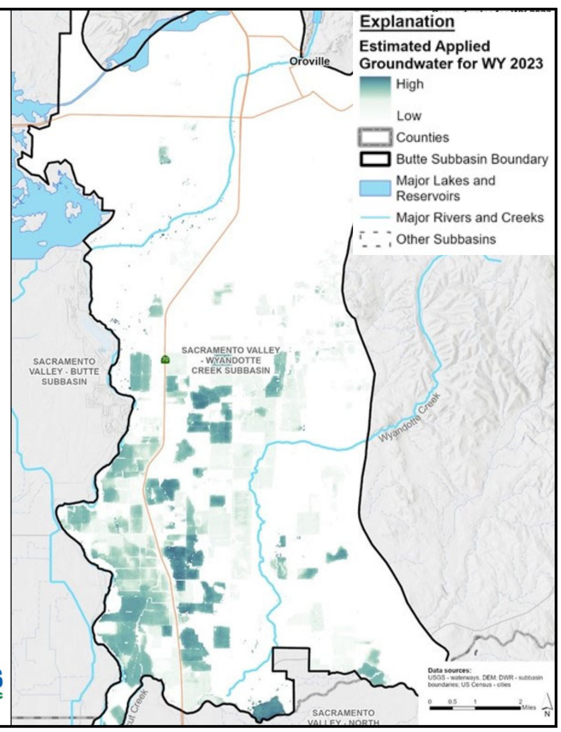
Groundwater Extraction

Groundwater extraction in the agricultural and urban water use sectors are shown; other water use sectors are not included in these results.



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Groundwater Extraction

Groundwater Extraction in 2023

- ~35 TAF for the year
  - 61% of all water use in Subbasin 39% was Surface Water
  - Less than 23-year pumping average since 2000 of ~47 TAF
  - Above average of last 4 wet years of ~39 TAF
  - ~ 76% of last years which was 47 TAF
  - 95% Agriculture and 5% Rural/municipal

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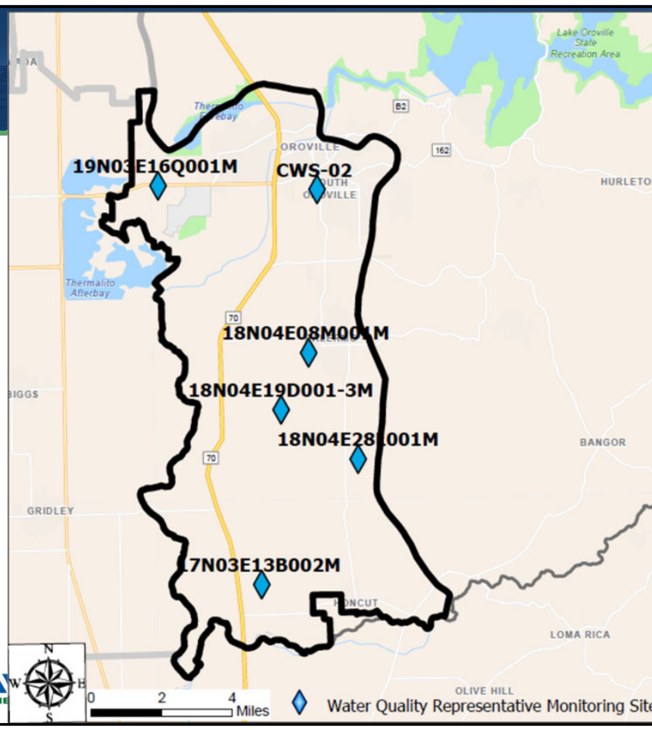
Wyandotte Creek Subbasin Water Quality Representative Monitoring Sites

Thanks to **Zeke Higgins** from the **Thermalito Water and Sewer District, Jeanie Trizzino Volunteer and Greg Wheeler, landowner** for assistance with fieldwork this year!



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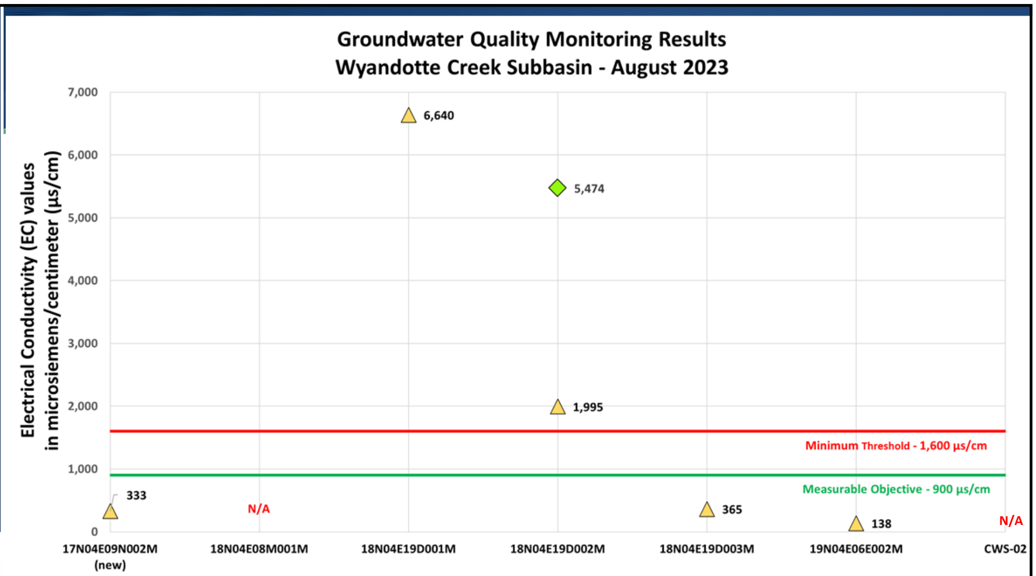
2023 Wyandotte Creek Subbasin Groundwater Quality Monitoring Results

August 2023

Butte County
WATER & RESOURCE CONSERVATION



* Note - **08M001M** - data not included, data was deemed questionable due to site conditions
09N002M - was included as a new site in 2023
CWS-02 - was not measured due to site contaminants
16Q001M - was not measured due to access issues (site dropped in 2023)

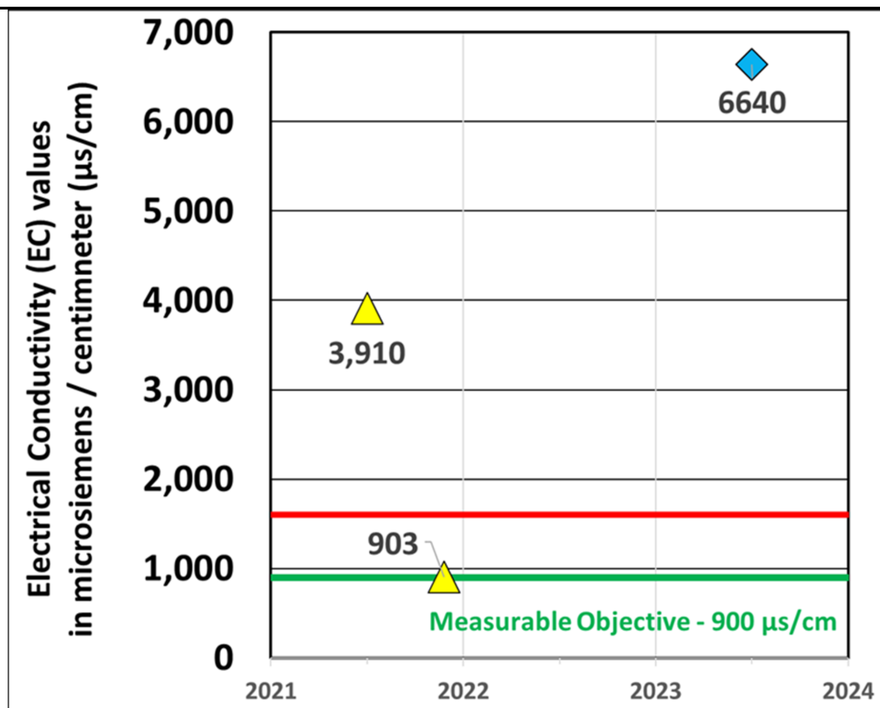
2023 Groundwater Quality

Well ID:
19D001M
Lone Tree Road

Observation
Well Type

Total Well Depth:
1,000'

Screened Zones:
700' – 720'



2023

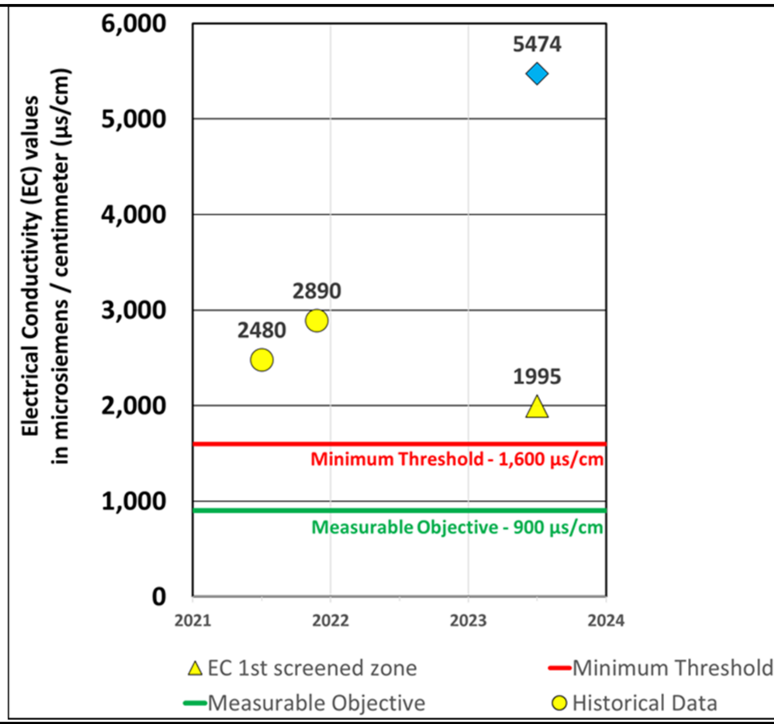
Groundwater Quality

Well ID:
19D002M
Lone Tree Road

Observation
Well Type

Total Well Depth:
1,000'

Screened Zones:
430' – 450'
550' – 570'



GSP Implementation

2023 Implementation Highlights:

- WY 2023 Annual Report submitted and WY 2023's was started
- Property-related service fees adopted by the GSAs
- DWR's SGM Grant Program proposal
  - planning and refining, evaluating and ranking PMAs, submitting the grant application which was partially funded
- Airborne electromagnetic (AEM) survey by DWR in the summer of 2022
- Progress has been made on 9 PMAs since the last annual report
- No indications of undesirable results for any Sustainability Indicators

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GSP Implementation (Continued)

GSP approved in July of 2023 with five recommended corrective actions by 2027 by DWR including requests for more information on:

- Sustainable management criteria for groundwater quality conditions and,
- Sustainable management criteria for chronic lowering of groundwater and,
- How degradation during dry-years will be managed / removal of dry year condition
- Sustainable management criteria for land subsidence and,
- Filling data gaps, collecting additional monitoring data, and implementing the current strategy to manage depletions of interconnected surface water.

The GSAs are committed to addressing all of these actions by 2027 through DWR SGMA Implementation grant funded projects.

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GSP Implementation (Continued)
Project Implementation – A subset

Project (Proponent)	Current Status	Notable Progress Since Last Annual Report
Oroville Wildlife Area Robinson's Riffle Project	Funded	Awarded grant funded, expected to be completed by 2026
Palermo Clean Water Consolidation Project	Underway	Application for funding submitted, annexation process completed
Thermalito Water and Sewer District Water Treatment Plant Capacity Upgrade Project	Funded	**DWR SGM Grant Program application** submitted in December 2022 **was funded to advance these projects.**
Intra-basin Water Transfer	Funded	
Agricultural Surface Water Supplies	Funded	

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Acknowledgements

- **Participating Butte County Well Owners**
- **Groundwater Sustainability Agency Managers**
- **Technical Advisory Committee to the Butte County Water Commission**
- **Water Quality Monitoring Volunteers**
- **Luhdorff & Scalmanini Consulting Engineers & Davids Engineering, Inc.**

Thank you!

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Discussions / Questions?

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ANNUAL REPORT | APRIL 2024

WYANDOTTE CREEK SUBBASIN (5-021.69) GROUNDWATER SUSTAINABILITY PLAN ANNUAL REPORT – 2023

SUBMITTED BY

WYANDOTTE CREEK GROUNDWATER SUSTAINABILITY AGENCY

PREPARED UNDER CONTRACT WITH

BUTTE COUNTY DEPARTMENT OF WATER AND RESOURCE CONSERVATION

PREPARED BY

Prepared by Luhdorff and Scalmanini Consulting Engineers and Davids Engineering under contract with Butte County Department of Water and Resource Conservation on behalf of the GSA for the Wyandotte Subbasin.

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronym	Meaning
µS/cm	micro siemens per centimeter
AEM	airborne electromagnetic
AF	acre-feet
AFY	acre-feet per year
AMSL	above mean sea level
BBGM	Butte Basin Groundwater Model
Cal Water	California Water Service
DMS	Data Management System
DWR	Department of Water Resources
EC	electrical conductivity
GSP	Groundwater Sustainability Plan
GSA	Groundwater Sustainability Agency
IM	Interim Milestone
MA	management area
MO	Measurable Objective
MT	Minimum / Maximum Threshold
PMAs	projects and management actions
RMS	representative monitoring site
SFWPA	South Feather Water and Power Agency
SI	sustainability indicator
SGM	Sustainable Groundwater Management
SGMA	Sustainable Groundwater Management Act
SMC	sustainable management criteria
Subbasin	Wyandotte Creek Subbasin
TWSD	Thermalito Water and Sewer District
WY	Water Year (October 1-September 30)

EXECUTIVE SUMMARY

The Wyandotte Creek Subbasin (Subbasin) (5-021.69) Annual Report was prepared on behalf of the Wyandotte Creek Groundwater Sustainability Agency (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 GSA is formed through a Joint Powers Agreement (Agreement) of three member agencies, including Butte County, the City of Oroville, and Thermalito Water and Sewer District. 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 2023 (October 1, 2022, to September 30, 2023) for the Wyandotte Creek Subbasin, located within Butte County, and shown in **Figure ES-1.**

Measured conditions in the Subbasin were in compliance with Minimum/Maximum Thresholds (MTs) for all applicable sustainability indicators (SIs), with two exceptions, wells 18N04E19D001M and 18N04E19D002M, which had electrical conductivity (EC) levels at 6,640 micro siemens per centimeter (µS/cm) and 5,474 µS/cm, respectively. Upon completion in 2021, both new wells had high baseline measurements of 3,910 µS/cm and 2,480 µS/cm, respectively. An MT is a quantitative value that represents the groundwater conditions at a representative monitoring site that, when exceeded individually or in combination with minimum thresholds at other monitoring sites, may cause an undesirable result(s) in the basin per DWR's definition. 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. On the contrary, for the groundwater quality SMC, as the value of the EC concentrations increase from the MO established for that site, they are moving in the direction of the MT. The SIs and sustainable management criteria (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 representative monitoring sites (RMS).

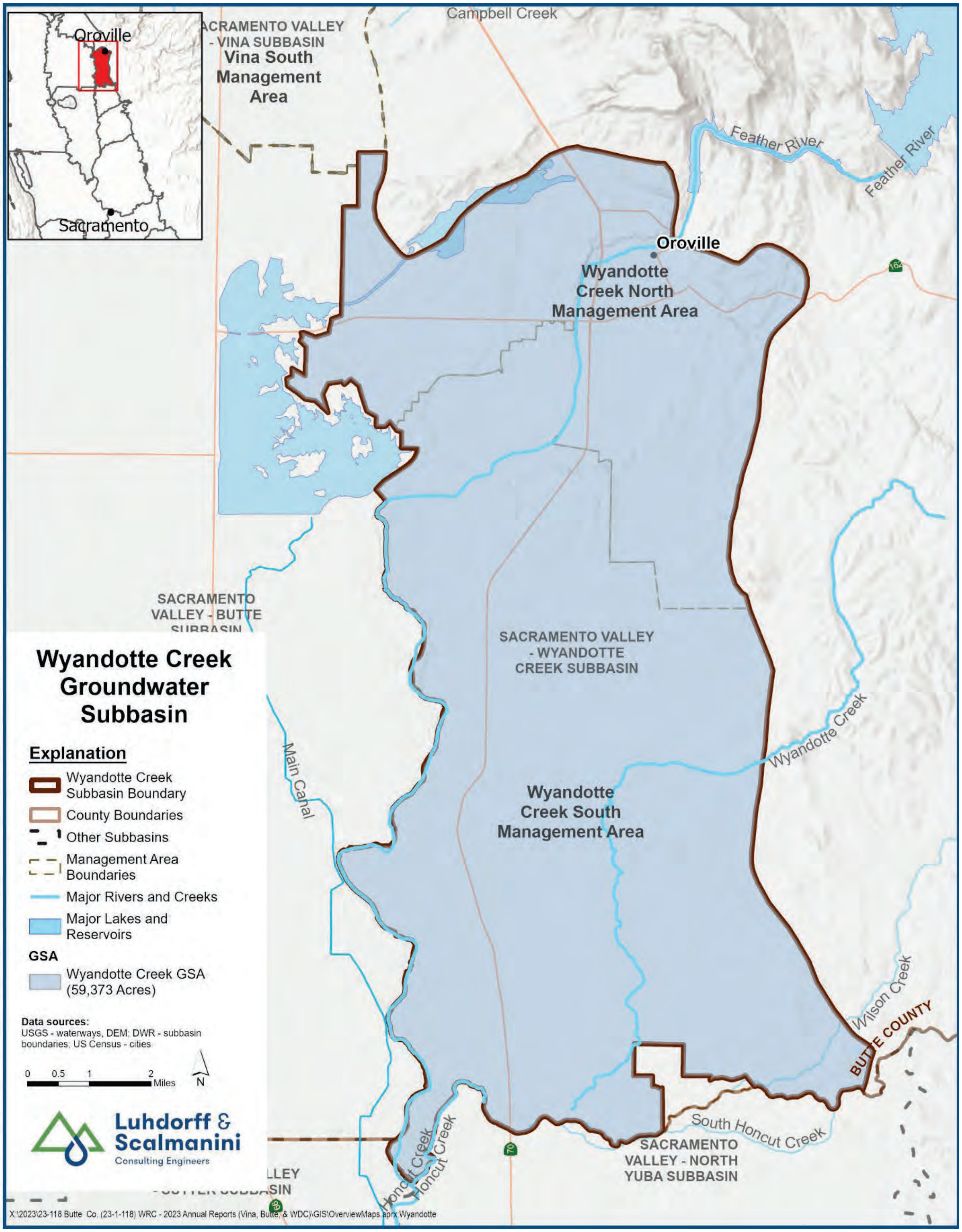

Figure ES-1. Subbasin and Groundwater Sustainability Agency Boundaries

Table ES-1. Sustainability Indicator Summary

2023 Status	Undesirable Result Identification	Measurable Objective (MO) Definition	Minimum Threshold (MT) Definition
Chronic Lowering of Groundwater Levels			
No indication of undesirable results There were no RMS wells with spring or fall 2023 groundwater level measurements below the MT.	When 2 RMS wells within a management area reach their MT for two consecutive non-dry year types	The groundwater level based on the groundwater trend line for the dry periods (over the period of record) of observed short-term climatic cycles extended to 2030	Elevation based on the 15th percentile of shallowest domestic wells using refined DWR database (includes wells installed since 1980) based on the elevation of the bottom of the wells within a 3-mile radius of the RMS well
Reduction of Groundwater Storage			
No indication of undesirable results There were no RMS wells with spring or fall 2023 groundwater level measurements below the MT.	Groundwater levels are a proxy, per SGMA regulations.	Groundwater levels are a proxy, per SGMA regulations.	Groundwater levels are a proxy, per SGMA regulations.
Degraded Water Quality			
No indication of undesirable results In August of 2023, a non-dry year, 2 of 7 RMS wells had EC levels above their MTs. Multi-completion wells 18N04E19D001M and 18N04E19D002M had EC levels at 6,640 µS/cm and 5,474 µS/cm, respectively. Upon completion in 2021, both new wells had high baseline measurements of 3,910 µS/cm and 2,480 µS/cm, respectively. The first year of monitoring, 2022, was a dry year.	When 2 RMS wells exceed their MT for two consecutive non-dry years	Measured electrical conductivity less than or equal to the recommended Secondary Maximum Contaminant Level (900 µS/cm) based on State Secondary Drinking Water Standards at each well	The upper limit of the Secondary Maximum Contaminant Level for electrical conductivity (1,600 µS/cm) is based on the State Secondary Drinking Water Standards.

Table ES-1. Sustainability Indicator Summary

2023 Status	Undesirable Result Identification	Measurable Objective (MO) Definition	Minimum Threshold (MT) Definition
Land Subsidence			
No indication of undesirable results There were no RMS wells with spring or fall 2023 groundwater level measurements below the MT.	Groundwater levels are a proxy, per SGMA regulations.	Groundwater levels are a proxy, per SGMA regulations.	Groundwater levels are a proxy, per SGMA regulations.
Depletion of Interconnected Surface Water			
No indication of undesirable results There were no RMS wells with spring or fall 2023 groundwater level measurements below the MT.	Uses groundwater levels as a proxy. GSP identifies the data gap and describes the "Interconnected Surface Water Sustainable Management Criteria Framework."	Groundwater levels are a proxy, per SGMA regulations.	Groundwater levels are a proxy, per SGMA regulations.

Notes:

Salinity is the primary water quality constituent of concern, which is evaluated by measuring electrical conductivity (EC).

MO = Measurable Objective, MT = Minimum Threshold, RMS = representative monitoring site, µS/cm = micro siemens per centimeter

Current Groundwater Level and Storage Conditions

The current groundwater conditions in the Subbasin are characterized by groundwater elevations that have remained consistently near or above the MO, staying well above the corresponding MT and remaining within the Subbasin's established margin of operational flexibility for each RMS well. Importantly, none of the RMS wells experienced a decline below the MT for two non-dry WYs, hence avoiding undesirable results as defined in the GSP.

Groundwater elevations are, on average, 39 feet above the MT throughout the Subbasin and on average, 14 feet above the MOs in WY 2023. Elevations are mostly near or slightly higher than those observed in recent years. This positive trend is influenced by the wet conditions experienced in WY 2023, which resulted in increased surface water supplies and reduced groundwater extractions.

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

In contrast, WY 2023, classified as a Wet WY (CDEC, 2023), marked an increase in groundwater storage of approximately 22,300 acre-feet (AF) in the Primary Aquifer (a 269% change from the previous WY). For context, in the past 23 years, the largest decrease in groundwater storage is estimated to be -28,800 AF, and the greatest increase was estimated to be 36,500 AF. **Figure ES-2** shows groundwater pumping, as well as annual and cumulative change in groundwater storage from WY 2000 to WY 2023.

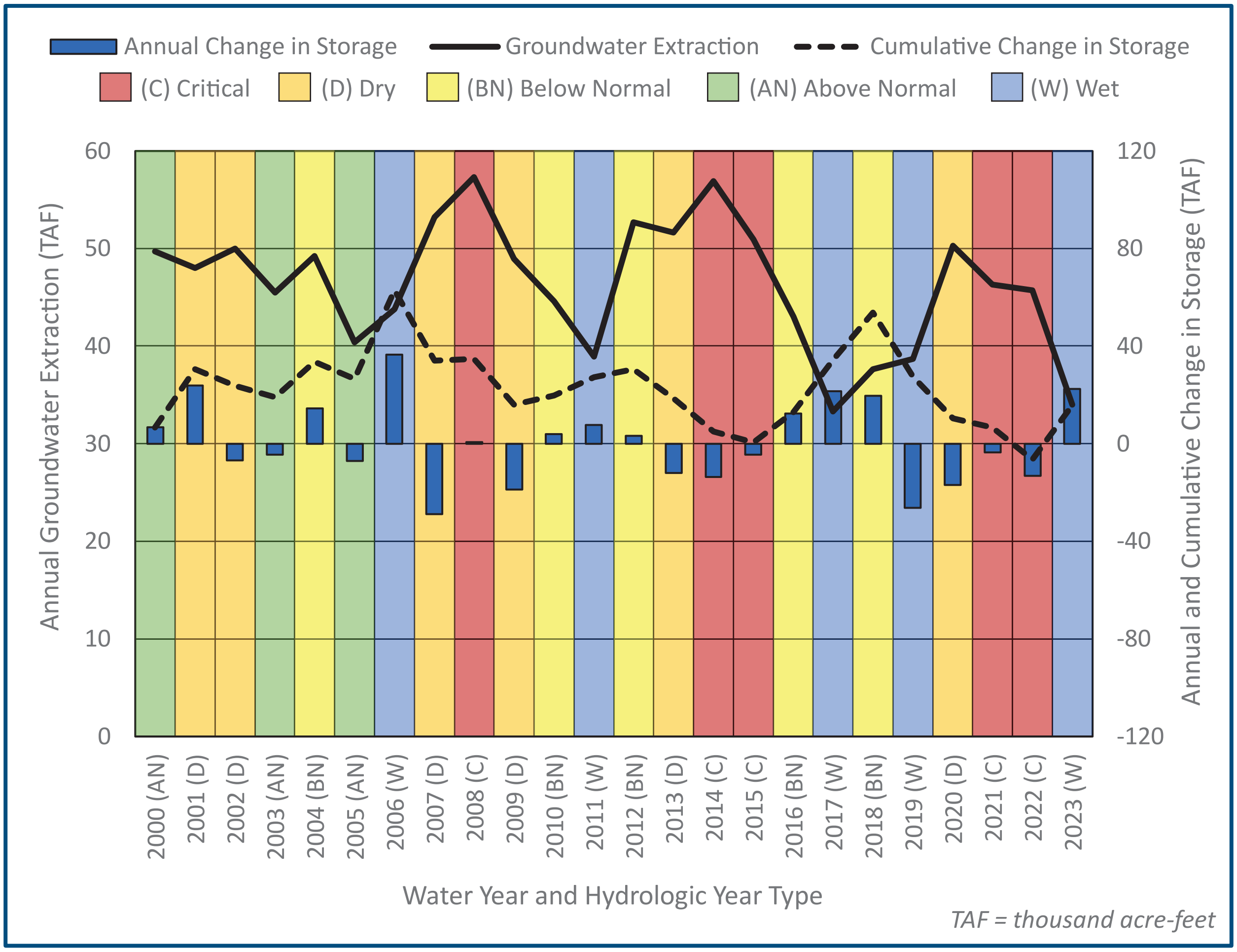

Figure ES-2. Groundwater Pumping, Annual and Cumulative Change in Storage from WY 2000 to WY 2023

Water Use

Groundwater extraction was approximately 34,500 AF in WY 2023, lower than the 45,700 AF extracted in WY 2022. The annual volume of surface water delivered to the Subbasin from surface water features such as the Feather River was about 22,400 AF in WY 2023, higher than the 16,200 AF delivered in WY 2022.

Groundwater provided the majority (61%) of the water for agriculture in the Subbasin, and surface water was the source for the remainder. Groundwater also met the demand for municipal and rural residential users in WY 2023. 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. Total Water Use by Water Use Sector				
Sector	WY 2023			
	Groundwater (AF)	Surface Water (AF)	Total (AF)	Total Irrigated Area (ac)
Agricultural	32,900	17,400	**50,300**	**13,700**
Municipal	600	5,000	**5,600**	--
Rural Residential	1,000	0	**1,000**	--
Total	**34,500**	**22,400**	**56,900**	**13,700**

GSP Implementation Progress

Since the previous Annual Report (Butte County, 2023), the Wyandotte Creek GSA has coordinated with stakeholders to seek funding through DWR's Sustainable Groundwater Management Grant Program for projects and management actions (PMAs) previously identified in the GSP. An awards list for the grant application was released by DWR in September 2023. Additionally, several actions by the GSA continue to fulfill GSP requirements, such as monitoring groundwater levels and quality, updating the Data Management System (DMS), and annual reporting to DWR.

Also, since the previous Annual Report, DWR has formally approved the Wyandotte Creek Subbasin GSP. The Wyandotte Creek Subbasin GSA acknowledges and will address the five key recommended corrective actions listed in the DWR's **GSP determination letter** (https://sgma.water.ca.gov/portal/service/gspdocument/download/9924), including:

1. Providing additional information on historical and current groundwater quality conditions in the Subbasin and refining the definition of sustainable management criteria through a number of actions further described in the letter.

2. Providing more information regarding criteria used to identify significant and unreasonable conditions, undesirable results, and the potential impacts to various beneficial uses and users of groundwater related to the chronic lowering of groundwater level minimum thresholds through a number of actions further described in the letter.

3. Revising the definition of undesirable results to remove the non-dry year condition or discuss how degradation during dry periods will be managed as necessary to ensure that adverse water quality conditions are offset during other periods.

4. Providing more information about the criteria used to identify undesirable results and sustainable management criteria for land subsidence through a number of actions further described in the letter.

5. Using future DWR guidance regarding estimations of the location, quantity, and timing of depletions of interconnected surface water and establishing specific sustainable management criteria to sustainably manage depletions of interconnected surface water through a number of actions further described in the letter.

In 2023, the GSAs in the Subbasin prepared to implement future projects to address recommended corrective actions, which will be largely funded by the SGM Implementation Grant Program. The ongoing implementation of PMAs, described 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 Wyandotte Creek Subbasin (Subbasin) (5-021.69) was prepared on behalf of the Wyandotte Creek Groundwater Sustainability Agency (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 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 third Annual Report submitted on behalf of the Subbasin and includes data for the most recent WY 2023 (October 1, 2022 to September 30, 2023). The public seeking information on Wyandotte Creek Subbasin and GSP Implementation, Wyandotte Creek Advisory Board meeting schedules and recordings, and other resources should visit the **Wyandotte Creek Groundwater Sustainability Agency website** (https://www.wyandottecreekgsa.com/).

1.1 Report Contents

This report is the third Annual Report prepared for the adopted Wyandotte Creek 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 2023, the 12-month period spanning October 2022 through September 2023 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 93 square mile (59,382 acres) area on the southeastern side of Butte County. The Subbasin is managed by the Wyandotte Creek GSA, formed through a Joint Powers Agreement (Agreement) by three member agencies, including Butte County, the City of Oroville, and Thermalito Water and Sewer District. The GSA worked to develop and submit a GSP for the Subbasin and to submit Annual Reports every year.

The Agreement defines two Management Areas (MAs) within the Wyandotte Creek Subbasin: Wyandotte Creek Oroville and Wyandotte Creek South. An MA refers to an area within a subbasin for which a GSP may identify different minimum thresholds (MTs), measurable objectives (MOs), monitoring, and projects and management actions (PMAs) based on unique local conditions or other circumstances as described in the GSP regulations. The interests and vulnerability of stakeholders and groundwater uses in these MAs vary based on the nature of the water demand (agricultural, domestic, municipal), numbers and characteristics of wells supplying groundwater, and to some degree, the hydrogeology and mix of recharge sources. Although all stakeholders have a shared interest in the sustainable management of groundwater in this predominantly groundwater-dependent Subbasin, the landscape of beneficial users varies between Mas.

The Wyandotte Creek North MA is predominantly an urban area with three water providers, including California Water Service, Oroville (Cal Water-Oroville) and Thermalito Water and Sewer District (TWSD), providing ground and surface water supplies for residential and municipal/industrial use and South Feather Water and Power Agency (SFWPA) providing surface water supplies for agricultural, residential and municipal/industrial use. The Wyandotte Creek South MA is dominated by irrigated agriculture dependent on groundwater and, to a lesser extent, surface water diversions primarily from Feather River. To a limited extent, private domestic wells provide the primary source of water to households or, in some cases, provide a secondary supply for outdoor water use.

The Subbasin Is shown in **Figure 1-1** and **Figure 1-2**. The Subbasin lies in the eastern central portion of the Sacramento Groundwater Basin, **Figure 1-1**. The Subbasin's northern and eastern boundary is the alluvial basin, the western boundary is the Feather River and the Thermalito Afterbay, and the southern boundary is the Butte-Yuba County line (except for Ramirez Water District, which is fully within the North Yuba Subbasin) (DWR, 2018) **Figure 1-2**. The major surface water feature located in the Subbasin is the Feather River, which flows along the Subbasin's western border. Smaller local streams entering and traversing the Subbasin include North Honcut Creek, Wyandotte Creek, and Wyman Ravine. Groundwater generally flows from north to southwest.

The Wyandotte Creek Subbasin GSP estimates the sustainable yield of the Subbasin to be 46,100 acre-feet per year (AFY) based on historical groundwater pumping averages of 47,100 AFY and an average annual decrease in storage of 1,000 AFY (Geosyntec, 2021). In WY 2023, water use in the Subbasin is dominated (88%) by agricultural uses, including irrigation of nut and fruit trees, vineyards, row crops, grazing, and rice fields. Municipal and household water use accounts for about 12% of total water used. Groundwater constitutes the majority (61%) of the Subbasin's water supplies, while surface water constitutes about 39%.

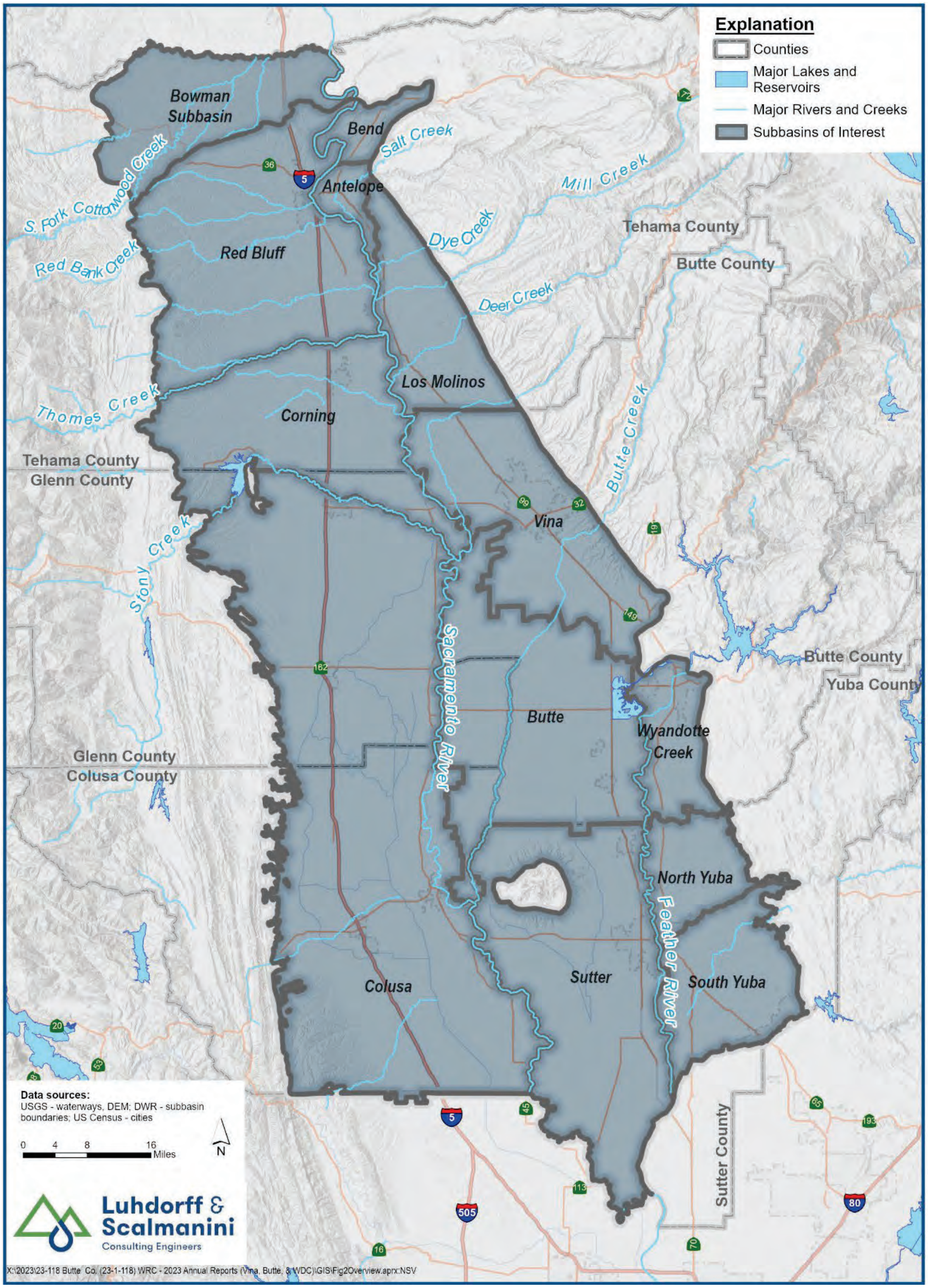

Figure 1-1. Subbasins in the Northern Sacramento Valley

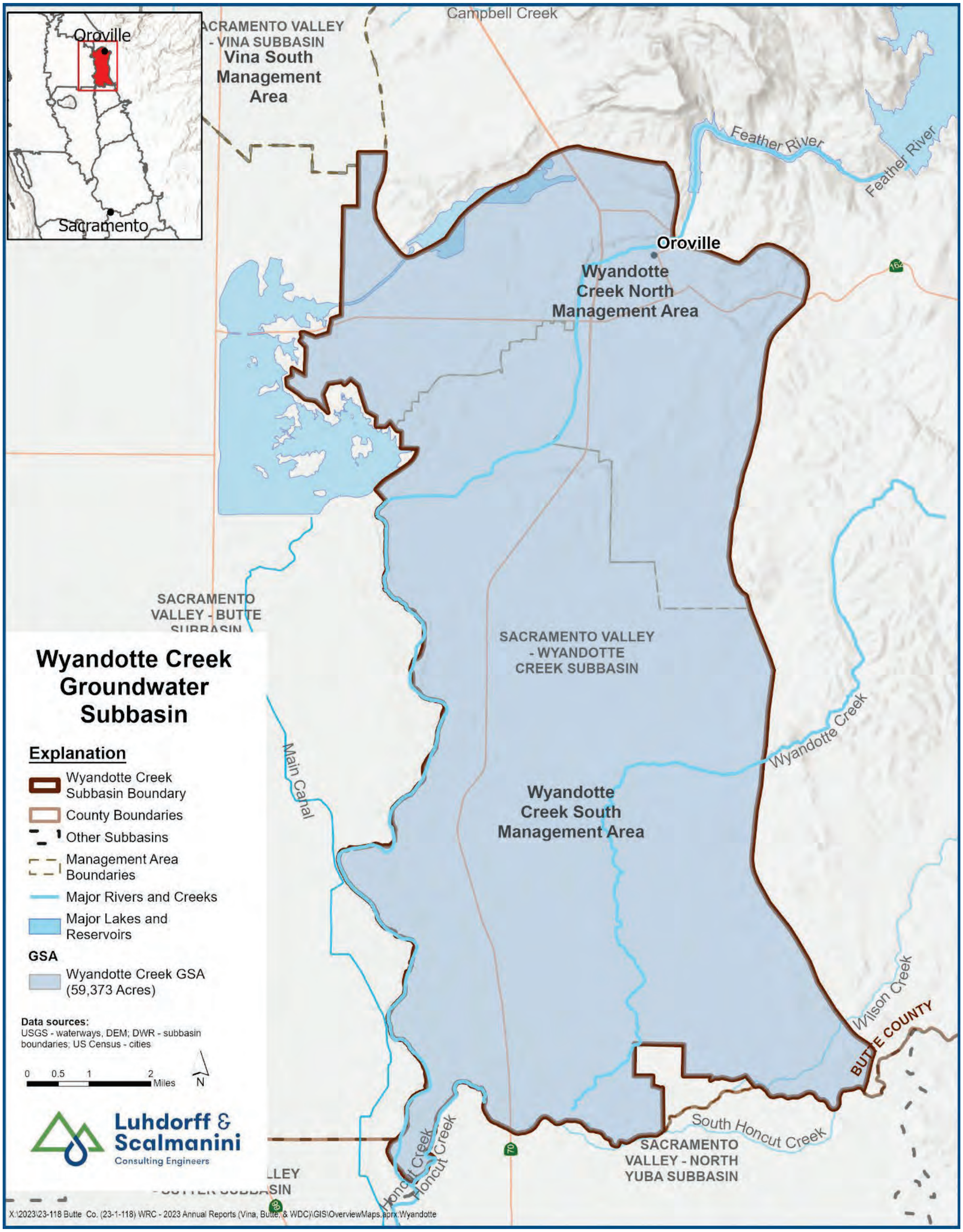

Figure 1-2. Groundwater Sustainability Agency Boundaries

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 (such as rice flood-up), 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 follow a variety of patterns in different areas of the Subbasin; however, groundwater generally ranges from about 40 to 80 feet below ground surface and is relatively stable in most of the Subbasin.

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, nine RMS wells are used to monitor conditions in the Primary Aquifer. **Appendix A** includes a map of the approximate locations of the RMS wells and hydrographs depicting groundwater elevations in the RMS wells. Sustainable management criteria (SMC), described in **Appendix B**, are assigned for groundwater levels at the RMS wells.

Certain RMS wells measured by DWR and Butte 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 twice in Spring and Fall but up to four times each year in March, July, August, 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 2023 groundwater elevation measurements from RMS wells in the Primary Aquifer systems are summarized in **Table 5-2**. Groundwater elevation data in the Subbasin is collected by DWR and Butte County and is publicly available from DWR's online SGMA Data Viewer tool (https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer). The groundwater level monitoring methods are consistent with the protocols described in the Wyandotte Creek Subbasin GSP. Depending on the well, groundwater elevations are measured using steel tape, electric sounder, or pressure transducers. The accuracy of groundwater level measurements is typically either 0.01 feet or 0.1 feet, depending on the equipment used.

The following sections provide a summary of groundwater elevations and conditions during WY 2023 through the presentation and description of groundwater elevation contours (**Section 2.1**) and hydrographs of groundwater elevations (**Section 2.2**).

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

Groundwater elevation contour maps for Spring and Fall 2023 were prepared for the Primary Aquifer, as shown in **Figures 2-1** through **2-2**. 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.

The contour maps of the Primary Aquifer (**Figures 2-1 and 2-2**) each show that groundwater elevations are generally higher in the northern and eastern areas of the Subbasin versus the southern and western areas, indicating a general gradient – and thus groundwater flow from north to south and northeast to southwest. In general, elevations in Fall 2023 tend to be roughly eight feet lower than elevations in Spring 2023 throughout the Subbasin; groundwater levels are typically lower in the fall in valley floor locations due to irrigation season pumping. However, groundwater levels have increased relative to the same season in the prior year (e.g., Spring 2022 to Spring 2023) for both Spring and Fall measurements due to increased precipitation in 2023. Maps showing the regional context of groundwater contours, including groundwater contours in the Wyandotte Creek, Vina and Butte Subbasins, are included in **Appendix A**.

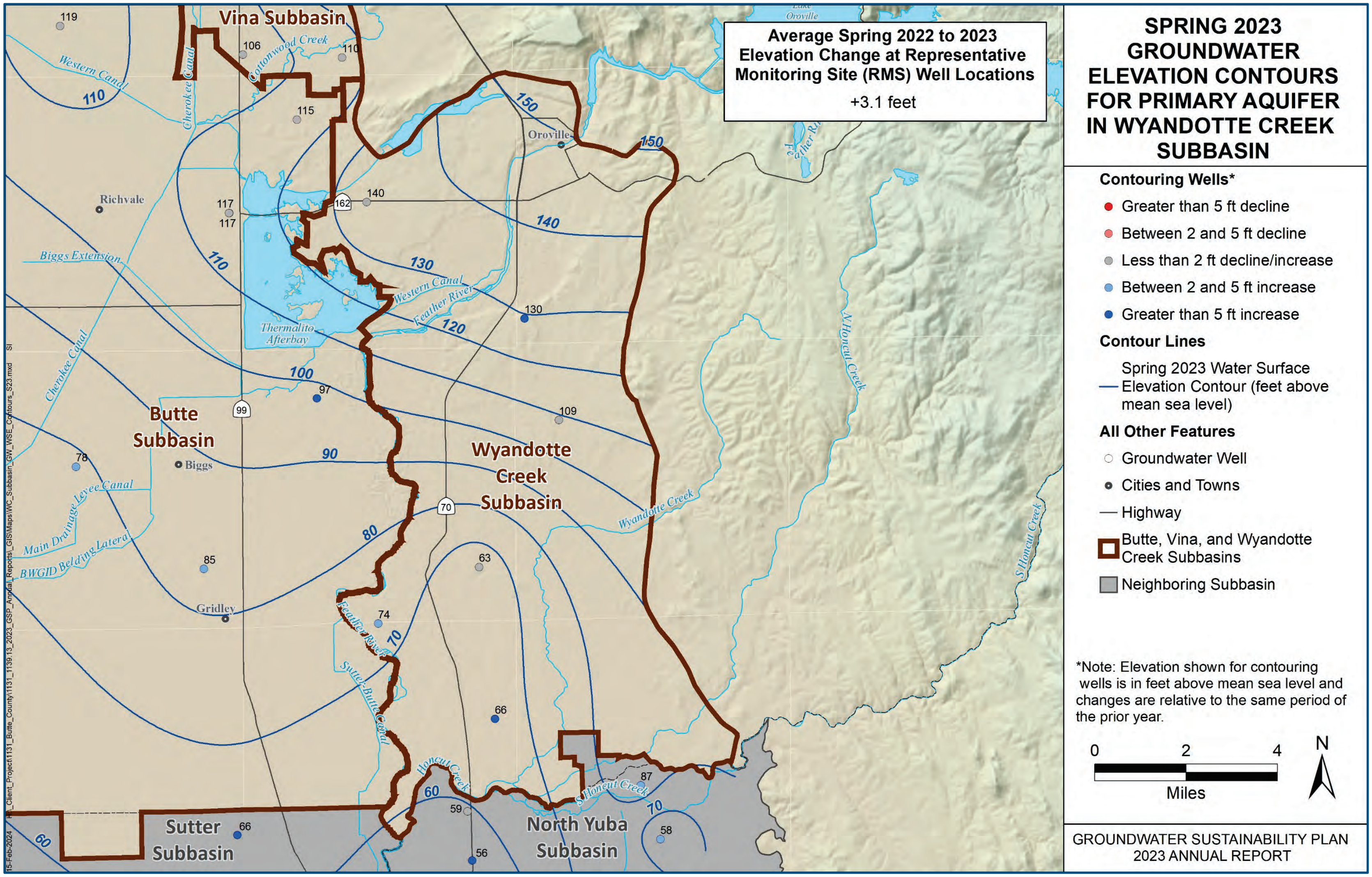

Figure 2-1. Contours of Equal Groundwater Elevation for the Primary Aquifer, Spring 2023 (Seasonal High)

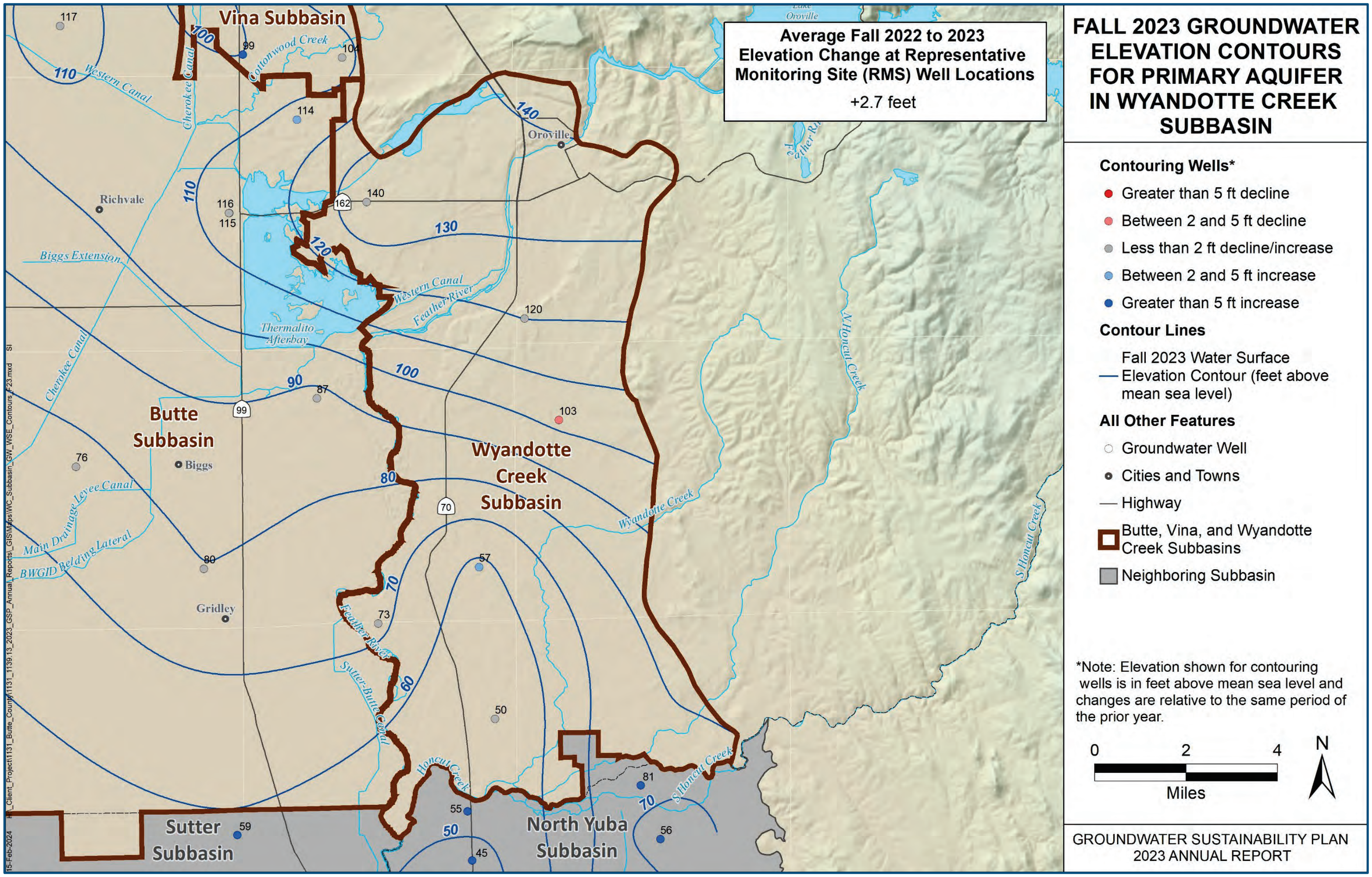

Figure 2-2. Contours of Equal Groundwater Elevation for the Primary Aquifer, Fall 2023 (Seasonal Low)

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

Groundwater elevation hydrographs for each RMS well are presented in **Appendix A**. **Appendix B** provides an explanation of the SMC terminology defined in Section 3 of the GSP (e.g., MT, MO, Interim Milestone [IM]). **Table 5-1** summarizes the MOs, MTs, and identification of undesirable results for WY 2023, and **Table 5-2** contains a summary of the Spring 2023 (Seasonal High) and Fall 2023 (Seasonal Low) groundwater elevations measured at each RMS well. **Table 5-2** also summarizes where each RMS well is located, the established MO and MT for groundwater elevations, the Interim Milestone for 2027, the changes in groundwater elevations from WY 2022 to WY 2023, and the differences between the 2023 groundwater elevations and the MO.

Groundwater levels have historically remained at or near the MOs in the Subbasin. The GSP established IMs equal to the MOs to provide numerical metrics for the GSA to track the Subbasin's conditions relative to the overall sustainability goal, ensuring that the groundwater management in the Subbasin remains sustainable.

Spring and Fall 2023 groundwater elevations were generally near or slightly higher than seasonal groundwater elevations in previous years, particularly WY 2022. In WY 2023, the average seasonal high was 106 feet above mean sea level (AMSL), and the average seasonal low was 99 feet AMSL. The WY 2022 average seasonal high was 103 feet AMSL, and the average seasonal low was 96 feet AMSL. Increases in groundwater levels generally were expected to result from the decreased groundwater extraction in WY 2023 relative to WY 2022, as well as increased recharge due to wet climate conditions.

In total, all RMS wells remained above the MO as of Spring 2023, and all groundwater levels in the Fall of 2023 were at or above the MO. 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. On average, groundwater levels in RMS wells were roughly 35 feet higher than MT elevations in Fall 2023. All measured groundwater levels remained within the Subbasin's margin of operational flexibility and above the MTs.

3. WATER SUPPLY AND USE

As required by §356.2, this section summarizes water supply and use in the Subbasin, categorized by groundwater supply, 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 2023. Groundwater extraction volumes are either based on measured data or are estimates from a water use analysis based on 2023 land use data and climate conditions. The water use analysis methodology is discussed in **Appendix E**. Surface water use was estimated from historic deliveries when records were not available.

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

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

The majority of the Subbasin uses groundwater supplies for agricultural irrigation, although portions of the Subbasin may rely on surface water for irrigation. In years characterized by drought and low precipitation, diminished surface water supplies lead to increased extraction and reduced recharge and can cause a decline in groundwater storage. Contrastingly, in wet years, such as WY 2023, substantial surface water supplies help to increase recharge and offset extraction and can increase groundwater storage.

Municipal water users extracted approximately 600 acre-feet (AF) of groundwater in the Subbasin in WY 2023. Municipal water supplies are measured and provided by Cal Water-Oroville, TWSD. The record of municipal supplies does not distinguish between urban and industrial water uses.

Table 3-1. Groundwater Use by Water Use Sector

Sector	WY 2023 (AF)
Agricultural	32,900
Municipal	600
Rural Residential	1,000
Total	34,500

Rural residential water users rely on private domestic wells to meet their household water needs and extracted approximately 1,000 AF in WY 2023. 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 California Water Service Chico-Hamilton City District 2020 Urban Water Management Plan 2020 (Cal Water-Chico, 2020) was 181 gallons per capita per day. This is considered representative of rural residential per capita water use in the region. Parcels were chosen within the Subbasin, except for those in municipal service areas. Residential parcels were selected based on Butte County's general plan zoning codes from the general plan. Population estimates were derived from these zoning codes and average household sizes from the US census. The resulting population estimate was used to estimate residential groundwater pumping.

The total estimated groundwater extraction was approximately 34,500 AF in WY 2023, the majority of which was used to meet agricultural water demands (approximately 32,900 AF). The total groundwater extraction is about 12,300 AF less than the historical (2000 – 2022) groundwater pumping average (46,800 AFY; **Table 4-1**) and also lower than 38,700 AF, which was the average annual extraction of the last four wet WYs on record (2006, 2011, 2017, and 2019). **Figure 3-1** shows the general areas and pumping rates where extraction occurs by sector. About 95% of the total groundwater extraction was used by the agricultural sector, while the remaining 5% was used for municipal and rural residential needs.

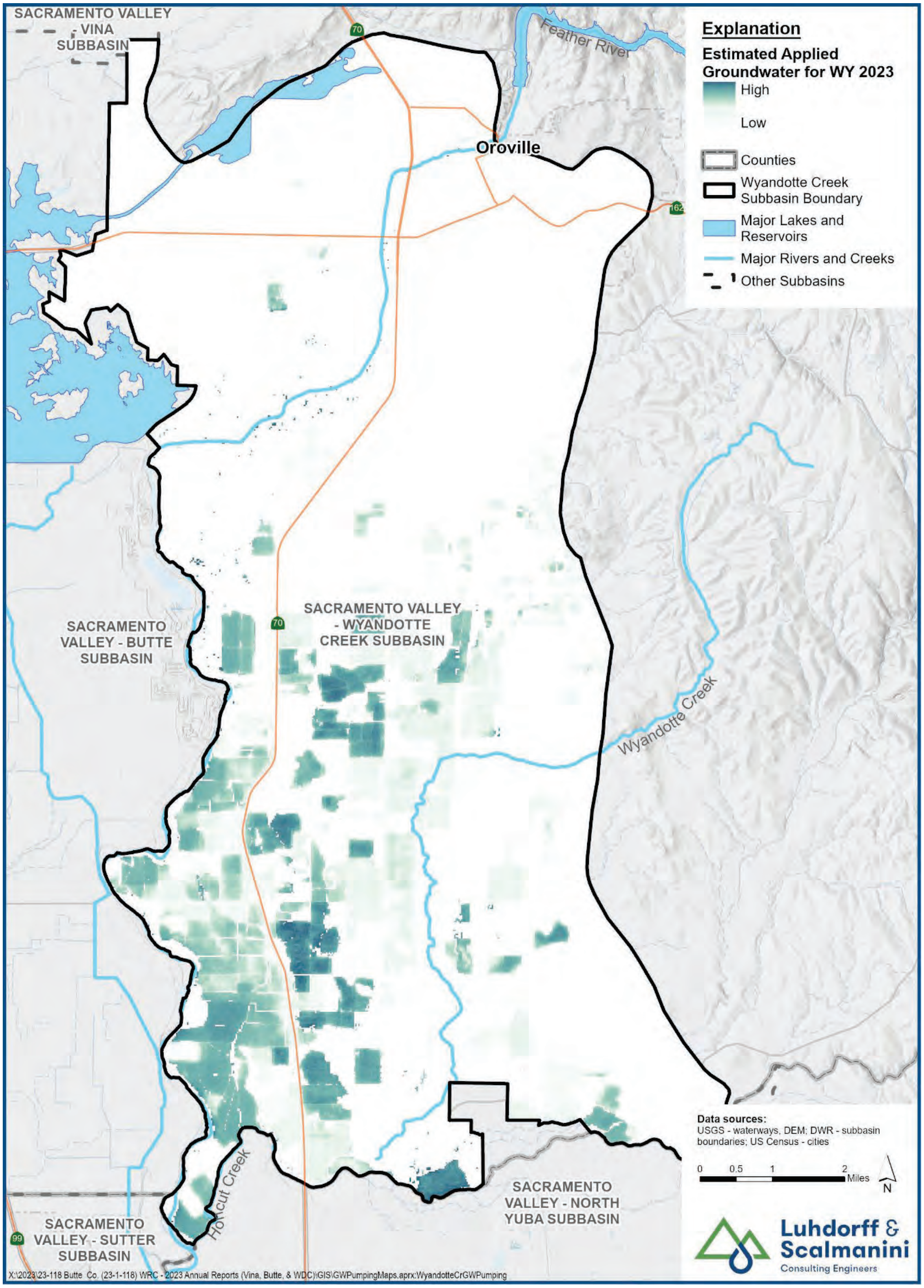

Figure 3-1. Estimated Applied Groundwater – WY 2023

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 was estimated based on available historical diversions data in similar water years.

Diversions from the Feather River and Honcut Creek outside of district areas are estimated based on the historic State Water Resources Control Board's (SWRCB) Electronic Water Rights Information Management System (eWRIMS; SWRCB, 2023) data for total diversions. For the appropriative water rights outside of surface water suppliers, the face value of the water right was taken and multiplied by a local factor of 59%. The local factor is based on an overview of measured deliveries in the area.
Surface water is a significant source of water supply for municipal and/or industrial use (municipal and industrial use are not differentiated). In total, approximately 22,400 AF of surface water was applied for beneficial uses in the Subbasin in WY 2023, supplying approximately 35% of the water used by agriculture and 89% of the water used by the municipal sector. This includes surface water sourced from the Feather River and Honcut Creek. Although both diverted and applied water volumes are shown in **Table 3-2**, the volumes shown are equivalent for each. Surface water use volumes were assembled from multiple sources, and not enough information is currently known to estimate the differences between diverted and applied volumes that are influenced by data source and supplier-specific characteristics such as conveyance losses and water reuse.

In contrast with the curtailments and reduced surface water supplies experienced in WY 2022, WY 2023 was a Wet WY with substantial surface water supplies. These, combined with wet climate conditions and increased stream flows, supported groundwater recharge and offset groundwater extraction volumes compared to WY 2022.

Table 3-2. Surface Water Use by Water Use Sector for WY 2023

Sector	Diverted (AF)	Applied (AF)
Agricultural	17,400	17,400
Municipal	5,00	5,000
Total	**22,400**	**22,400**

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

Groundwater supplied approximately 65% of the agricultural water demand in the Subbasin in WY 2023, while surface water supplied the remaining approximately 35% of the agricultural water demand. 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 2023. The results are either based on measured data or estimates, as described in the previous two sections. **Table 3-3** also shows the total irrigated area in WY 2023 within the Subbasin.

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

Sector	WY 2023			
	Groundwater (AF)	Surface Water (AF)	Total (AF)	Total Irrigated Area (ac)
Agricultural	32,900	17,400	**50,300**	**13,700**
Municipal	600	5,000	**5,600**	--
Rural Residential	1,000	0	**1,000**	--
Total	**34,500**	**22,400**	**56,900**	**13,700**

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. Estimated Uncertainty in Water Use Estimates

Water Budget Component	Data Source	Estimated Uncertainty (%)	Source
Groundwater			
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 Subbasin.*

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 relatively stable over time. 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 is 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 2023 (a Wet WY), groundwater storage increased by approximately 23,300 AF. Decreased groundwater extraction in WY 2023 relative to WY 2022 contributed to the increase, as well as increased recharge due to wet climate conditions. These and related factors, such as flood irrigation with surface water and increased stream flows, resulted in higher groundwater levels in Spring 2023 compared to Spring 2022.

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 2000 through WY 2023 in **Table 4-1** and **Figure 4-1**. In contrast to the Critically Dry conditions of WY 2022, WY 2023 was a Wet WY and correspondingly saw an increase in groundwater storage of approximately 22,300 AF in the Primary Aquifer.

The historical record since 2000 includes multiple data sources. Groundwater extractions for WY 2000 through WY 2018 were obtained from the Butte Basin Groundwater Model (BBGM, BCDWRC, 2021), and the water budgets were prepared as part of the Wyandotte Creek Subbasin GSP (Geosyntec, 2021). The WY 2019 and WY 2020 groundwater extraction values were calculated as the average based on the hydrologic year type from WY 2000 to WY 2018. The WY 2021 and WY 2022 groundwater extraction values were obtained from prior Annual Reports and were developed using the same methods as WY 2023, as described in **Section 3** and **Appendix E**. 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 2000 through WY 2023 based on the methodology described below in **Section 4.2**. This methodology differs from the change in groundwater storage estimates available through the BBGM. An evaluation of a total of 20 pairs of concurrent annual storage changes over the period from WY 1999 through WY 2018 was assembled from the BBGM, and the methodology described in **Section 4.2** was completed to evaluate the consistency of the new methodology with the BBGM results. Although groundwater storage changes differ in some cases, the general trends are similar, and there is agreement between the methodologies. It is anticipated that the methodology described in **Section 4.2** will be utilized for Annual Report updates until the BBGM model is updated from 2018 through the present (anticipated to be completed as part of the Periodic Evaluation of the GSP due in January 2027, if not sooner).

Table 4-1. 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)
Storage Change and Cumulative Change in Storage			
2000 (AN)	49,700	6,600	6,600
2001 (D)	48,000	23,800	30,400
2002 (D)	50,000	-6,800	23,600
2003 (AN)	45,500	-4,600	19,000
2004 (BN)	49,200	14,500	33,500
2005 (AN)	40,400	-7,100	26,400
2006 (W)	43,800	36,500	62,900
2007 (D)	53,200	-28,800	34,100
2008(C)	57,300	600	34,700
2009 (D)	48,900	-18,800	15,900
2010 (BN)	44,600	3,800	19,700
2011 (W)	38,900	7,600	27,300
2012 (BN)	52,700	3,300	30,600
2013 (D)	51,600	-12,000	18,600
2014 (C)	56,900	-13,600	5,000
2015 (C)[2]	50,900	-4,600	400
2016 (BN)	43,000	12,400	12,800
2017 (W)	33,300	21,400	34,200
2018 (BN)	37,600	19,500	53,700
2019 (W)	38,700	-26,300	27,400
2020 (D)	50,300	-17,000	10,400
2021 (C)[2]	46,300	-3,700	6,700
2022 (C)[2]	45,700	-13,200	-6,500
2023 (W)	34,500	22,300	15,800

Table 4-1. 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)
Historic Averages (2000-2022)[3]			
2000-2022 (22 years)	46,800	-300	N/A
Wet (4 years)	38,700	9,800	N/A
Above Normal (3 years)	45,200	-1,700	N/A
Below Normal (5 years)	45,400	10,700	N/A
Dry (6 years)	50,300	-9,900	N/A
Critical (5 years)	51,400	-6,900	N/A

Notes:

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

GW = Groundwater

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 values from 2000 to 2018 were determined using BBGM (Geosyntec, 2021). Values for 2019-2020 are averages from that period. Estimates for 2021 were based on a drought impact analysis (**Appendix E**), while estimates for 2022-2023 are based on a GEEEO process, described in the same appendix.*

[2] *Indicates curtailment year with reduced surface water supply allocations to Feather River water districts.*

[3] *The historical average calculation covers the period from 2000 to 2022, excluding the current water year.*

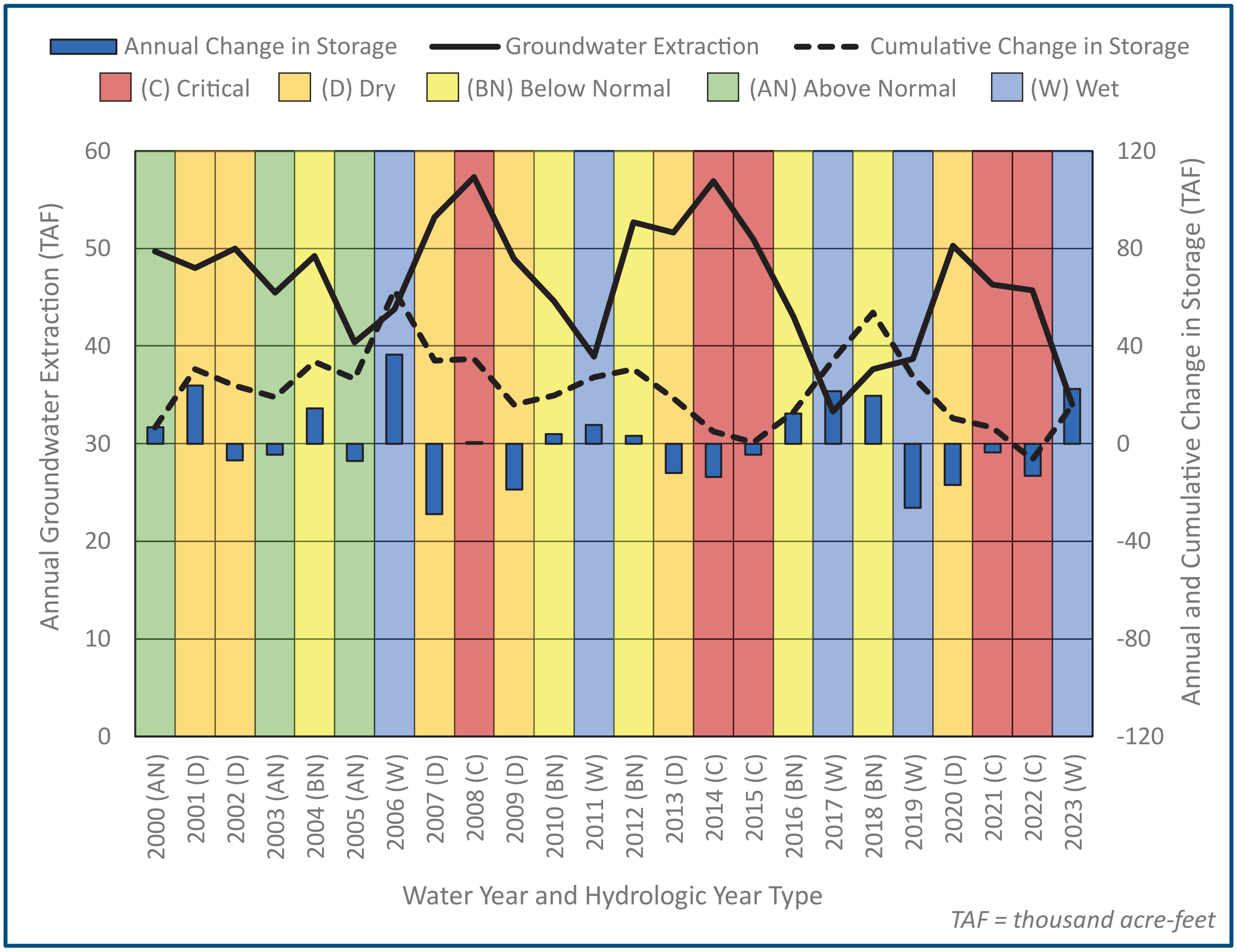

Figure 4-1. Groundwater Pumping and Annual and Cumulative Change in Storage from WY 2000 to WY 2023

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

The spatial distributions of estimated changes in groundwater storage for the Primary Aquifer for the period from Spring 2022 to Spring 2023 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. Change in groundwater storage was estimated based on the change in measured spring-to-spring groundwater levels at each RMS well, multiplied by the area of a Thiessen polygon surrounding that RMS well (defining a representative area for each RMS well) and a representative storage coefficient of 0.1 for the Primary Aquifer.

Spring measurements used to calculate the change in groundwater storage were computed as the average of all available groundwater level measurements from March and April of the respective year. The representative storage coefficient was established by roughly calibrating the estimated change in storage based on changes in observed groundwater levels (i.e., calculated using groundwater level data, representative area, and a storage coefficient parameter) with estimated change in storage outputs from the BBGM, as reported in the GSP to aggregate characteristics across all zones of the Primary Aquifer system. A total of 20 pairs of concurrent annual storage changes assembled from both methods over the period from WY 1999 through WY 2018 were used for calibration. Determination of a representative storage coefficient allows for estimating the change in volume of groundwater storage based on the measured change in groundwater levels and known representative area (i.e., Thiessen polygon) associated with each groundwater level measurement.

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 for each representative area (i.e., Thiessen polygon) in the Primary Aquifer over the previous year ranged from roughly zero to 4,000 AF. The representative areas in the northern central and southern portions of the Subbasin had a larger positive change in storage than other parts of the Subbasin. Total groundwater storage change in the Primary Aquifer was estimated to be approximately 22,300 AF between Spring 2022 and Spring 2023.

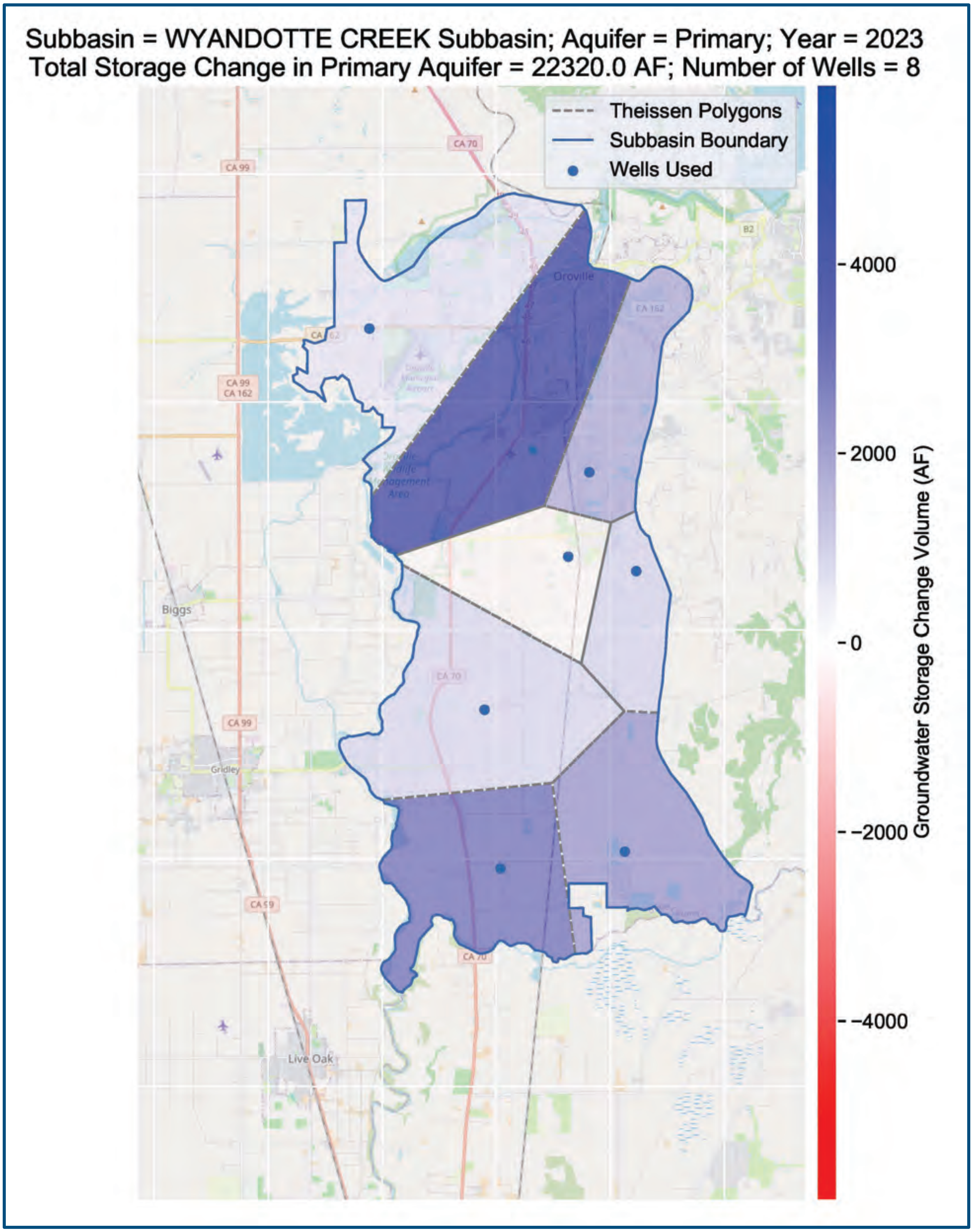

Figure 4-2. Change in Groundwater Storage from Spring 2022 to Spring 2023 in the Primary Aquifer

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 (i.e., Thiessen polygon), and the calibrated storage coefficient parameter used to calculate the change in groundwater storage. As described in **Section 4.2**, a calibration process was conducted to roughly align the estimated change in groundwater storage based on observed groundwater levels to the estimated change in groundwater storage outputs from the BBGM. Thus, the uncertainty of the estimated change in groundwater storage reported in **Table 4-1** and **Figure 4-2** is estimated to be approximately equal to the uncertainty of the estimated change in groundwater storage outputs from the BBGM (typically 20-30% for integrated hydrologic models).

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

5.1 Main Activities of Water Year 2023

The main activities and updates since the previous Annual Report are as follows:

- The GSA completed the WY 2023 Annual Report and other critical tasks.
- The GSA adopted a property-related service fee to fund its operations and implementation costs to comply with SGMA.
- The GSA coordinated a proposal seeking funding through DWR's SGM Grant Program. Coordination efforts included planning and refinement of project and management actions (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 awards list in September 2023; results are summarized below in **Table 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 be used in future efforts to help refine the current hydrogeologic conceptual model. Data is available at: https://data.cnra.ca.gov/dataset/aem.
- All sustainability indicators (SIs) are in compliance with their MTs, except for the water quality SI (see **Appendix F**).
- Progress has been made on nine PMAs since the last annual report (**Tables 5-3 and 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

The GSP was approved in July of 2023, and DWR proposed five recommended corrective actions that will enhance the GSP:

1. Providing additional information on historical and current groundwater quality conditions in the Subbasin, and refining the definition of sustainable management criteria through a number of actions further described in the letter.

2. Providing more information regarding criteria used to identify significant and unreasonable conditions, undesirable results, and the potential impacts to various beneficial uses and users of groundwater related to the chronic lowering of groundwater level minimum thresholds through a number of actions further described in the letter.

3. Revising the definition of undesirable results to remove the non-dry year condition or discuss how degradation during dry periods will be managed as necessary to ensure that adverse water quality conditions are offset during other periods.

4. Providing more information about the criteria used to identify undesirable results and sustainable management criteria for land subsidence through a number of actions further described in the letter.

5. Using future DWR guidance regarding estimations of the location, quantity, and timing of depletions of interconnected surface water and establishing specific sustainable management criteria to sustainably manage depletions of interconnected surface water through a number of actions further described in the letter.

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

5.2 Progress Toward Achieving Interim Milestones

All SIs are in compliance with their MTs, with the exception of Water Quality SI (see summary **Table 5-1**). An MT is a quantitative value that represents the groundwater conditions at an RMS that, when exceeded individually or in combination with MTs at other monitoring sites, may cause a UR in the basin per DWR's definition. If groundwater levels are lower than the value of the MO for that site, they are moving in the direction of the MT. On the contrary, for the groundwater quality SMC, as the value of the electrical conductivity (EC) concentrations increase from the MO established for that site, they are moving in the direction of the MT. Seawater Intrusion is not an applicable SI.

Groundwater elevations have remained near or above their MOs and above their corresponding MTs and, therefore, remained within the Subbasin's margin of operational flexibility established for each RMS well. None of the RMS wells fell below the MT for two non-dry 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 Interim Milestones for groundwater levels at each of the RMS wells. Generally, groundwater elevations are above the MTs throughout the Subbasin, with elevations mostly near or slightly higher than 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 following recent years of cutbacks and curtailments. Spring and Fall 2023 groundwater elevations were all at or above the established MOs (**Table 5-2**).

Table 5-1. Sustainability Indicator Summary

2023 Status	Undesirable Result Identification	Measurable Objective (MO) Definition	Minimum Threshold (MT) Definition
Chronic Lowering of Groundwater Levels			
No indication of undesirable results There were no RMS wells with spring or fall 2023 groundwater level measurements below the MT.	When 2 RMS wells within a management area reach their MT for two consecutive non-dry year types	The groundwater level based on the groundwater trend line for the dry periods (over the period of record) of observed short-term climatic cycles extended to 2030	Elevation based on the 15^{th} percentile of shallowest domestic wells using refined DWR database (includes wells installed since 1980) based on the elevation of the bottom of the wells within a 3-mile radius of the RMS well
Reduction of Groundwater Storage			
No indication of undesirable results There were no RMS wells with spring or fall 2023 groundwater level measurements below the MT.	Groundwater levels are a proxy, per SGMA regulations.	Groundwater levels are a proxy, per SGMA regulations.	Groundwater levels are a proxy, per SGMA regulations.
Degraded Water Quality			
No indication of undesirable results In August of 2023, a non-dry year, 2 of 7 RMS wells had EC levels above their MTs. Multi-completion wells 18N04E19D001M and 18N04E19D002M had EC levels at 6,640 µS/cm and 5,474 µS/cm, respectively. Upon completion in 2021, both new wells had high baseline measurements of 3,910 µS/cm and 2,480 µS/cm, respectively. The first year of monitoring, 2022, was a dry year.	When 2 RMS wells exceed their MT for two consecutive non-dry years	Measured electrical conductivity less than or equal to the recommended Secondary Maximum Contaminant Level (900 µS/cm) based on State Secondary Drinking Water Standards at each well	The upper limit of the Secondary Maximum Contaminant Level for electrical conductivity (1,600 µS/cm) is based on the State Secondary Drinking Water Standards.

Table 5-1. Sustainability Indicator Summary

2023 Status	Undesirable Result Identification	Measurable Objective (MO) Definition	Minimum Threshold (MT) Definition
Land Subsidence			
No indication of undesirable results There were no RMS wells with spring or fall 2023 groundwater level measurements below the MT.	Groundwater levels are a proxy, per SGMA regulations.	Groundwater levels are a proxy, per SGMA regulations.	Groundwater levels are a proxy, per SGMA regulations.
Depletion of Interconnected Surface Water			
No indication of undesirable results There were no RMS wells with spring or fall 2023 groundwater level measurements below the MT.	Uses groundwater levels as a proxy. GSP identifies the data gap and describes the "Interconnected Surface Water Sustainable Management Criteria Framework."	Groundwater levels are a proxy, per SGMA regulations.	Groundwater levels are a proxy, per SGMA regulations.

Notes:

Salinity is the primary water quality constituent of concern, which is evaluated by measuring electrical conductivity (EC).

MO = Measurable Objective, MT = Minimum Threshold, RMS = representative monitoring site, µS/cm = micro siemens per centimeter

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

The reduction in groundwater storage SMC utilizes the chronic lowering of groundwater levels SMC as a proxy (**Table 5-1**). Thus, groundwater conditions related to storage and chronic lowering of groundwater levels are discussed together. Groundwater conditions in the Subbasin are on track to meet the first 5-year 2027 Interim Milestones and avoid undesirable results for groundwater levels at each of the RMS wells. In Spring 2023, all groundwater elevations were above the established MOs and MTs (as indicated in **Table 5-2**). **Table 5-2** shows measurements from 2023 for spring seasonal highs and fall seasonal lows, along with measurable objectives and minimum thresholds. It also compares the 2023 measurements to those from 2022 and to the measurable objectives. Higher water levels were observed in Spring 2023 compared to Spring 2022 due to wet conditions, which has helped to increase recharge and offset extraction, bolstering groundwater storage in the Subbasin.

Table 5-2. Measurable Objectives, Minimum Thresholds, and Seasonal Groundwater Elevations of Representative Monitoring Site Wells

State Well Number[1]	Groundwater Elevation (feet above mean sea level)				Spring 2023 vs. MO (ft)	Fall 2023 vs. MO (ft)	Spring 2023 vs. Spring 2022 (ft) (seasonal high)	Fall 2023 vs. Fall 2022 (ft) (seasonal low)
	2023 Measurements		MO	MT				
	Spring (seasonal high)	Fall (seasonal low)						
Wyandotte North Management Area								
19N03E**16Q001M**	140.1	139.5	133	85	7.1	6.5	0.8	1.3
19N04E**32P001M**	133.4	127.8	107	78	26.4	20.8	5.2	5.3
CWS-03	136	133	133	102	3	0	-1	-1
Wyandotte South Management Area								
17N03E**13B002M**	66.4	49.7	47	35	19.4	2.7	5.8	-1.9
17N04E**09N002M**	69.8	56.3	49	35	20.8	7.3	4.4	9.4
18N03E**25N001M**	63.3	56.9	52	37	11.3	4.9	1.1	4.1
18N04E**08M001M**	109.1	102.8	86	59	23.1	16.8	-0.5	-2.7
18N04E**16C001M**	110.5	104.5	95	71	15.5	9.5	3.5	8.6
19N04E**31F001M**	130	120.5	99	76	31	21.5	8.5	1.6

[1] The portion of the State Well Number shown in bold underlined text is the RMS ID.

MO = measurable objective, MT = minimum threshold

5.2.2 Degraded Water Quality SMC

The degraded water quality MT and MO are summarized in **Table 5-1**. Salinity is the main constituent of concern in the Subbasin and is evaluated by EC. Salinity (i.e., EC) is measured at RMS wells throughout the

Subbasin, and data was collected by the GSA in WY 2023. In August of 2023, a non-dry year, two of the seven RMS wells had EC levels above their MTs. Multi-completion wells 19D001M and 19D002M had EC levels at 6,640 micro siemens per centimeter (µS/cm) and 5,474 µS/cm, respectively. These are newly constructed wells as part of the DWR Technical Support Services program. Upon completion in 2021, both of these new wells had high baseline measurements of 3,910 µS/cm and 2,480 µS/cm, respectively. DWR waited another four months after construction to resample, and again, both wells had relatively high measurements. A summary of groundwater quality monitoring results is provided in **Appendix F**. Groundwater conditions are on track to avoid undesirable water quality results.

5.2.3 Land Subsidence SMC

Conditions indicate that there has not been any inelastic land subsidence during the reporting period. The land subsidence SMC utilizes the chronic lowering of groundwater levels SMC as a proxy (**Table 5-1)**. Interferometric Synthetic Aperture Radar (InSAR) data provided by DWR (DWR, 2024) was analyzed from October 2022 to October 2023 to track annual changes. Subsidence estimates based on InSAR methodology were reviewed and compared to continuous GPS measurements (Towill, 2023). The accuracy report found that a one-year measurement error, reported as a root-mean-squared error (RMSE), was approximately 0.025 feet. **Figure 5-1** shows a maximum vertical displacement between 0 feet and -0.04 feet occurred within the subbasin from October 2022 to October 2023. Groundwater conditions in the Subbasin are on track to meet the first 5-year 2027 Interim Milestones and avoid undesirable results for land subsidence.

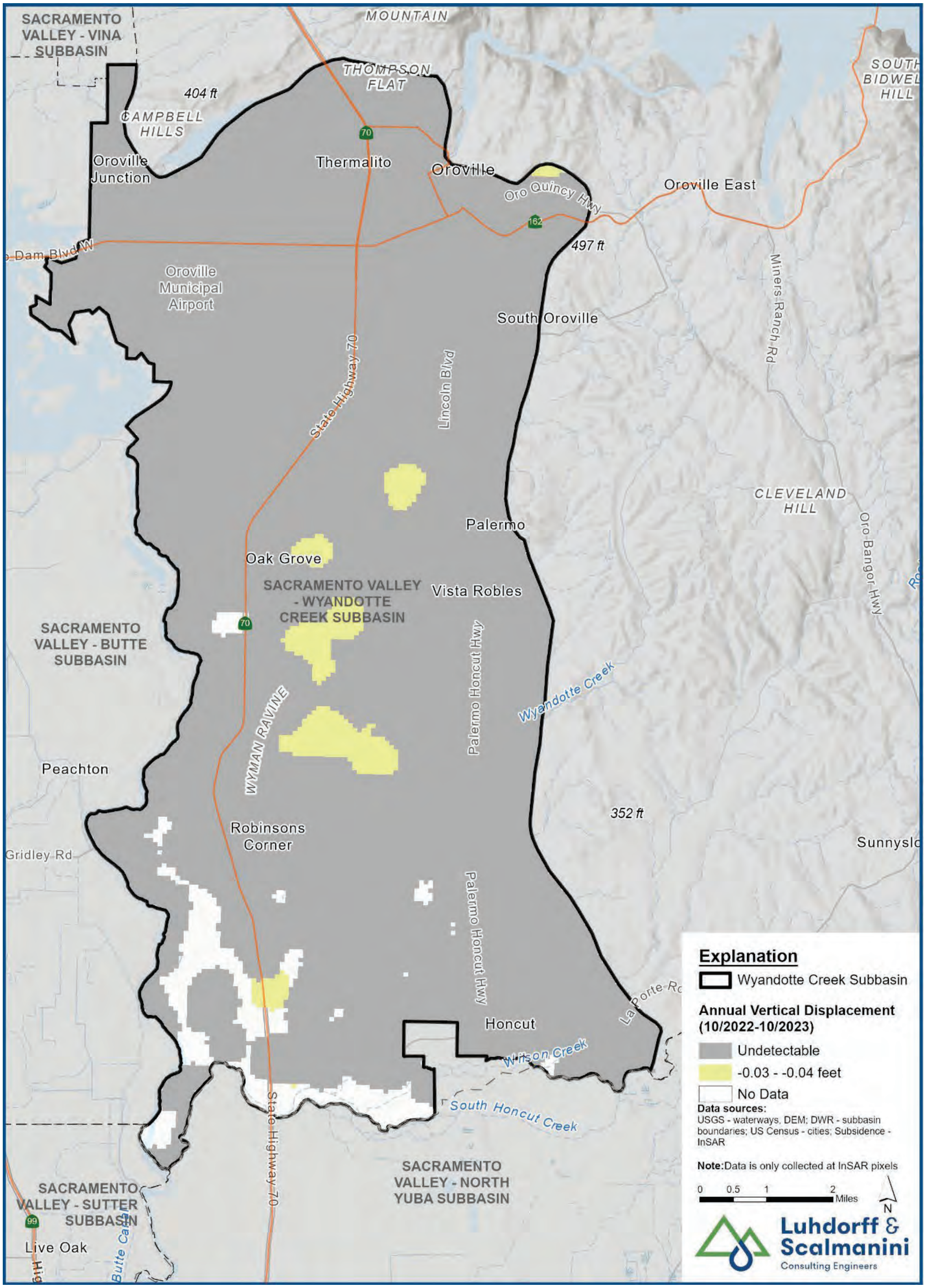

Figure 5-1. Vertical Displacement of Ground Surface from 10/2022 to 10/2023

5.2.4 Depletion of Interconnected Surface Water SMC

The depletion of interconnected surface utilizes the chronic lowering of groundwater levels SMC as a proxy (**Table 5-1**). Groundwater conditions in the Subbasin are on track to meet the first 5-year 2027 Interim Milestones and to avoid undesirable results for groundwater levels at each of the RMS wells.

5.3 Progress Toward PMA Implementation

The following sections summarize the GSAs' progress towards implementing PMAs that were developed to manage groundwater conditions in the Subbasin and achieve the groundwater sustainability objectives described in the GSP. Projects as outlined in the GSP are provided below and summarized in **Table 5-3**. Updates on the status of management actions are described below and summarized in **Table 5-4**.

Groundwater users in the Subbasin benefit from generally stable and shallow groundwater levels supported by naturally occurring recharge and recharge resulting from surface water use in the Subbasin. Surface water supplies available to diverters in the Subbasin are used, when available, for irrigation, agronomic practices, and for other projects described in the GSP. Ongoing access to surface water supplies is crucial to preserving the sustainability of the Subbasin.

Table 5-3. Subbasin Summary of Project Implementation Status

GSP Section Reference	Project (Proponent)	Current Status	Notable Progress Since Last Annual Report
5.2.4.1	Residential Water Conservation Project	Ongoing	Conservation programs saved ~100 AFY of water
5.2.4.4	Oroville Wildlife Area Robinson's Riffle Project	Ongoing	Sutter Butte Flood Control Agency (SBFCA) was awarded grant funding; grant-funded work was initiated in March 2023 and is expected to be completed in spring 2026
5.2.4.6	Thermalito Water and Sewer District Water Treatment Plant Capacity Upgrade Project	Funded	The SGM Grant Program application submitted in December 2022 was awarded. The project is complete.
5.2.4.8	Palermo Clean Water Consolidation Project	Underway, seeking funding	The application for funding to the Drinking Water State Revolving Fund was submitted, and the annexation process for the project was completed.
5.2.5.1	Intra-basin Water Transfer	Funded	The SGM Grant Program application submitted in December 2022 was awarded for the planning phase of this project.
5.2.5.2	Agricultural Surface Water Supplies	Funded	The SGM Grant Program application submitted in December 2022 was awarded for the planning phase of this project.

Table 5-4. Subbasin Summary of Management Actions			
GSP Section Reference	Management Action	Current Status	Notable Progress Since Last Annual Report
5.3.1	General Plan Updates	In Progress	The 2040 general plan update was adopted in March 2023.
5.3.2	Domestic Well Mitigation	Funded	Not in effect; however, funds secured for domestic well survey to address data gap identified in the GSP.
5.3.5	Expansion of Water Purveyors' Service Area	In Progress	Ongoing development of the Palermo Clean Water Consolidation Project. Funding secured through SGM Grant Program to assess other opportunities.

5.4 GSP Project Implementation Progress

5.4.1 Residential Water Conservation Project (GSP Section 5.2.4.1)

Notable progress on this project since 2022 includes continued implementation of water conservation practices by residential water providers, including the Cal-Oroville, TWSD, and the SFWPA, in accordance with their 2020 Urban Water Management Plans. In WY 2023, urban pumping, primarily in the City of Oroville, served by two different water service providers (Cal Water-Oroville and TWSD) declined by about 100 AF compared to WY 2022, resulting in a benefit to the Subbasin.

5.4.2 Oroville Wildlife Area Robinson's Riffle Project (GSP Section 5.2.4.4)

Notable progress on this project since 2022 includes securing funding from both DWR and the California Department of Fish and Wildlife for the planning, design, and permitting of the project. The grant-funded work was initiated in March 2023 and is expected to be completed in spring 2026.

5.4.3 Thermalito Water and Sewer District Water Treatment Plant Capacity Upgrade Project (GSP Section 5.2.4.6)

Notable progress on this project since 2022 includes the Wyandotte Creek GSA's December 2022 submittal of a grant application to pursue funds through DWR's SGM Grant Program to increase the capacity of the water treatment plant serving the City of Oroville and the surrounding area, resulting in a reduced need for supplemental groundwater pumping. This project was fully funded and completed. Two additional membrane filter racks were added, which increased the treatment plant capacity from 4 million gallons per day to 8 million gallons per day.

5.4.4 Palermo Clean Water Consolidation Project (GSP Section 5.2.4.8)

Notable progress on this project since 2022 includes the completion of the funding application to the Drinking Water State Revolving Fund and the annexation process for the project area has been completed and approved by LAFCO, laying the groundwork to extend the SFWPA water supply system to serve the parcels included in the Palermo project description. Funding for a portion of the project through the American Rescue Plan Act, Integrated Regional Water Management funds, and DWR Small Community Relief funds has also been secured (DWRSRF). The project is expected to receive final DWRSRF funding approval in the first half of the calendar year 2024, with project construction beginning in the second half of the 2024 calendar year.

5.4.5 Intra-basin Water Transfer (GSP Section 5.2.5.1)

Notable progress on this project since 2022 includes the Wyandotte Creek GSA's December 2022 submittal of a grant application to pursue funds through DWR's SGM Grant Program to supply surface water to agricultural groundwater users in the Subbasin to offset groundwater pumping with available surface water, providing in-lieu recharge benefits to the Subbasin. This project was awarded funding.

5.4.6 Agricultural Surface Water Supplies (GSP Section 5.2.5.2)

Notable progress on this project since 2022 includes the Wyandotte Creek GSA's December 2022 submittal of a grant application to pursue funds through DWR's SGM Grant Program to supply agricultural users surface water to be used in place of groundwater by using dual water source irrigation systems to reduce groundwater demand. This project was awarded funding.

5.5 GSP Management Action Implementation Progress

Below are Management Action Updates and their progress in implementation since the last Annual Report.

5.5.1 General Plan Updates (GSP Section 5.3.1)

Notable progress on this project since 2022 includes updates from Butte County (Wyandotte Creek GSA Management Committee members) on the 2040 General Plan Update in cooperation with the Butte County Water Commission and Department of Development Services to the Water Resources Element and applicable General Plan Goals, Policies, and Actions. These updates ensured that important components of the GSP are supported by the 2040 General Plan, available at:
https://www.buttecounty.net/DocumentCenter/View/7749/Butte_County_General_Plan_2040_Compiled_Appendix_Optimized---Updated?bidId=.

5.5.2 Domestic Well Mitigation (GSP Section 5.3.2)

Notable progress on this project since 2022 includes the Wyandotte Creek GSA's December 2022 submittal of a grant application to pursue funds through DWR's SGM Grant Program for a Community Monitoring and Domestic Well Survey project that would support the goals of this management action by creating a registry of domestic wells in the region. This project was awarded funding.

5.5.3 Expansion of Water Purveyor's Service Area (GSP Section 5.3.5)

Notable progress on this project since 2022 includes the development of the project and securing funds for the Palermo Clean Water Consolidation Project (described above) to expand SFWPA's service areas and provide drinking water to residential areas that are currently using private domestic groundwater wells. In addition, Butte County has applied for drought-related funding to identify other areas in the county that could benefit from expanding service areas to private well owners.

6. Conclusions

The GSA adopted and submitted the GSP to DWR in January 2022 and continues to actively work on sustainable groundwater management in the Subbasin. As presented in **Section 5** of this report, recent progress made on activities applicable to the GSP demonstrates the commitment of the GSA to implement the GSP by allocating the necessary time and resources to achieve long-term sustainable management of the groundwater resources in the Wyandotte Creek Subbasin.

7. References

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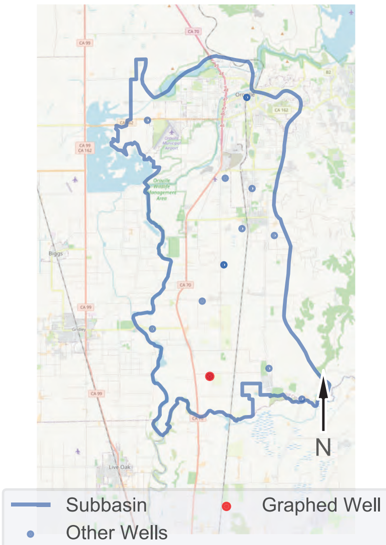
Water Year 2023 Annual Report

Appendix A

Characteristics and Hydrographs of Representative Monitoring Site (RMS) Wells and Regional Groundwater Contour Maps

WYANDOTTE CREEK Subbasin - State Well Number (SWN): 17N03E13B002M

Well Location Map



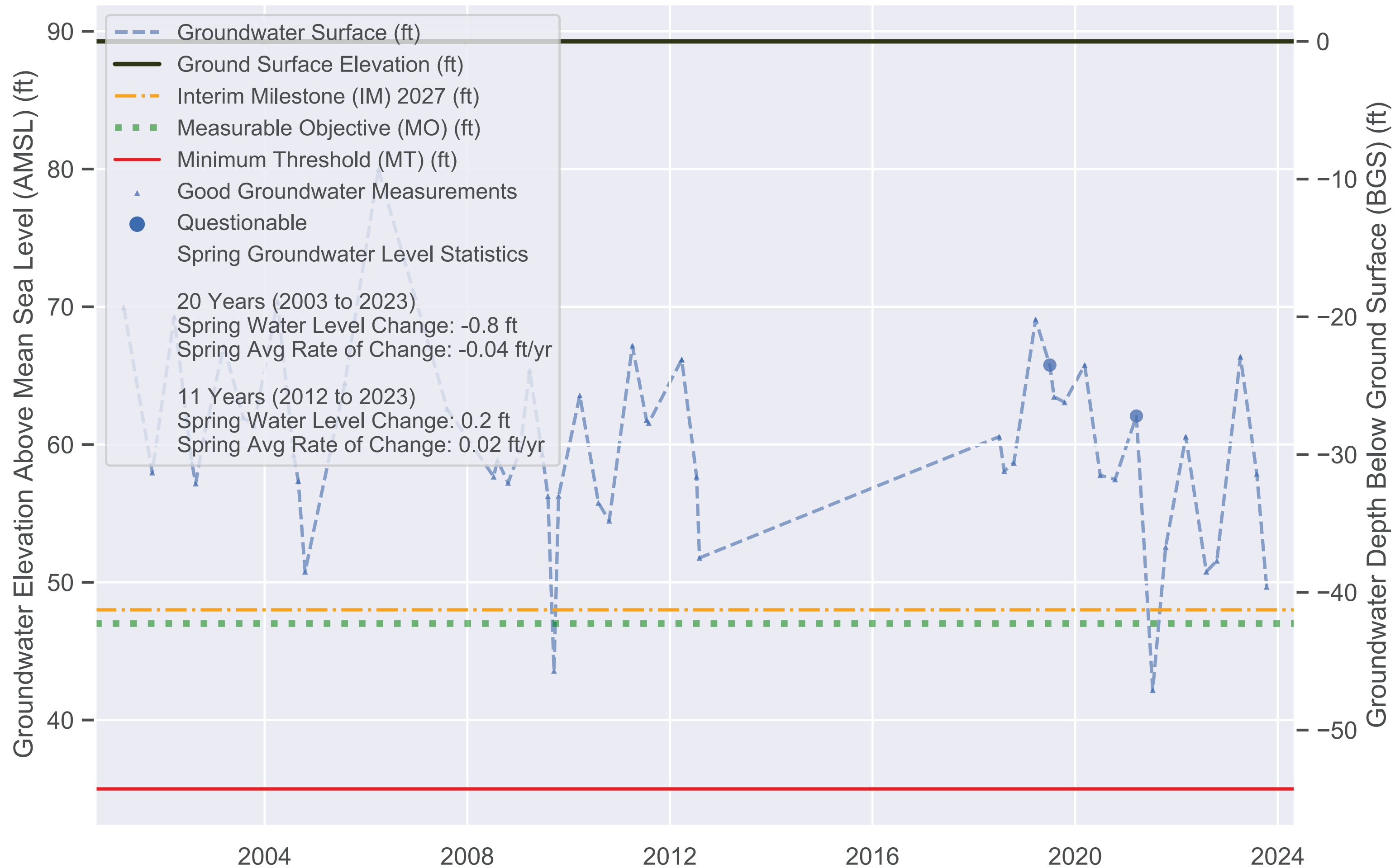
Sustainable Management Criteria:

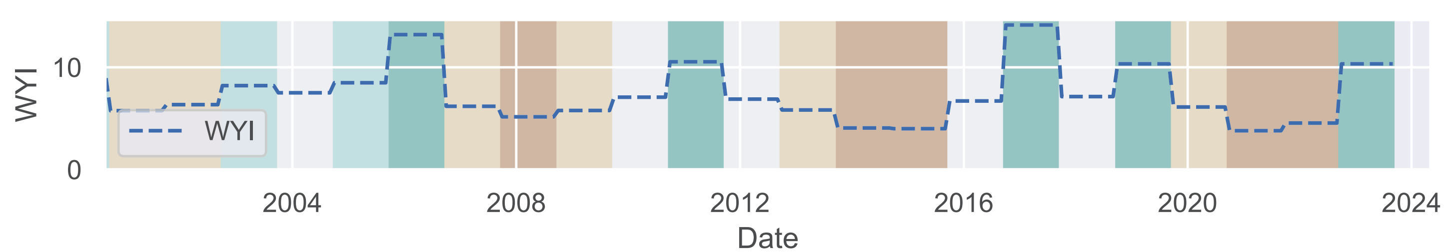
IM (2027) = 48.0 ft AMSL
MO = 47.0 ft AMSL
MT = 35.0 ft AMSL

Sacramento Valley Water Year Index (WYI) shown on lower right. Meaning of colors defined below.

- Wet (W)
- Above Normal (AN)
- Below Normal (BN)
- Dry (D)
- Critical (C)

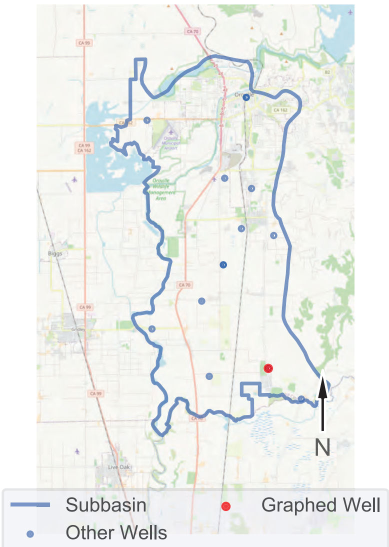
Perforation 1: 0.0 - 0.0 ft BGS





WYANDOTTE CREEK Subbasin - State Well Number (SWN): 17N04E09N002M

Well Location Map

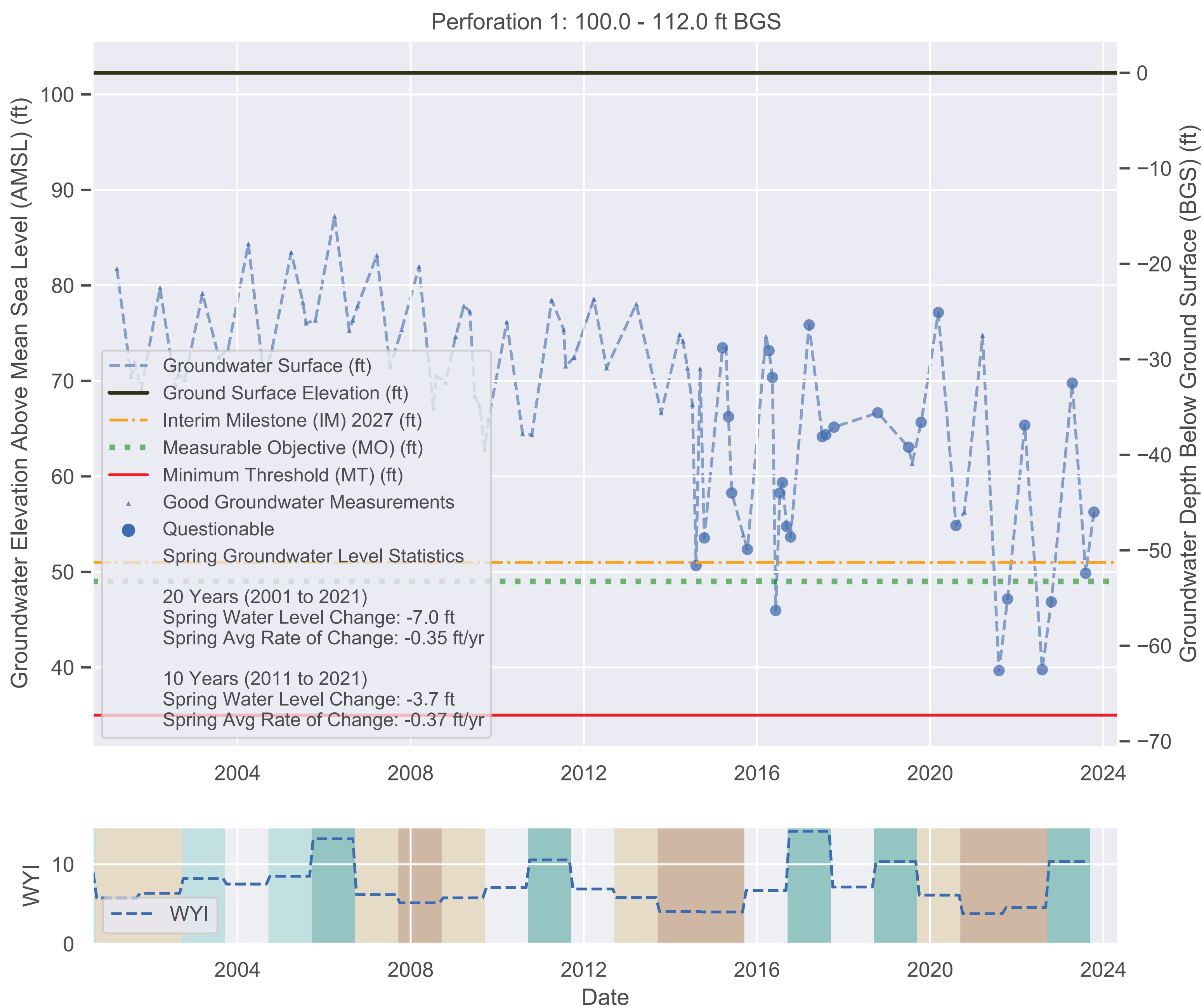


Sustainable Management Criteria:

IM (2027) = 51.0 ft AMSL
MO = 49.0 ft AMSL
MT = 35.0 ft AMSL

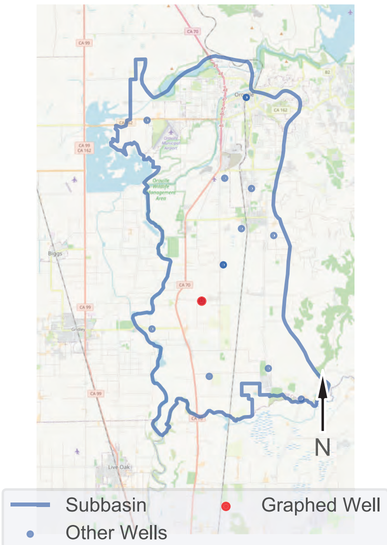
Sacramento Valley Water Year Index (WYI) shown on lower right. Meaning of colors defined below.

- Wet (W)
- Above Normal (AN)
- Below Normal (BN)
- Dry (D)
- Critical (C)



WYANDOTTE CREEK Subbasin - State Well Number (SWN): 18N03E25N001M

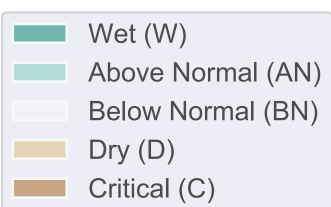
Well Location Map



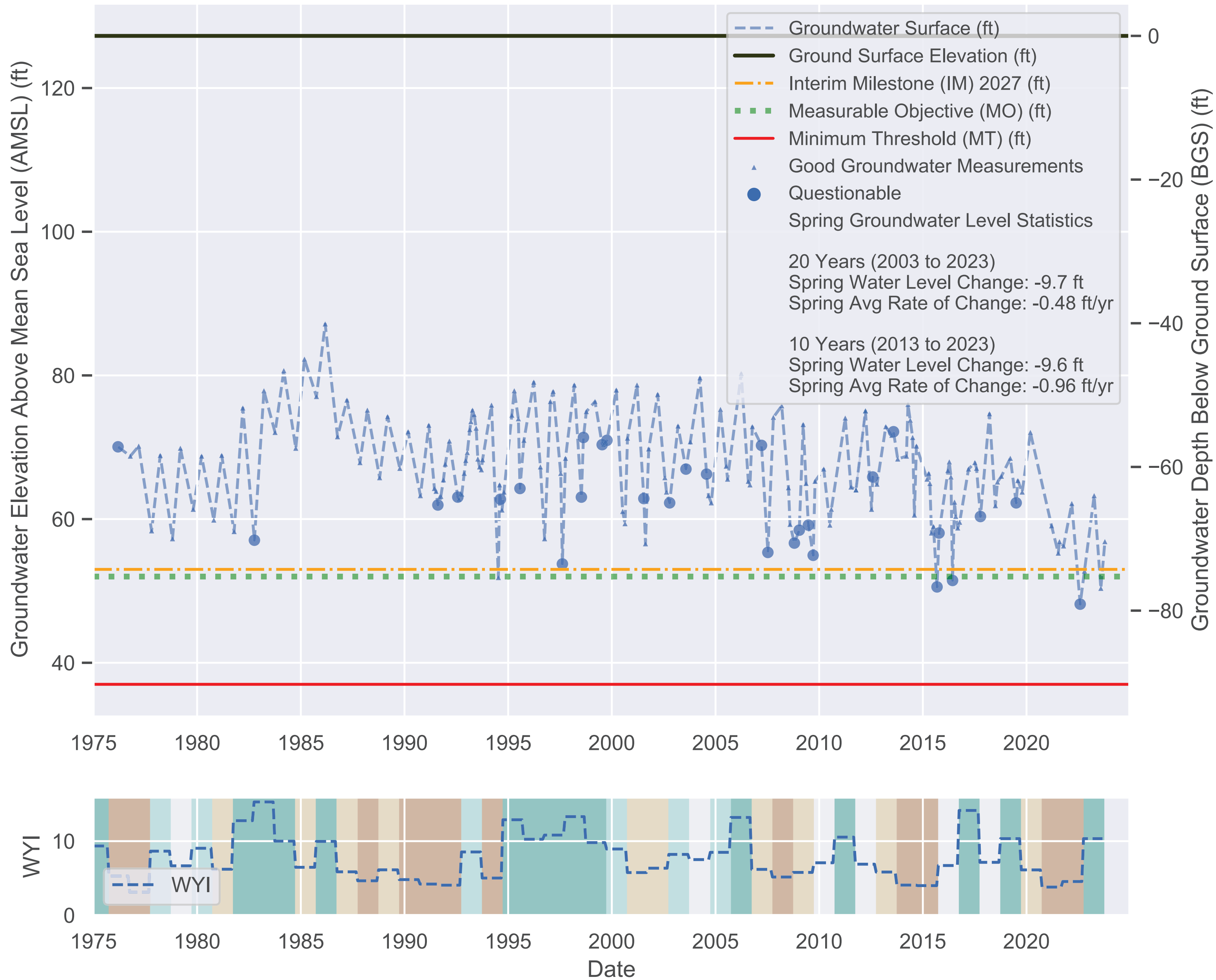
Sustainable Management Criteria:

IM (2027) = 53.0 ft AMSL
MO = 52.0 ft AMSL
MT = 37.0 ft AMSL

Sacramento Valley Water Year Index (WYI) shown on lower right. Meaning of colors defined below.

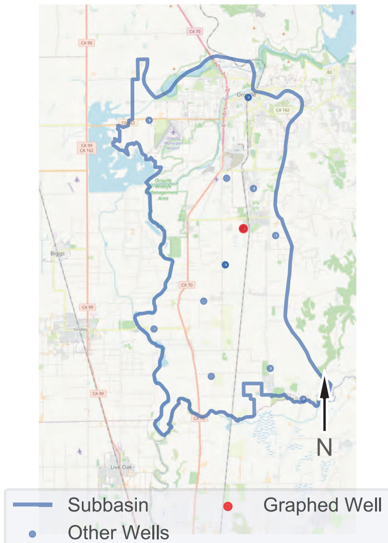


Perforation 1: 81.0 - 164.0 ft BGS



WYANDOTTE CREEK Subbasin - State Well Number (SWN): 18N04E08M001M

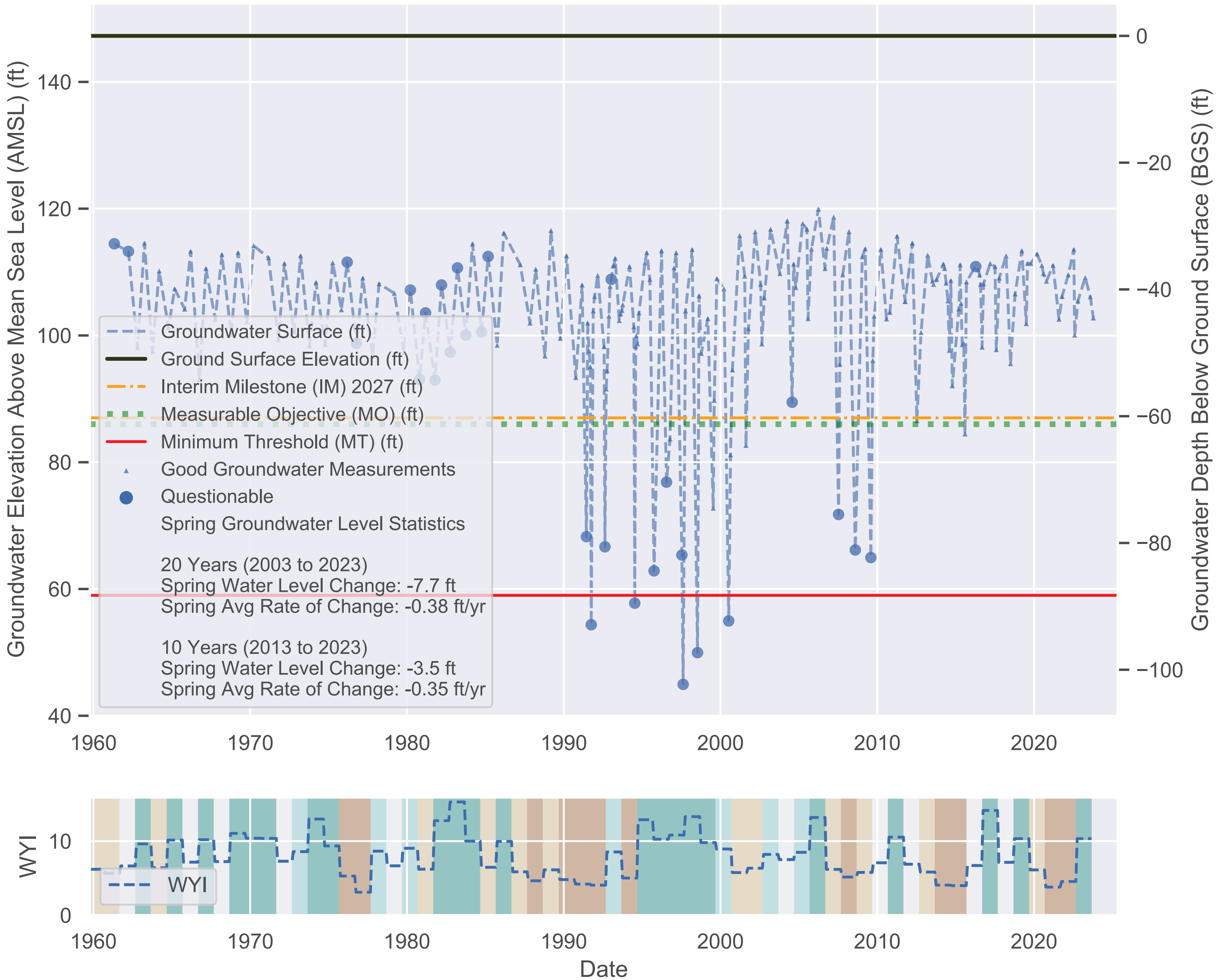
Well Location Map



Sustainable Management Criteria:

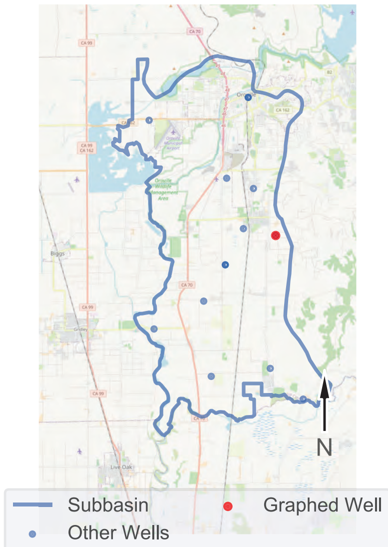
IM (2027) = 87.0 ft AMSL
MO = 86.0 ft AMSL
MT = 59.0 ft AMSL

Sacramento Valley Water Year Index (WYI) shown on lower right. Meaning of colors defined below.



WYANDOTTE CREEK Subbasin - State Well Number (SWN): 18N04E16C001M

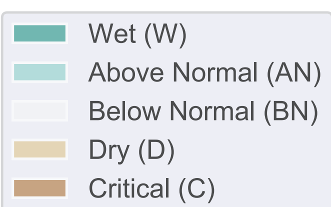
Well Location Map



Sustainable Management Criteria:

IM (2027) = 96.0 ft AMSL
MO = 95.0 ft AMSL
MT = 71.0 ft AMSL

Sacramento Valley Water Year Index (WYI) shown on lower right. Meaning of colors defined below.



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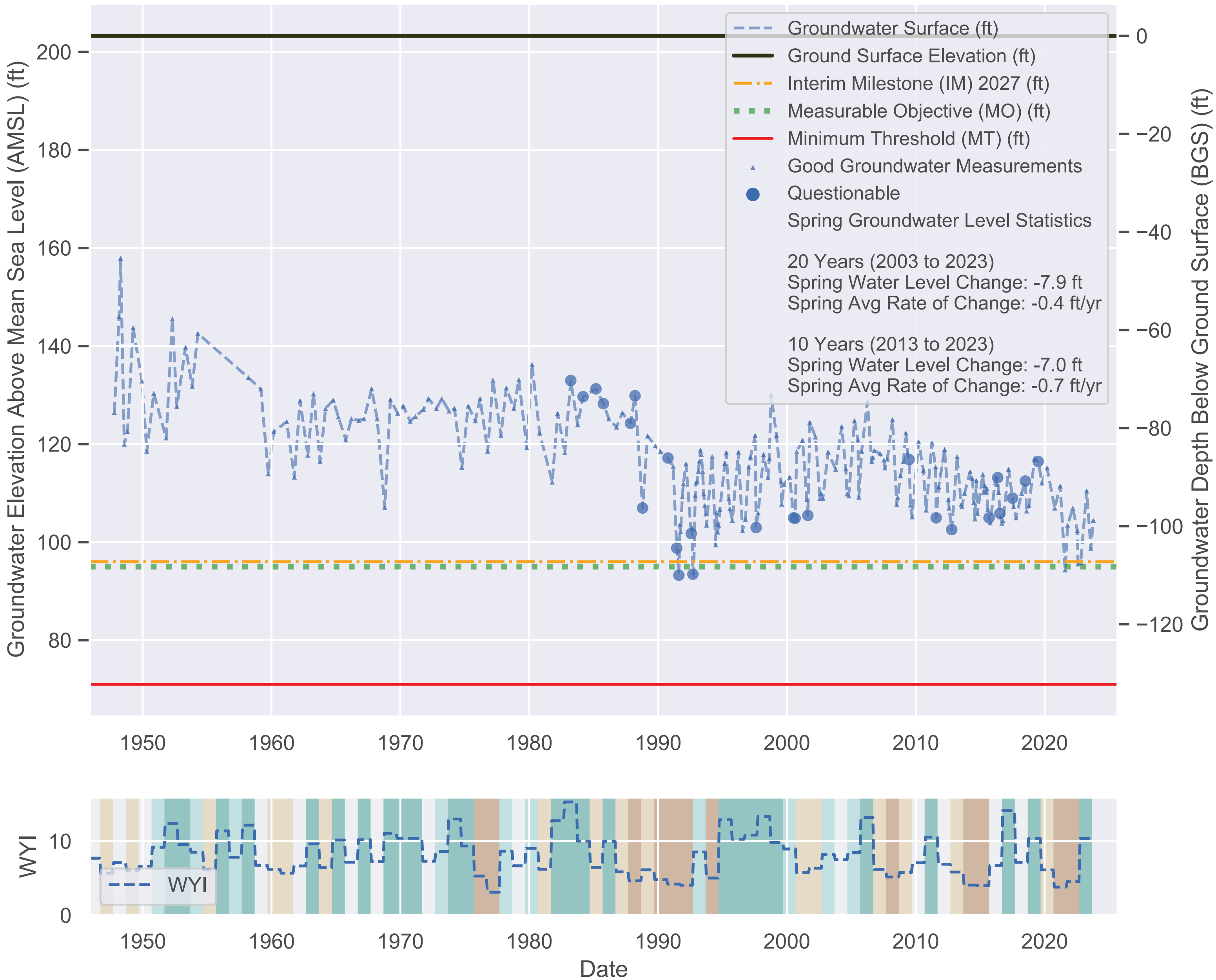
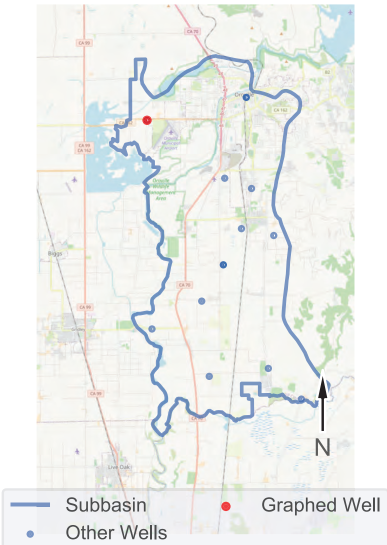


WYANDOTTE CREEK Subbasin - State Well Number (SWN): 19N03E16Q001M

Well Location Map



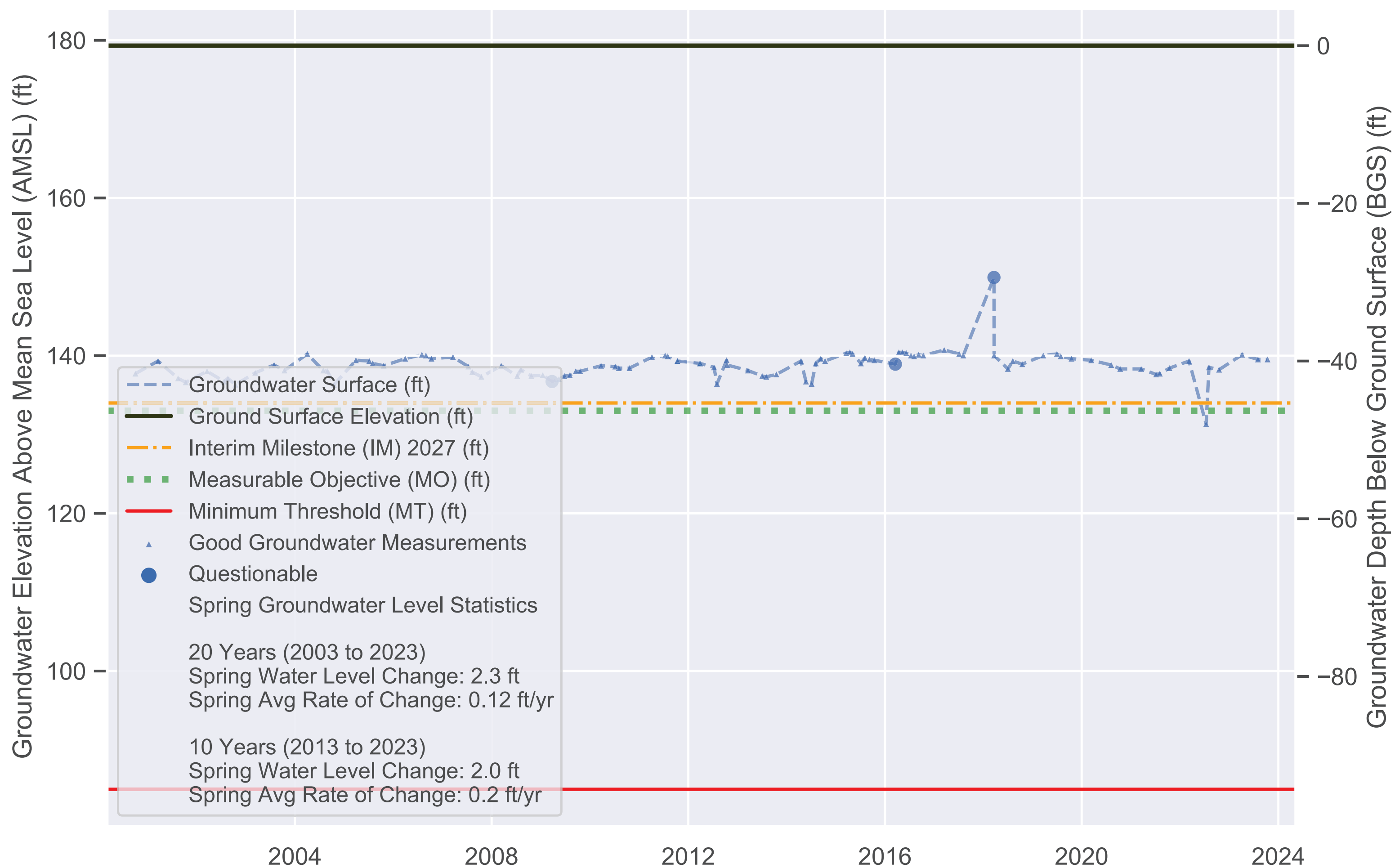
Sustainable Management Criteria:

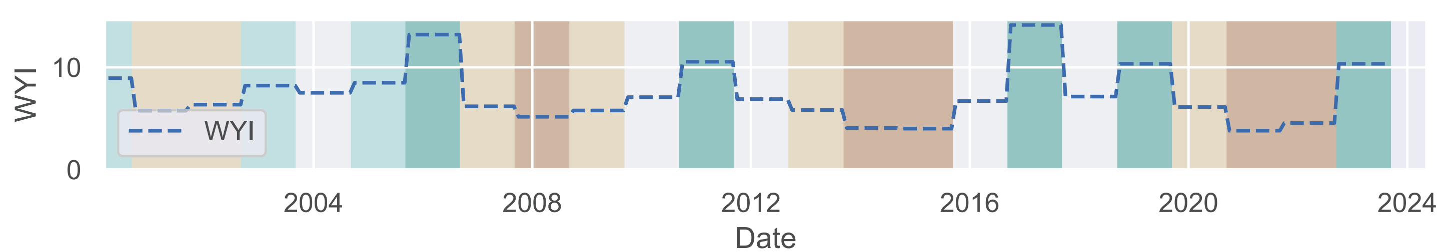
IM (2027) = 134.0 ft AMSL
MO = 133.0 ft AMSL
MT = 85.0 ft AMSL

Sacramento Valley Water Year Index (WYI) shown on lower right. Meaning of colors defined below.

Wet (W)
Above Normal (AN)
Below Normal (BN)
Dry (D)
Critical (C)

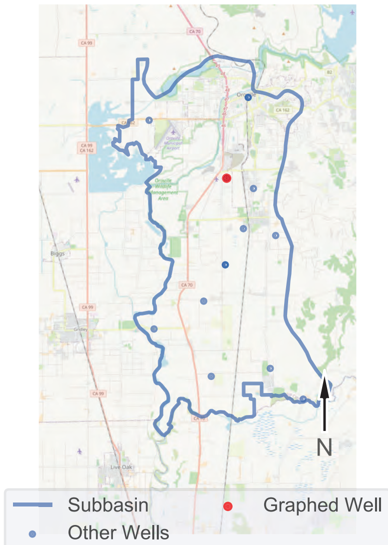
Perforation 1: 100.0 - 120.0 ft BGS





WYANDOTTE CREEK Subbasin - State Well Number (SWN): 19N04E31F001M

Well Location Map

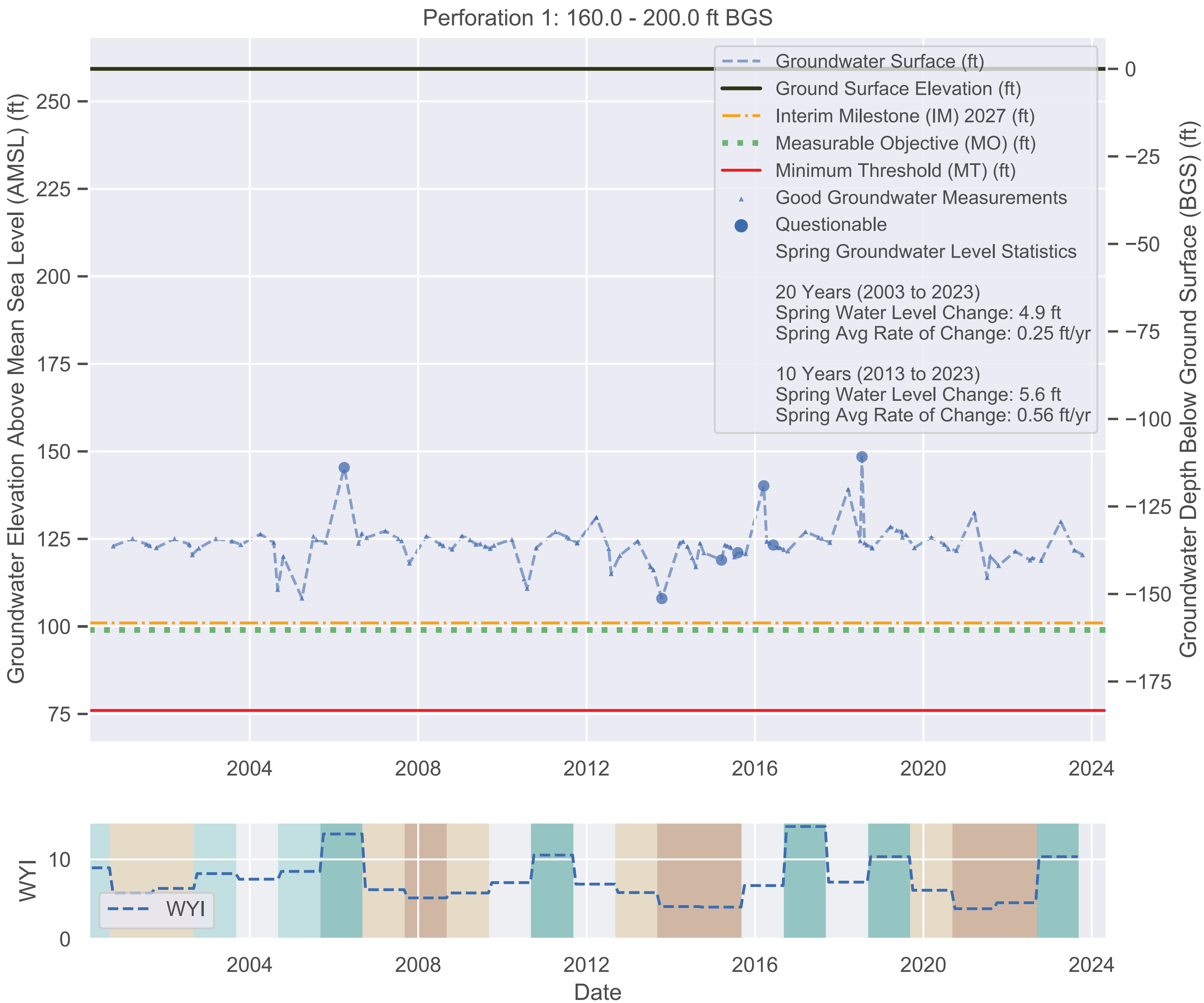


Sustainable Management Criteria:

IM (2027) = 101.0 ft AMSL
MO = 99.0 ft AMSL
MT = 76.0 ft AMSL

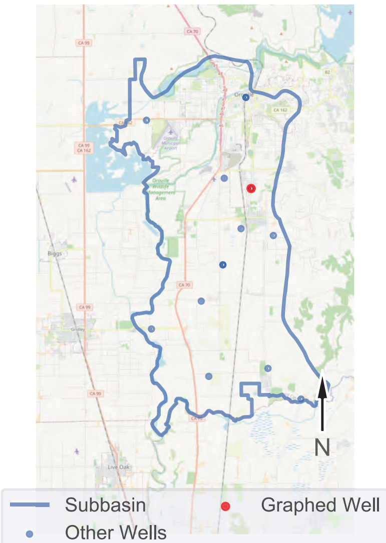
Sacramento Valley Water Year Index (WYI) shown on lower right. Meaning of colors defined below.

- Wet (W)
- Above Normal (AN)
- Below Normal (BN)
- Dry (D)
- Critical (C)



WYANDOTTE CREEK Subbasin - State Well Number (SWN): 19N04E32P001M

Well Location Map



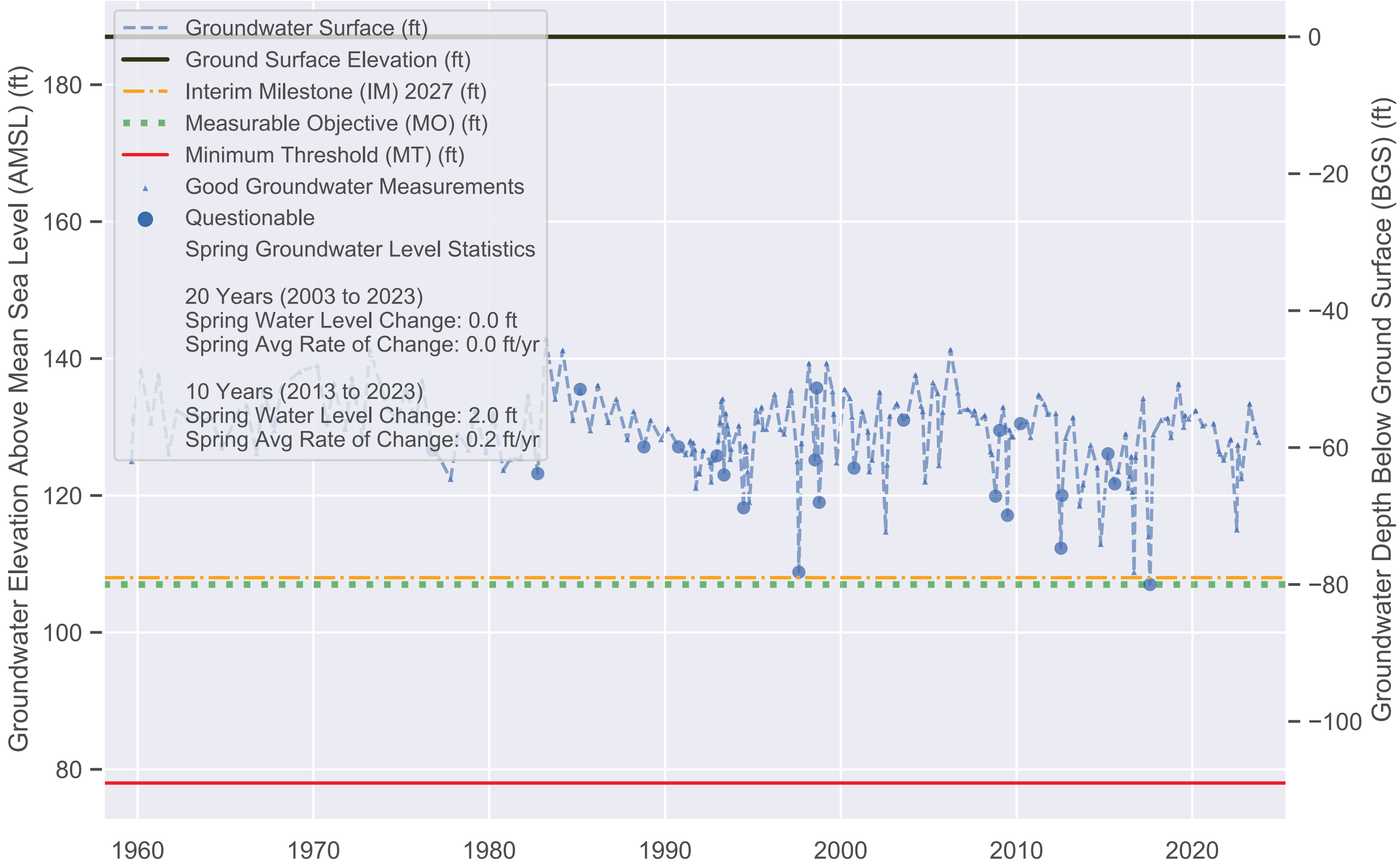
Sustainable Management Criteria:

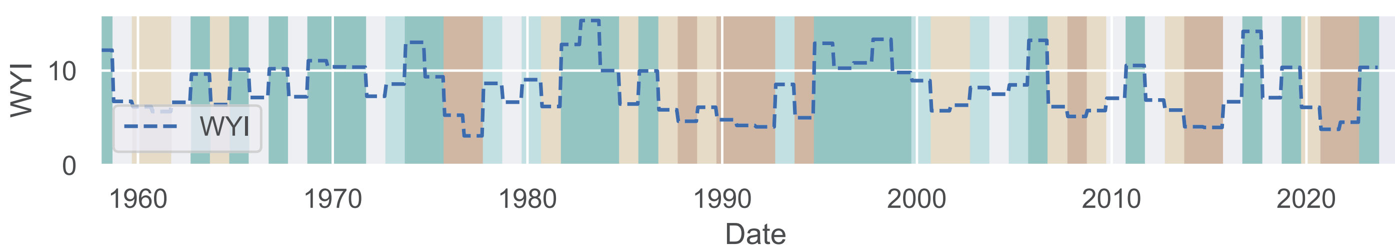
IM (2027) = 108.0 ft AMSL
MO = 107.0 ft AMSL
MT = 78.0 ft AMSL

Sacramento Valley Water Year Index (WYI) shown on lower right. Meaning of colors defined below.

- Wet (W)
- Above Normal (AN)
- Below Normal (BN)
- Dry (D)
- Critical (C)

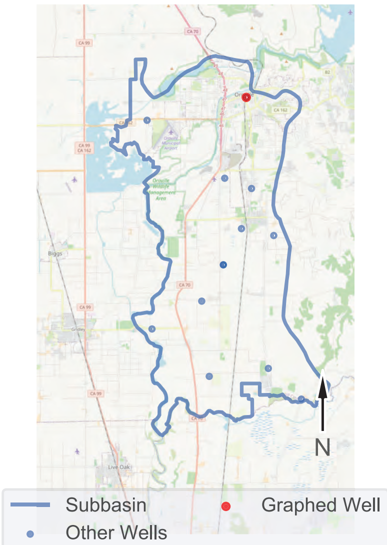
Perforation data not available.





WYANDOTTE CREEK Subbasin - State Well Number (SWN): CWS-03

Well Location Map



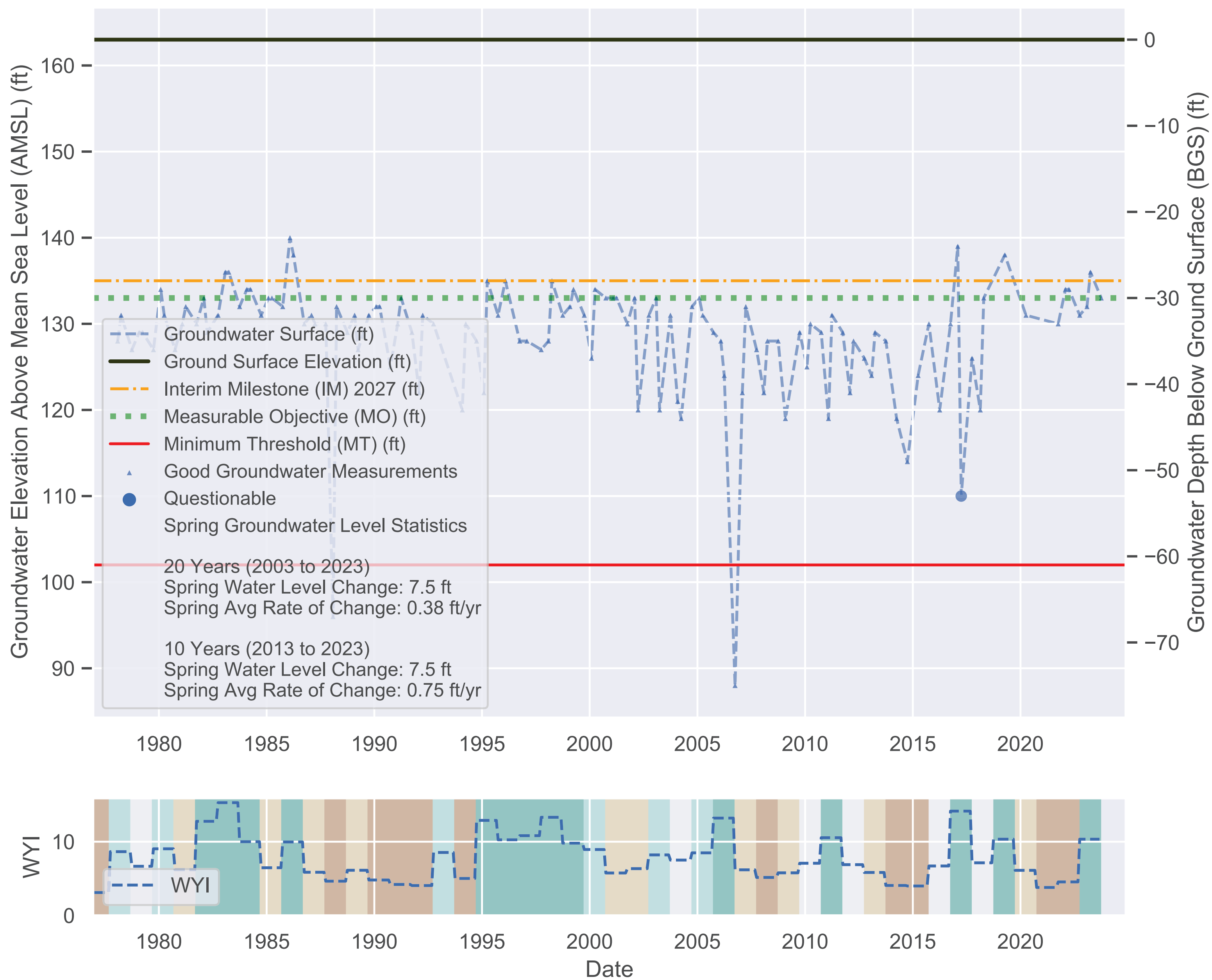
Sustainable Management Criteria:

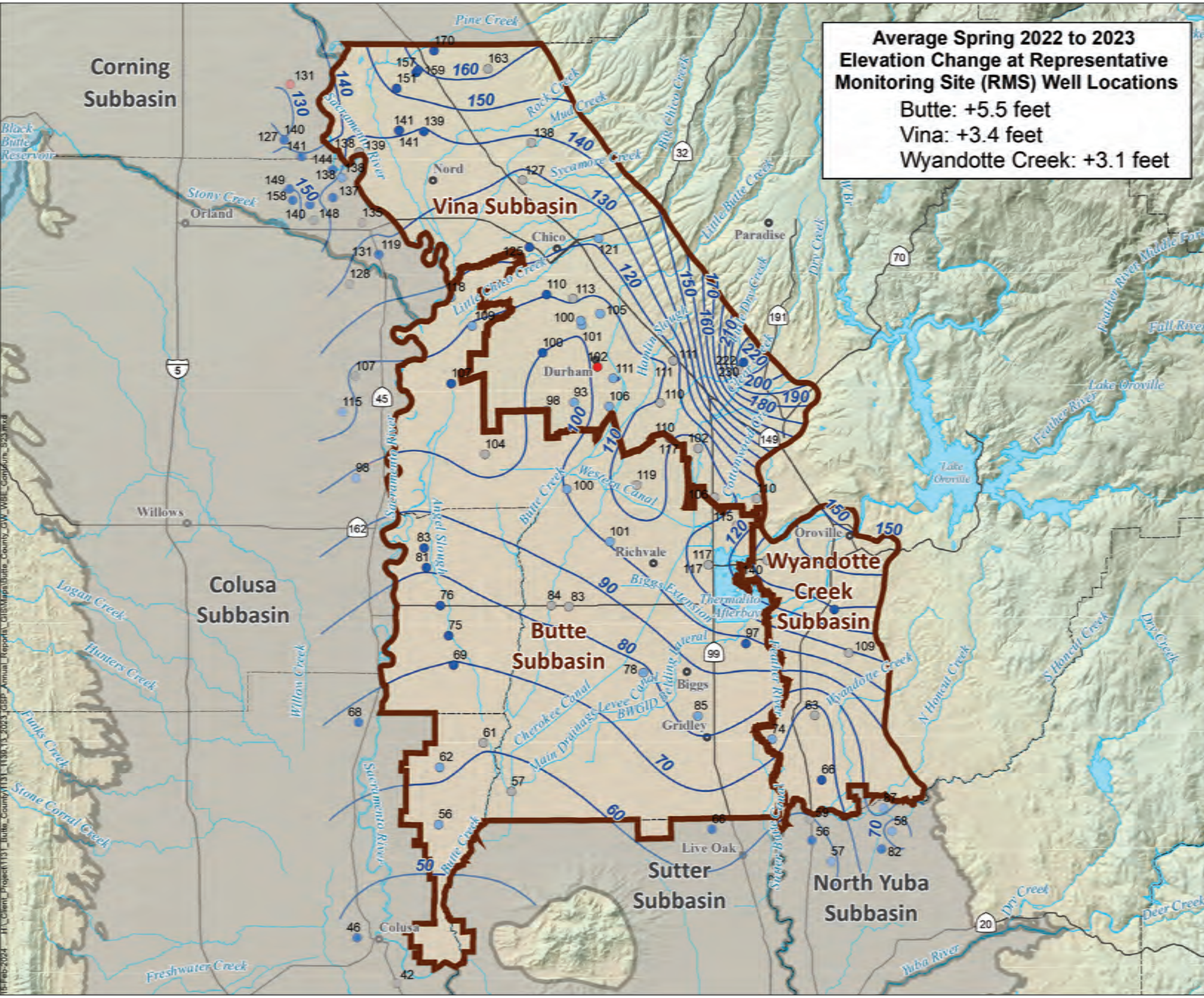
IM (2027) = 135.0 ft AMSL
MO = 133.0 ft AMSL
MT = 102.0 ft AMSL

Sacramento Valley Water Year Index (WYI) shown on lower right. Meaning of colors defined below.

Wet (W)
Above Normal (AN)
Below Normal (BN)
Dry (D)
Critical (C)

Perforation data not available.





SPRING 2023 GROUNDWATER ELEVATION CONTOURS FOR PRIMARY AQUIFER IN BUTTE COUNTY SUBBASINS

Contouring Wells*

- Greater than 5 ft decline
- Between 2 and 5 ft decline
- Less than 2 ft decline/increase
- Between 2 and 5 ft increase
- Greater than 5 ft increase

Contour Lines

- Spring 2023 Water Surface Elevation Contour (feet above mean sea level)

All Other Features

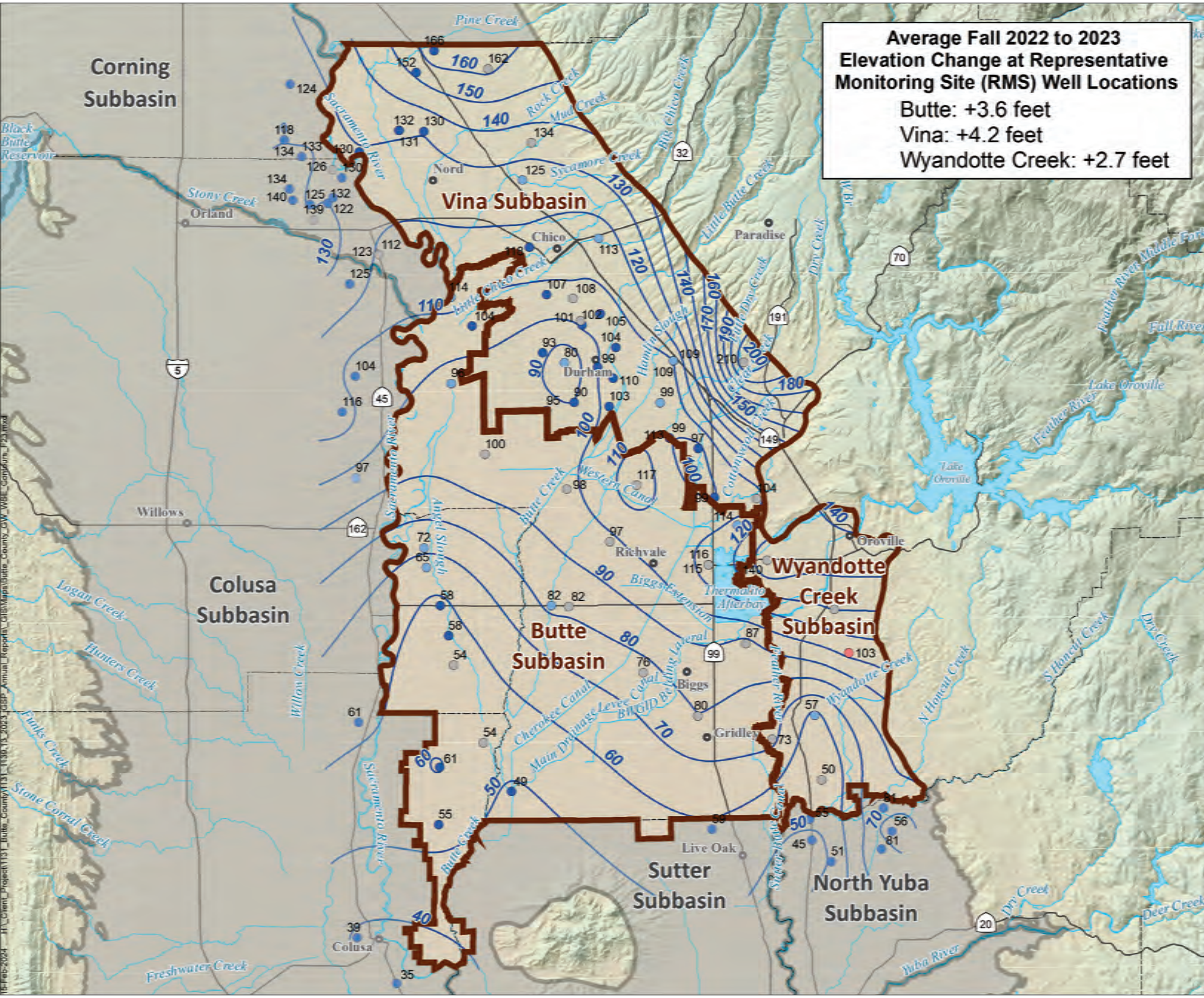
- Groundwater Well
- Cities and Towns
- Highway
- Butte, Vina, and Wyandotte Creek Subbasins
- Neighboring Subbasin

*Note: Elevation shown for contouring wells is in feet above mean sea level and changes are relative to the same period of the prior year.

0 4 8
Miles

N

FALL 2023 GROUNDWATER ELEVATION CONTOURS FOR PRIMARY AQUIFER IN BUTTE COUNTY SUBBASINS



Contouring Wells*

- Greater than 5 ft decline
- Between 2 and 5 ft decline
- Less than 2 ft decline/increase
- Between 2 and 5 ft increase
- Greater than 5 ft increase

Contour Lines

- Fall 2023 Water Surface Elevation Contour (feet above mean sea level)

All Other Features

- Groundwater Well
- Cities and Towns
- Highway
- Butte, Vina, and Wyandotte Creek Subbasins
- Neighboring Subbasin

*Note: Elevation shown for contouring wells is in feet above mean sea level and changes are relative to the same period of the prior year.

0 4 8
Miles

N

Water Year 2023 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.

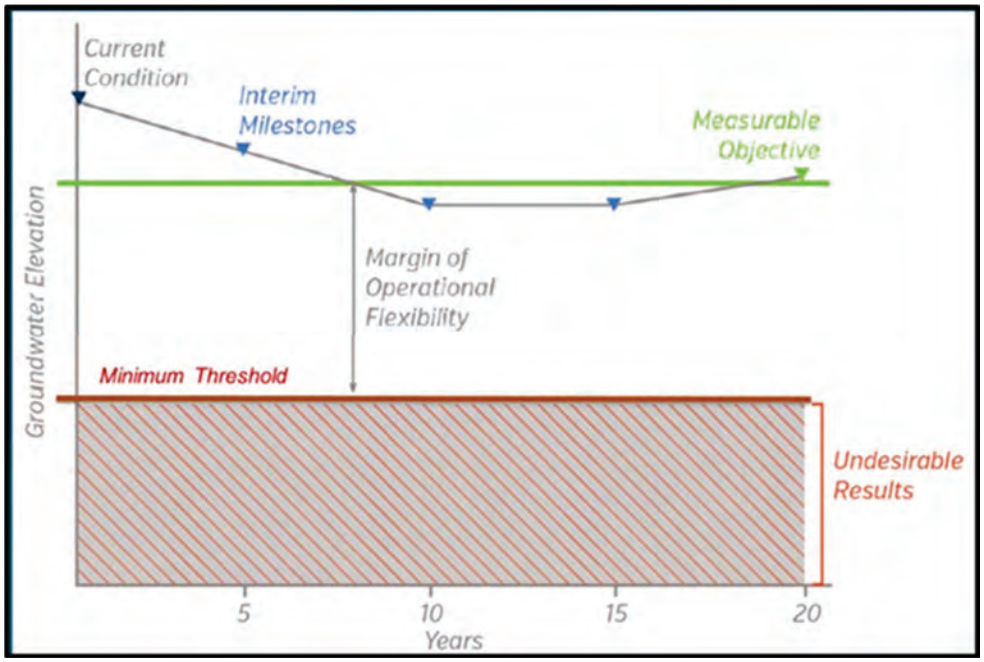


Illustration of Terms Used for Describing Sustainable Management Criteria Using the Groundwater Level SI

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 Wyandotte Creek Subbasin is fully explained and defined in Section 3 of the

GSP available here: https://sgma.water.ca.gov/portal/gsp/preview/99

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Appendix C

GSP Annual Reporting Elements Guide

Groundwater Sustainability Plan Annual Report Elements Guide

Basin Name	Wyandotte Creek Subbasin		
GSP Local ID			
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.	37-39; 78-93	
	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.	5-16	
	(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.	19-20	
	(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.	44-55	
	(2) Groundwater extraction for the preceding water year. Data shall be collected using the best available measurement methods and shall be presented in a table that summarizes groundwater extractions by water use sector, and identifies the method of measurement (direct or estimate) and accuracy of measurements, and a map that illustrates the general location and volume of groundwater extractions.	21-23;25	
	(3) Surface water supply used or available for use, for groundwater recharge or in-lieu use shall be reported based on quantitative data that describes the annual volume and sources for the preceding water year.	24;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	
	(5) Change in groundwater in storage shall include the following:		
	(A) Change in groundwater in storage maps for each principal aquifer in the basin.	31	
	(B) A graph depicting water year type, groundwater use, the annual change in groundwater in storage, and the cumulative change in groundwater in storage for the basin based on historical data to the greatest extent available, including from January 1, 2015, to the current reporting year.	28	
	(c) A description of progress towards implementing the Plan, including achieving interim milestones, and implementation of projects or management actions since the previous annual report.	32-43	

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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
34,500	600	0	32,900	0	0	0	1,000	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	5-10 %	Metered connection maintained by California Water Service and Thermalito Water and Sewer District.	0					32,900	Land use estimates were derived from crop mapping and CropScape survey results	Estimate	20-30 %	Typical uncertainty for water balance calculation	0					1,000	Rural residential groundwater extraction is estimated based on California Water Service Company's 2020 Urban Water Management Plan 2020 usage of an average per capita water use of 181 gallons per capita per day. Population data from the 2020 census was coupled with parcel data to identify total population not serviced by municipal supplies	Estimate	10-20 %	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
22,400	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	22,400	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
56,900	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	34,500	22,400	0	0	0		5,600	0	50,300	0	0	0	1,000	Rural Residential

Water Year 2023 Annual Report

Appendix E

Water Use Analysis Methodology

Water Year 2023 Annual Report

WY 2021

Water Use Analysis Methodology

Luhdorff & Scalmanini
Consulting Engineers

TECHNICAL MEMORANDUM

DATE: February 16, 2024 Project No. 23-118

TO: Eddy Teasdale, PG/CHG

FROM: Cab Esposito, GIT

SUBJECT: Butte County Groundwater Estimate Methodology WY 2021

BACKGROUND

In Spring 2022, Luhdorff & Scalmanini Consulting Engineers (LSCE) was contracted by the Butte County Department of Water and Resource Conservation to assess drought impacts in Butte County. As part of this work, groundwater pumping was estimated for Butte County. These groundwater pumping estimates were utilized in the Sustainable Groundwater Management Act (SGMA) reporting for Water Year (WY) 2021. This memo is an abridged description of the methodology developed in the Drought Impact Analysis Study (LSCE, 2022).

AGRICULTURAL WATER DEMAND

Agricultural groundwater use was estimated using a simplified water balance approach which incorporates reference evapotranspiration (ET), land use, precipitation, and surface water supplies. The water balance is conducted on a monthly time-step. Surface water supplies and pumping are aggregated based on Water Balance Subregions (WBS) and are based on the Butte Basin Groundwater Model (BBGM; BCDWRC, 2021). Soil moisture is assumed to have no carry-over from month to month. Recharge based on applied water was not estimated.

Reference ET was taken from the California Irrigation Management Information System (CIMIS) Durham Station. Land use was from Land IQ 2018 (DWR, 2021) land use survey. Land use was updated by estimating fallowed rice fields based on remotely sensed data. It was assumed that the remaining irrigated land uses did not change from 2018 to 2021. Butte County-specific crop coefficients and irrigation efficiencies were taken from the BBGM. Precipitation data was utilized from the Parameter-Elevation Relationships on Independent Slopes Model (PRISM) 4-km monthly data.

To account for differences in acreages, precipitation, reference ET, and other factors accounted for in the calibration of the BBGM, a linear adjustment was made to the total monthly water demand per WBS in the simplified water balance to better reflect estimates in the BBGM.

Surface water deliveries for WY 2019 and WY 2020 were done through Water Year Type (WYT) estimation. The Sacramento Valley WYT for WY 2019 was "Wet", and an average monthly delivery from WY 2006, 2011, and 2017 was used. The Sacramento Valley WYT for WY 2020 was "Dry," and an average of monthly delivery from WY 2007, 2009, and 2013 was used.

Water deliveries in WY 2021 are taken from multiple sources. For the Western Canal Water District, Richvale Irrigation District, Biggs-West Gridley Water District, and Butte Water District, deliveries were estimated based on publicly available surface water (SW) diversions information. These diversions are available from requirements outlined in Senate Bill (SB) 88, which requires all water rights holders who have previously or intend to divert in excess of 10 ac-ft per year to measure and report the water they divert. Other areas in the BBGM area did not report SW diversions; these include areas outside of irrigation districts in the Butte Subbasin, Reclamation District 1004, the Vina Subbasin, and the Wyandotte Creek Subbasin. Diversions in these areas were estimated based on a review of riparian water diversion from 2018-2020, total appropriative water rights in the region, and a review of diversion inputs in the BBGM. Diversion estimates from the above steps were then scaled to match diminished diversion in the Sacramento Valley.

DOMESTIC AND MUNICIPAL DEMAND – VALLEY FLOOR

Dispersed domestic, i.e., household, groundwater pumping in the Butte County valley floor was estimated using the number and type of residential parcels and baseline/2020 gallon per capita per day (GPCD) water use from Chico-Hamilton City District's 2020 Urban Water Management Plan (California Water Services Company, Chico-Hamilton City District, 2020).

Valley floor parcels were selected if their centers are located inside the Central Valley Basin and outside service area boundaries from the Division of Drinking Water of the California Water Resources Control Board and the California Environmental Health Tracking Program. Residential parcels were selected from the valley floor parcels using the General Plan Zoning Codes FR – Foothills Residential, MDR – Medium Density Residential, MHDR – Medium-High Density Residential, RR – Rural Residential, and VLDR – Very Low Density Residential.

Valley residential and rural residential parcels were considered to have households of 2.57 persons on average, as determined by the US Census Bureau for Butte County. Very low-density residential parcels may contain up to 1 household per acre and were estimated to have household densities of 0.5 households per acre (1.29 persons per acre, when adjusted for persons per household). Medium-density residential parcels may contain up to 6 households per acre and were estimated to have populations of 15.42 persons per acre. Medium-high-density residential parcels may contain up to 20 households per acre and were estimated to have populations of 25.7 persons per acre.

Municipal groundwater pumping was solicited from all applicable local agencies.

REFERENCES

Butte County Department of Water and Resource Conservation (BCDWRC). 2021. Model Documentation v 1.0. Butte Basin Groundwater Model. November 30. Available at: https://www.buttecounty.net/waterresourceconservation/groundwater.

California Department of Water Resources (DWR). 2021. 2018 California Statewide Agricultural Land Use. gis.water.ca.gov/app/CADWRLandUseViewer/.

California Water Service Company (Cal Water-Chico). 2020. 2020 Urban Water Management Plan's (UWMP) 2020 Chico-Hamilton City District. Available at: https://www.calwater.com/docs/uwmp2020/CH_2020_UWMP_FINAL.pdf.

Luhdorff and Scalmanini Consulting Engineers (LSCE). 2022. Drought Impact Analysis Study. Available at: https://www.buttecounty.net/1240/Drought-Impact-Analysis-Study.

Water Year 2023 Annual Report

WY 2022-2023

Water Use Analysis Methodology

TECHNICAL MEMORANDUM

To: Luhdorff and Scalmanini Consulting Engineers

From: Davids Engineering, Inc.

Date: Friday, February 09, 2024

Subject: **DRAFT - 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 Wyandotte Creek 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 Wyandotte Creek Subbasin Annual Report (Annual Report), the approach used to estimate unmeasured groundwater extraction for the agricultural and managed wetlands water use sectors 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 Butte Basin Groundwater Model (BBGM) 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)

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[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.

PRISM precipitation data along with rooting estimated mean rooting depths from the rooting depth ranges listed in Appendix B of ASCE 70 (2016) is used to create pixel-level estimates of effective precipitation (ETPR). For crops not listed in ASCE 70, rooting depths are based on rooting depths of similar crops and professional judgement. ETPR is computed using the National Engineering Handbook Part 623 method (USDA, 1993).

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. Water supply data is distributed as averages over the area where that information is applicable (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.

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

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

3.5 Other Agronomic Data

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

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

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

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Attachment A. GEEEO Computational Approach Details

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

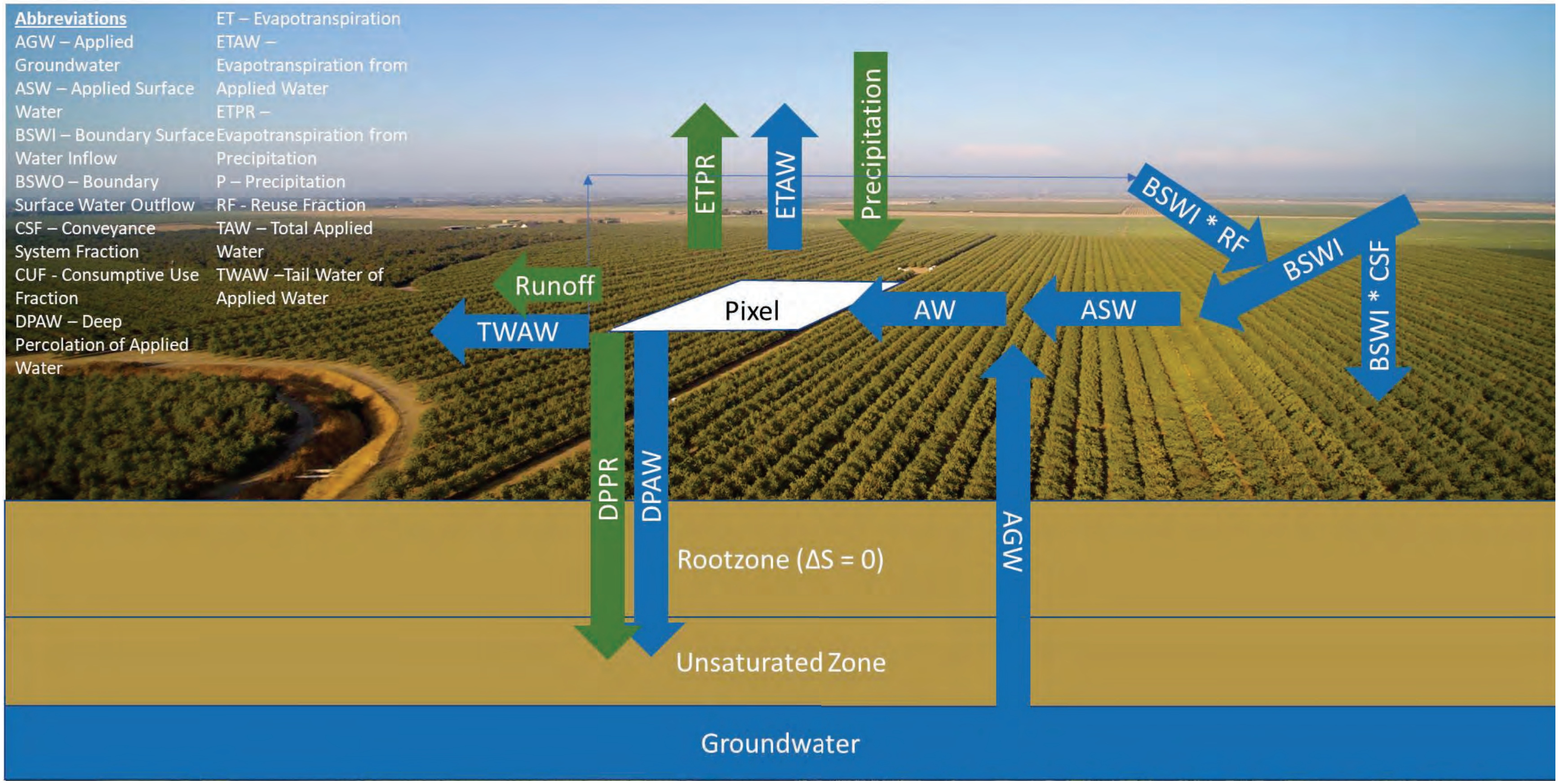

Figure A-1. Inflows and Outflows to Each 30 m x 30 m Pixel in the GEEEO Process.

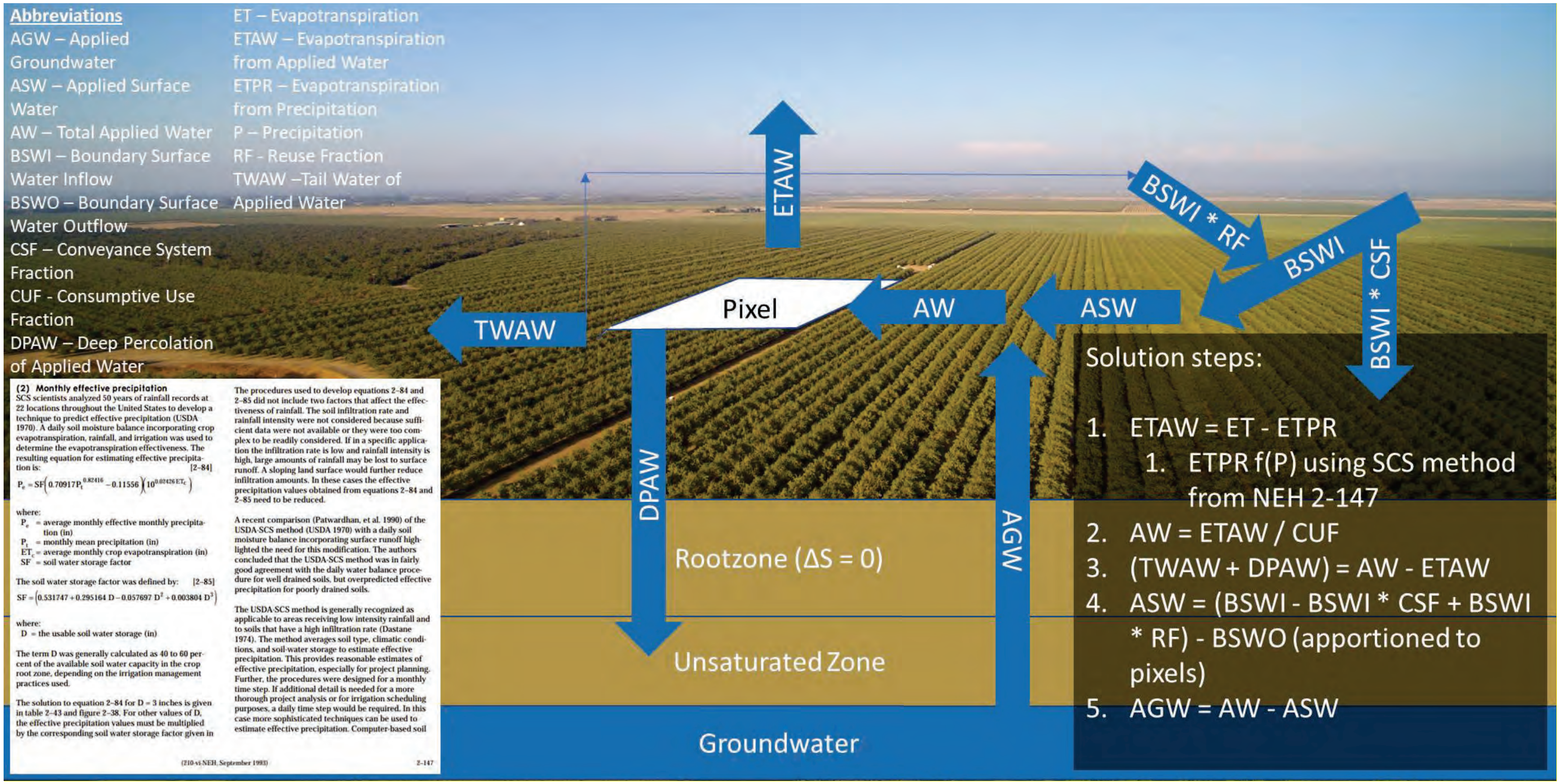

Figure A-2. Solution Steps for Calculating Applied Groundwater (AGW) in Each 30 m x 30 m Pixel in the GEEEO Process.

Water Year 2023 Annual Report

Appendix F

Water Quality

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TECHNICAL MEMORADUM

Groundwater Quality Monitoring Update for 2022 and 2023

Prepared by: Kelly Peterson, Water Resources Scientist, Department of Water and Resource Conservation

Purpose

The purpose of this memo is to summarize the groundwater quality conditions for salinity, measured as electrical conductivity (EC) in the Butte, Vina and Wyandotte Creek Subbasins during the first two years (2022 and 2023) of GSP related groundwater quality monitoring that occurred.

Background

The Sustainable Groundwater Management Act (SGMA) of 2014 required Groundwater Sustainability Agencies (GSAs) to develop, then submit, and implement long-term Groundwater Sustainability Plans (GSPs) to the California Department of Water Resources (DWR) in 2022. The Butte, Vina and Wyandotte Creek Subbasin GSPs include plans to monitor EC to avoid groundwater quality degradation (Davids, 2021; Geosyntec Consultants, Inc., 2021a; Geosyntec Consultants, Inc., 2021b).

Salinity is the main constituent of concern in all three Subbasins and is measured as EC as a basic groundwater quality characteristic to evaluate a basin for evidence of saline intrusion. Groundwater quality monitoring serves to establish baseline levels for these parameters throughout the Subbasins so that any future changes may be identified and further investigation and / or monitoring can subsequently be developed. Groundwater quality monitoring for implementation of the GSPs began in 2022, spearheaded by staff from the Butte County Water and Resource Conservation Department (Department) with assistance from various volunteers and GSA Managers for the fieldwork portion of the monitoring. The focus of the monitoring is targeting deep wells within each Subbasin to track the migration of connate water upwelling from deep portions of the aquifer.

Methodology

In 2021, the Department purchased a Solinst 107 EC meter which includes a probe that measures EC, temperature and water level (similar to an electric sounder) on a 1,000-foot-long laser-marked flat tape with markings every 1/100th ft. This meter was purchased to conduct EC monitoring at various depths within wells in the monitoring network and was used in 2022 and 2023, the first two years of GSP related groundwater quality monitoring. The meter was calibrated at the beginning of each day with known standard solutions according to the manufacturer’s specifications. At each site the probe was lowered to the water surface and a depth to water measurement was recorded. It was then lowered to the midpoint of each screened interval(s) within the well to record the EC of the water entering the well from that portion of the aquifer. The Solinst EC meter was only used in wells that did not have any pumping equipment within them i.e. multi-completion observation wells, in order to avoid damage to the equipment through entanglement in the wiring or pump.

For most of the remaining wells in the monitoring network with pumps, a Hach brand portable water quality meter with a conductivity probe was used to measure a water sample after the well was purged of standing water by pumping for at least 20 minutes. One exception, well 19N01W28A001M in the Glenn County portion of the Butte Subbasin, measured by Glenn County staff, was purged and pumped for less than 20 minutes.

Electrical conductivity measurements are taken at each RMS well once per year. The wells are typically measured within the month of August during the peak of the irrigation season.

The GSAs developed these new groundwater quality monitoring Representative Monitoring Site (RMS) networks to include wells distributed spatially throughout the Subbasins with a focus on including wells screened deep enough to capture changes in EC in the deeper portions of the aquifer where any changes in EC would be expected to be detected first. While there are shallow RMS wells within some of the networks, as part of future GSP implementation, GSAs may consider modifications to the groundwater quality RMS network as needed.

The Butte, Vina and Wyandotte Creek Subbasins groundwater quality monitoring networks are comprised of the individual groundwater quality monitoring RMS wells as described in each of the Subbasin’s GSPs. Each Subbasin has a monitoring network of eight RMS wells; however, modifications to the Wyandotte Creek Subbasin’s RMS network have been made since adoption of the GSP due to the inaccessibility of specific wells and the subsequent addition of sites described in more detail below. In 2023 the overall revised monitoring network included the eight original sites in both the Vina and Butte Subbasins as well as seven sites in the Wyandotte Creek subbasin for a total of 23 sites. Some of the water quality monitoring sites do have historic intermittent EC data, however most sites do not. A map of each Subbasin and the network of groundwater quality RMS sites is shown in **Figure 1.**

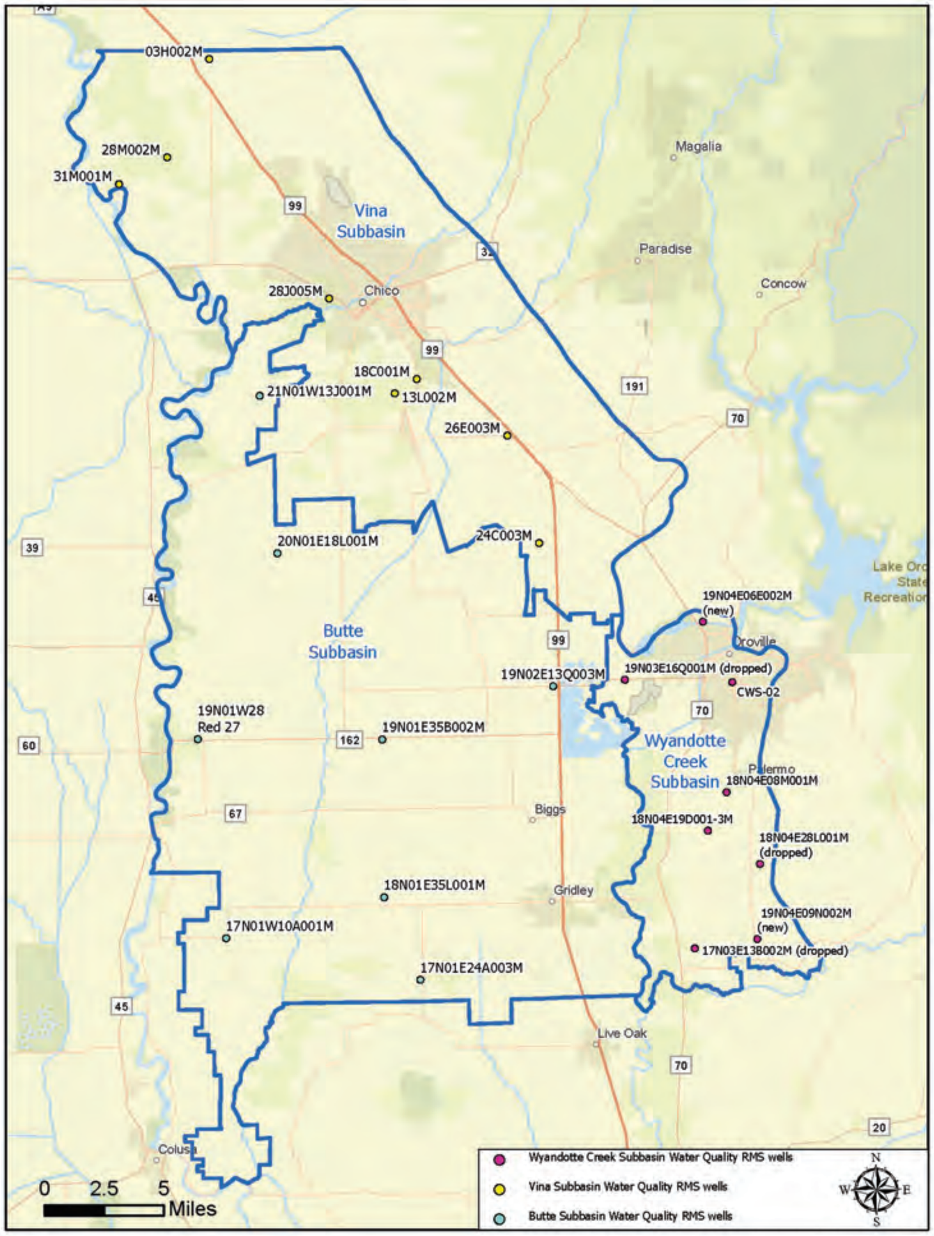

Figure 1. Groundwater Quality Representative Monitoring Site well locations in the Vina, Butte and Wyandotte Creek Subbasins

Modifications to the Wyandotte Creek Subbasins RMS network include removal of three original RMS wells and the addition of two wells. RMS well 13B002M was removed in 2022 due to an inoperative pump preventing access to a water sample. Two RMS wells were removed from the network per the request of the landowners, 28L001M in 2022 and 16Q001M in 2023. Efforts were made to identify other wells which could be used as alternatives in the Wyandotte Creek Subbasin. Two additional sites were identified and added to the monitoring network; 06E002M in 2022 and 09N002M in 2023. Well 06E002M has been monitored annually since 2002 as part of previous Butte County Basin Management

Objective (BMO) program groundwater quality monitoring effort sand 09N002M is a RMS well for groundwater level monitoring but a new groundwater quality monitoring well.

The RMS well details including well type, what equipment is used to monitor it, total well depth and depth of the screened zones(s) in each well are provided in **Table 1.** The RMS wells within the Butte Subbasin are predominantly multi-completion wells with the exception of 18N01E35L001M, a single observation well and 19N01W28A001M, a shallow irrigation well. Three of the RMS wells in the Butte Subbasin 18N01E35L001M, 19N01E35B002M and 20N01E18L001M are also extensometer sites which continuously monitor land subsidence. The RMS wells within the Vina Subbasin are all multi-completion wells (multiple wells at a single location screened at different depths below the ground surface) and the deepest of those wells at each location is selected for measurements. In the Wyandotte Creek subbasin, there are variety of well use types in the monitoring network including residential, irrigation, municipal and observation wells.

Sustainable Management Criteria

Groundwater quality monitoring measures EC levels in the Representative Monitoring Site (RMS) wells in comparison to the Measurable Objective (MO) and Minimum Threshold (MT) set for each RMS well in the GSPs as a way to gauge whether undesirable results are occurring in the subbasin. In each Subbasin's GSP, MTs were established to be protective of water uses and users. When considering MTs, it is important to note that in the case of groundwater levels, exceedance of a MT is caused by groundwater levels dropping below the threshold. However, for groundwater quality, exceedance of a MT is counterintuitively caused by measuring levels higher than the threshold. The MT for groundwater quality is a highest allowable value, rather than lowest. **Table 2**. identifies the MOs, MTs, and definition of Undesirable Results for each Subbasin.

As shown in **Table 2.** in the Butte Subbasin the preliminary MO for each RMS well for EC is set at 700 µs/cm for agricultural use, consistent with the Butte County Basin Management Objective (BMO) program, the previous 19-year long Butte County-wide groundwater quality monitoring effort. The MTs at the RMS wells are set as either the higher of 900 µs/cm or the measured historical high, whichever was greater. This MT was set based on best available data, the 19-year dataset of the Butte County BMO program, and maximum contamination levels established by the State. The occurrence of an Undesirable Result occurs in the Butte Subbasin if 25% of RMS wells exceed their MTs for 24 consecutive months.

In the Vina and Wyandotte Creek Subbasins the groundwater quality Sustainable Management Criteria (SMC) are established to address degraded groundwater quality caused by groundwater pumping where the potential exists for movement of underlying brackish water from greater depths into the freshwater pool where groundwater pumping for beneficial uses occurs. In these two subbasins, the MOs for salinity are set at 900 µs/cm and the MTs are 1,600 µs/cm, which is the upper limit of the Secondary Maximum Contaminant Level (SMCL) based on State Secondary Drinking Water Standards. Values exceeding this number are typically unacceptable for drinking water.

Table 1. Groundwater Quality Representative Monitoring Site Information

Subbasin	Representative Monitoring Site ID	Well Type	Monitoring Equipment	Total Well Depth (feet)	Depth of Screened Zone(s) (feet)
Butte	19N02E13Q003M	Observation*	Solinst 107	690	670 - 680
	17N01W10A001M	Observation*	Solinst 107	820	770 – 780, 790 - 800
	21N01W13J001M	Observation*	Solinst 107	830	780 - 820
	17N01E24A003M	Observation*	Solinst 107	833	770 - 790
	18N01E35L001M	Observation	Solinst 107	899	816 - 836
	19N01E35B002M	Observation*	Solinst 107	980	930 - 950
	20N01E18L001M	Observation	Solinst 107	1,000	767 – 810, 873 - 894
	19N01W28A001M	Irrigation	Hach Sension156	140	120 - 140
Vina	03H002M	Observation*	Solinst 107	553	510 - 540
	28M002M	Observation*	Solinst 107	1,031	791 – 801, 881 – 891, 951 – 961, 1011 - 1021
	31M001M	Observation*	Solinst 107	1,055	969 - 979
	28J005M	Observation*	Solinst 107	948	740 - 800
	18C001M	Observation*	Solinst 107	900	770 – 780, 800 – 810 830 – 840, 870 - 880
	13L002M	Observation*	Solinst 107	771	735 - 760
	26E003M	Observation*	Solinst 107	640	610 - 620
	24C003M	Observation*	Solinst 107	520	484 - 505
Wyandotte Creek	CWS-02	Municipal	Hach HQd	120	60 – 190, 300 - 322
	13B002M [1]	Irrigation	n/a	320	120 - 320
	08M001M	Irrigation	Solinst 107	656	168 – 204, 208 - 244
	19D001M	Observation*	Solinst 107	1,000	700 - 720
	19D002M	Observation*	Solinst 107	1,000	430 – 450, 550 - 570
	19D003M	Observation*	Solinst 107	1,000	120 - 130
	28L001M [1]	Irrigation	n/a	190	n/a
	16Q001M[2]	Residential	Hach HQd	120	100 - 120
	19N04E06E002M[3]	Municipal	Hach HQd	196	110 – 130, 164 – 174
	19N04E09N002M[4]	Irrigation	Hach HQd	325	45 – 55

[1] Removed from network in 2022 [2] Removed from network in 2023 [3] Added to network in 2022 [4] Added to network in 2023 * Multi-completion well

Table 2. Measurable Objectives and Minimum Thresholds for Electrical Conductivity [microsiemens (µs) / centimeter (cm)] in each Subbasin

Subbasin	Measurable Objective	Minimum Thresholds	Undesirable Result
Butte	700 µS/cm	The greater of 900 µS/cm or the measured historical high	25% of RMS wells exceed MTs for 24 consecutive months
Vina	900 µS/cm	1,600 µS/cm	2 RMS wells exceed their MT for two consecutive non-dry years
Wyandotte Creek	900 µS/cm	1,600 µS/cm	2 RMS wells exceed their MT for two consecutive non-dry years

Secondary Drinking Water Standards are set on the basis of aesthetic concerns. The occurrence of an Undesirable Result within both the Vina and Wyandotte Creek Subbasins occurs if two RMS wells within each Subbasin exceeds their MTs for two consecutive non-dry years.

Results

In 2022, a dry water year type, and 2023, a non-dry water year type, the majority of all wells monitored within each Subbasin had groundwater quality conditions (measured as EC) that fell within the acceptable range of groundwater quality values set forth by the GSPs and described in **Table 2.** Additionally, there were no indications of Undesirable Results in either year.

Butte Subbasin

In the Butte Subbasin the majority of RMS wells measured had EC values that were lower than the MO of 700 µS/cm and therefore lower than their specific MTs in both years. The MTs vary per well since they are based on historic data, if available, as shown in **Figures 2 - 4.** Results from one RMS well 17N01W10A001M, located in Colusa County, had EC values higher than the well's MT in 2023. Historic (DWR, 2020, DWR 2023a) and recent data for this well are shown in **Figure 4**. This well is near the Sutter Buttes mountain range in an area known for high concentrations of EC (Davids, 2021). Future plans may include the formation of the Sutter Buttes Water Quality Interbasin Working Group as described in more detail in section 6.1.2.2 of the Butte Subbasin GSP (Davids, 2021) to focus on collaborative discussions, consensus building and planning to address groundwater quality matters associated with the unique geology of the Sutter Buttes area.

Results from RMS well 20N01E18L001M are not depicted in the 2022 or 2023 figures as there was an obstruction within the well each year preventing the equipment from reaching the proper depths at the mid-point of the screening interval to measure EC. As part of future GSP implementation, the GSAs will consider modifications to the groundwater quality RMS network.

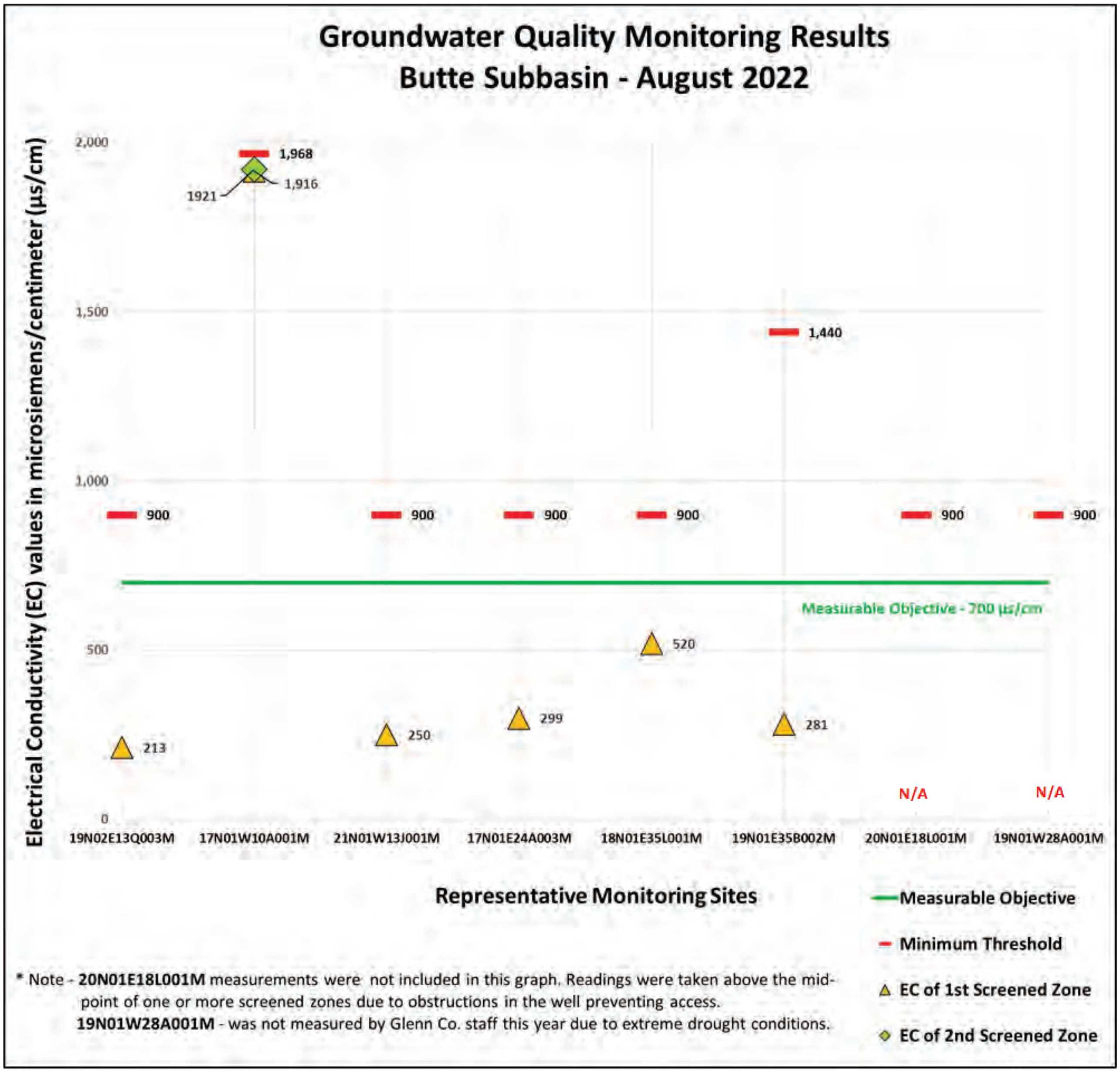

Figure 2. Groundwater quality monitoring results in the Butte Subbasin for the 2022 water year

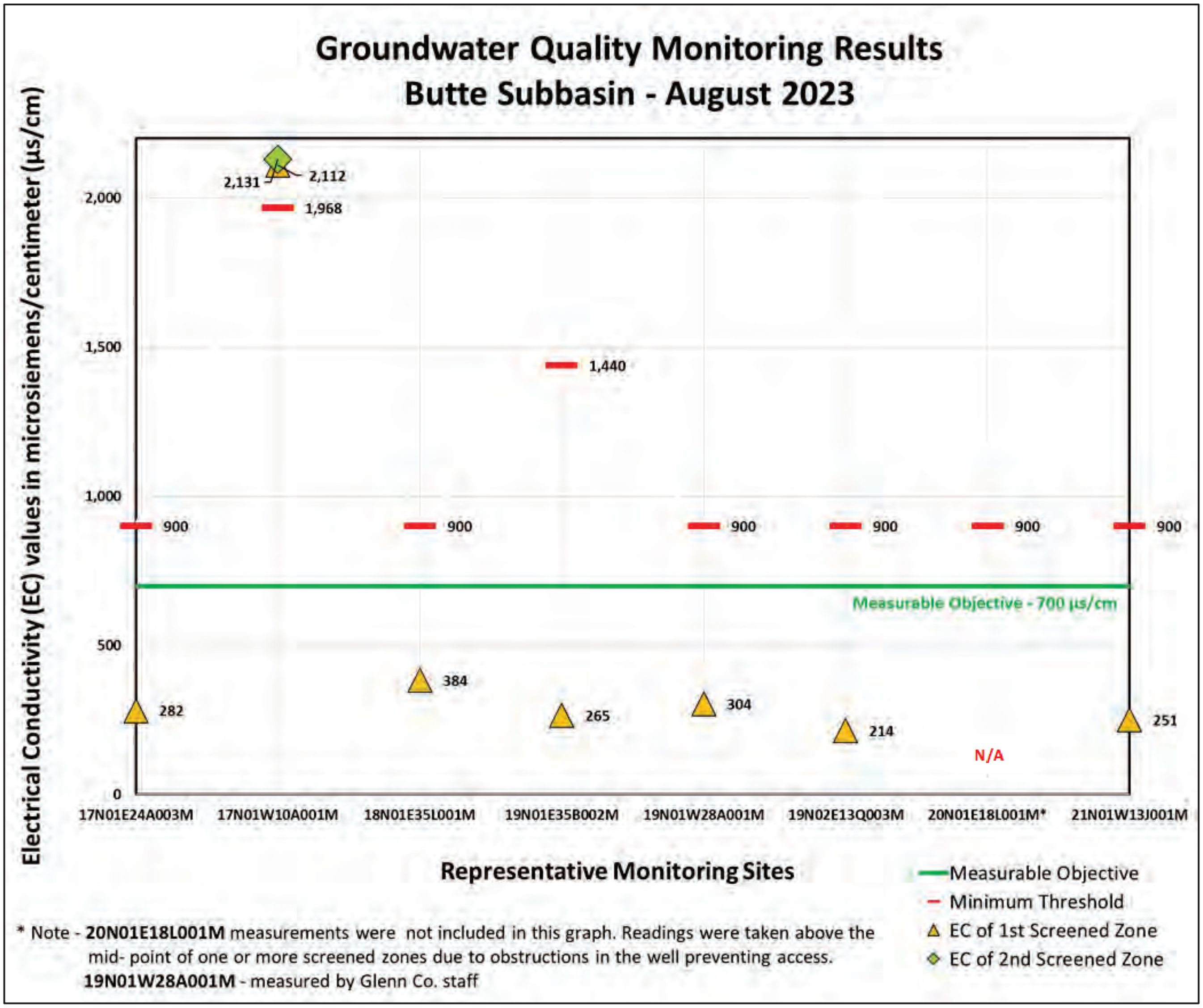

Figure 3. Groundwater quality monitoring results in the Butte Subbasin for the 2023 water year

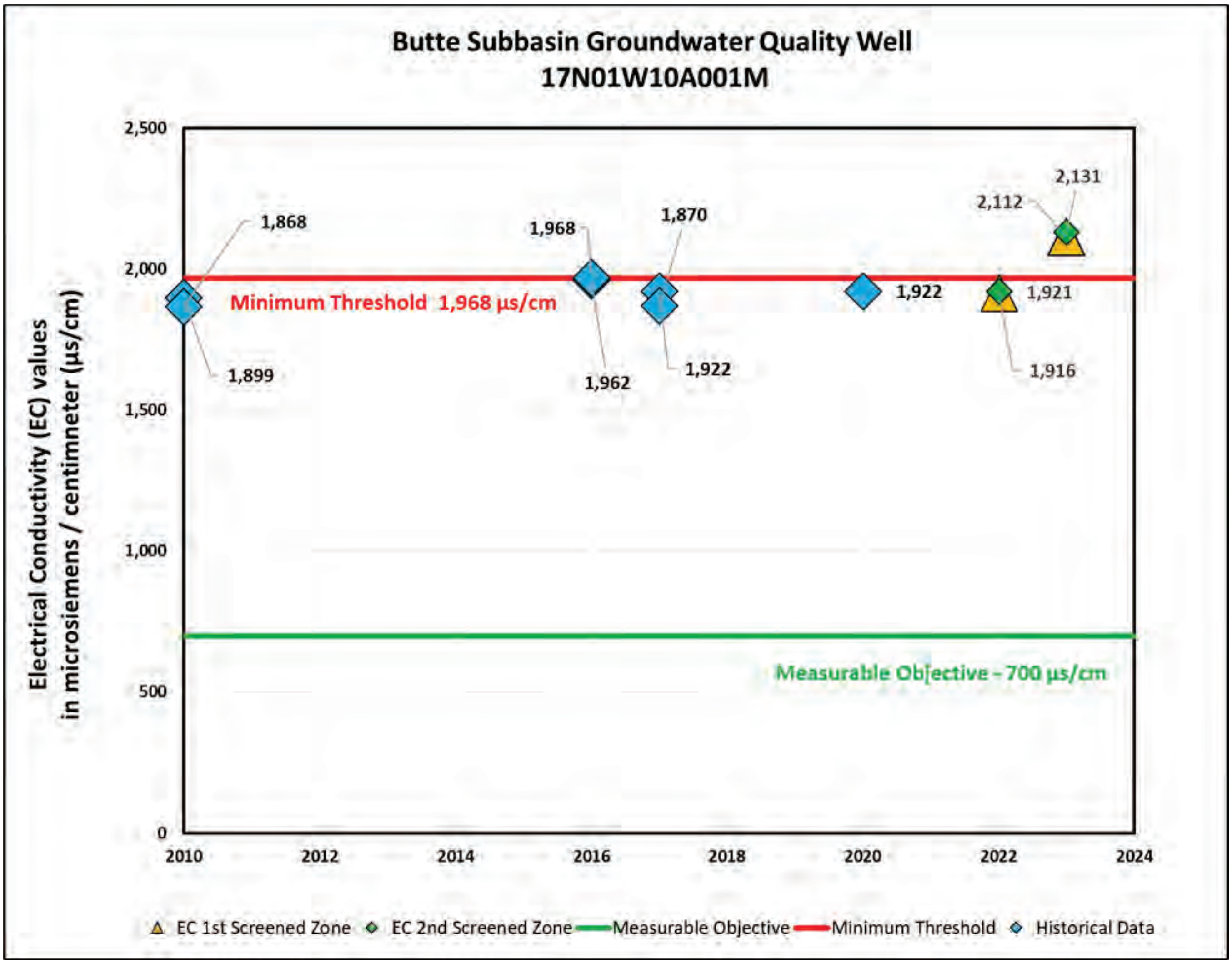

Figure 4. Groundwater quality data for well 17N01W10A001M in the Butte Subbasin

Vina Subbasin

In the Vina Subbasin all RMS wells measured had EC values that were lower than the MO of 900 µS/cm and therefore lower than the MT of 1,600 µS/cm in both years as shown in **Figures 5 and 6.** Results from RMS well 28J005 were not depicted in these figures as there was an obstruction within the well each year preventing the equipment from reaching the proper depths at the mid-point of the screening interval to measure EC. The probe could only be lowered to approximately 370’ above the screened interval for this well.

Based on observations in the field it is possible that RMS well 28J005, developed in 1955 has filled in with materials due to a collapse of the walls above the screened interval of the well. As part of future

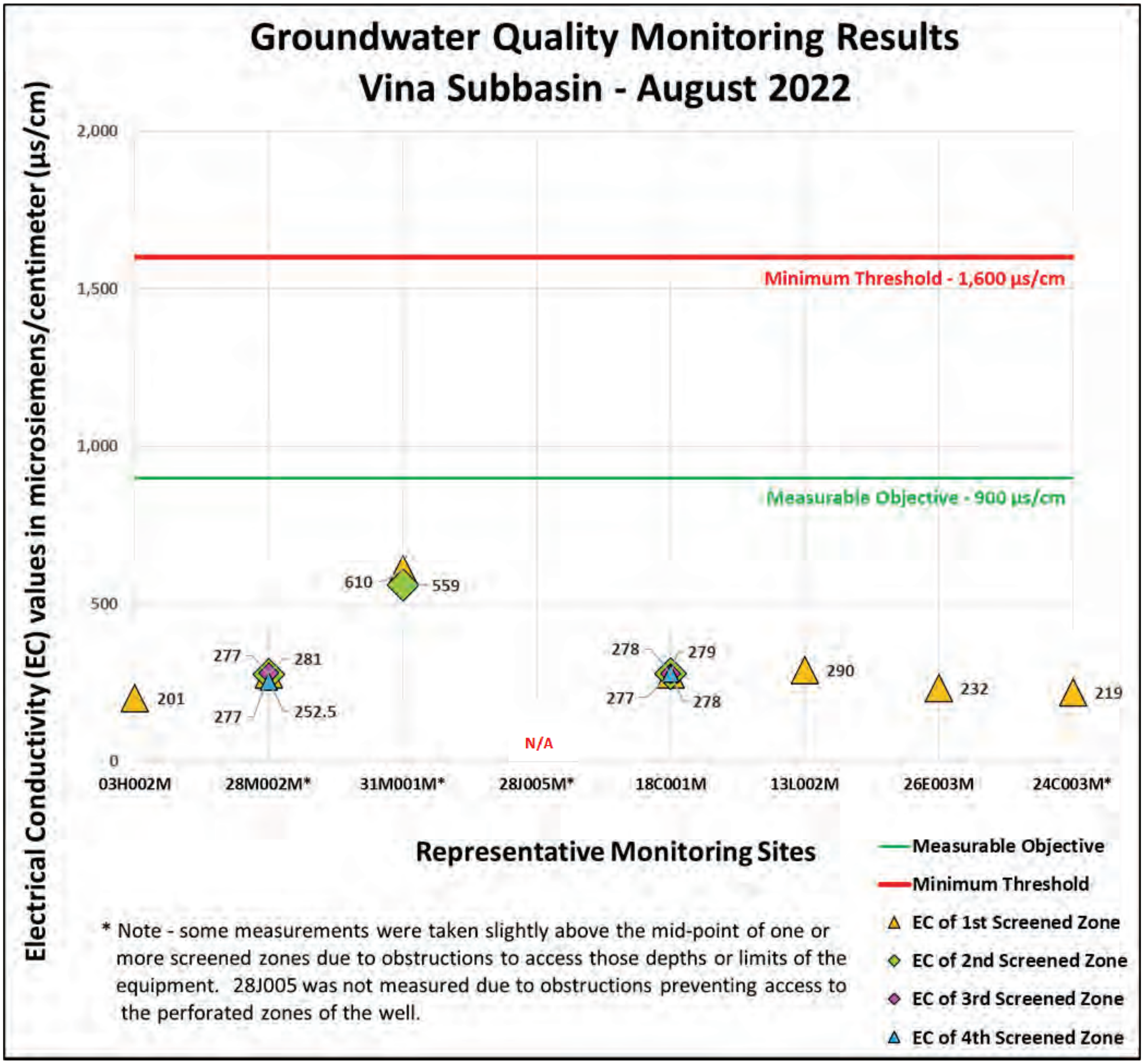

Figure 5. Groundwater quality monitoring results in the Vina Subbasin for the 2022 water year

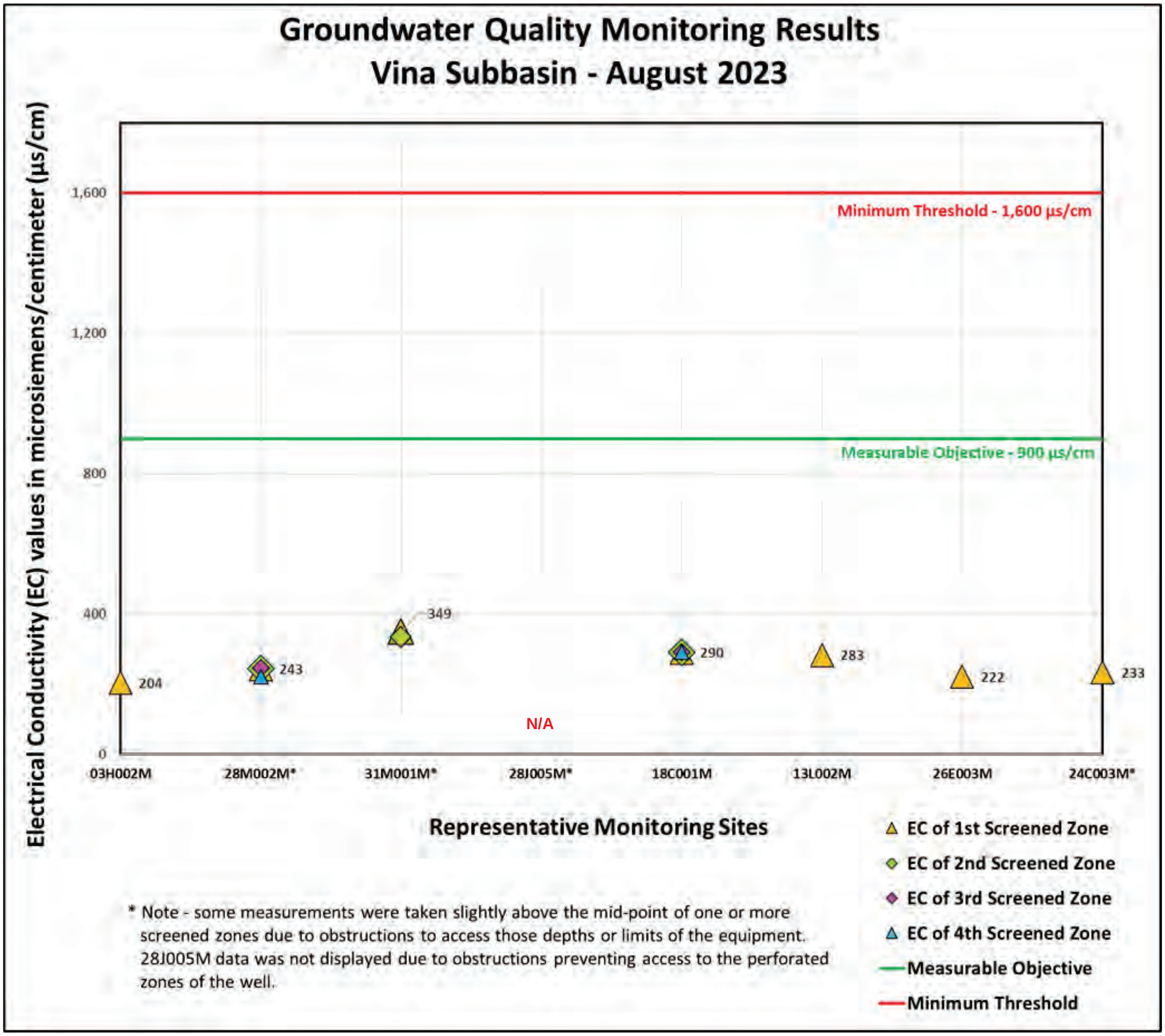

Figure 6. Groundwater quality monitoring results in the Vina Subbasin for the 2023 water year

GSP implementation, the GSAs may consider modifications to the groundwater quality RMS network as needed and / or technical support requests to DWR for video logging of the wells.

Wyandotte Creek Subbasin

In the Wyandotte Creek Subbasin the majority of RMS wells measured had EC values that were lower than the MO of 900 µS/cm and therefore lower than the MT of 1,600 µS/cm in both years as shown in **Figures 7 and 8.** Results from RMS well 08M001M were not depicted in these figures as the data deemed to be questionable based on site conditions. Anecdotally, this general area of the Subbasin is known to have areas of high concentrations of salinity and natural gas.

Additionally, two of the three new multi-completion wells drilled in 2021 by DWR through the Technical Support Services program exhibited high EC levels in 2023, exceeding the MT depicted in **Figures 8-9**. Wells 19D001M and 19D002M are each screened at varying intervals to monitor the deep and intermediate zones of the aquifer respectively. Both wells had high levels of EC greater than the MT when initially developed and again when the wells were re-tested months after initial development. Groundwater quality monitoring results for 2022 at these wells were not reported due to malfunctioning equipment. Better characterization of naturally occurring salinity is needed to help improve appropriate monitoring and management of groundwater with respect to water quality in this Subbasin.

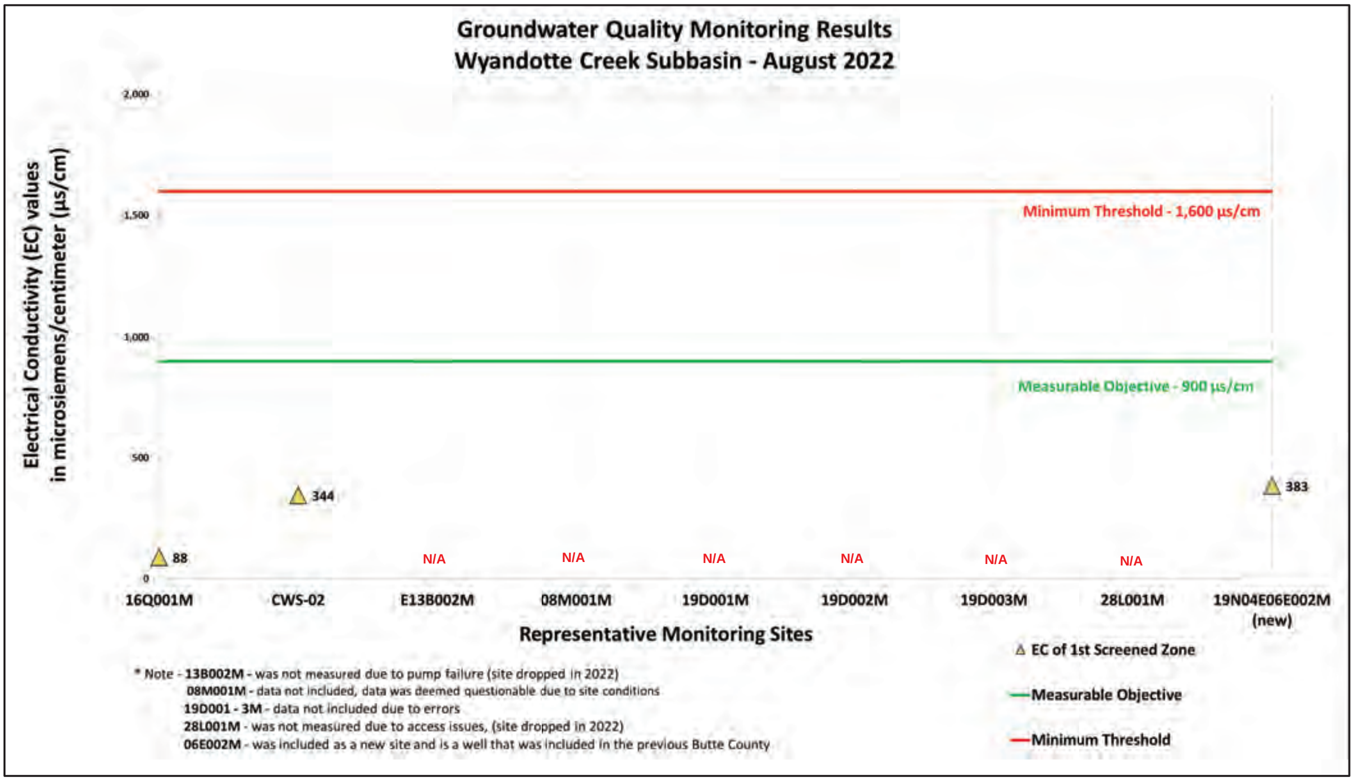

Figure 7. Groundwater quality monitoring results in the Wyandotte Creek Subbasin for the 2022 water year

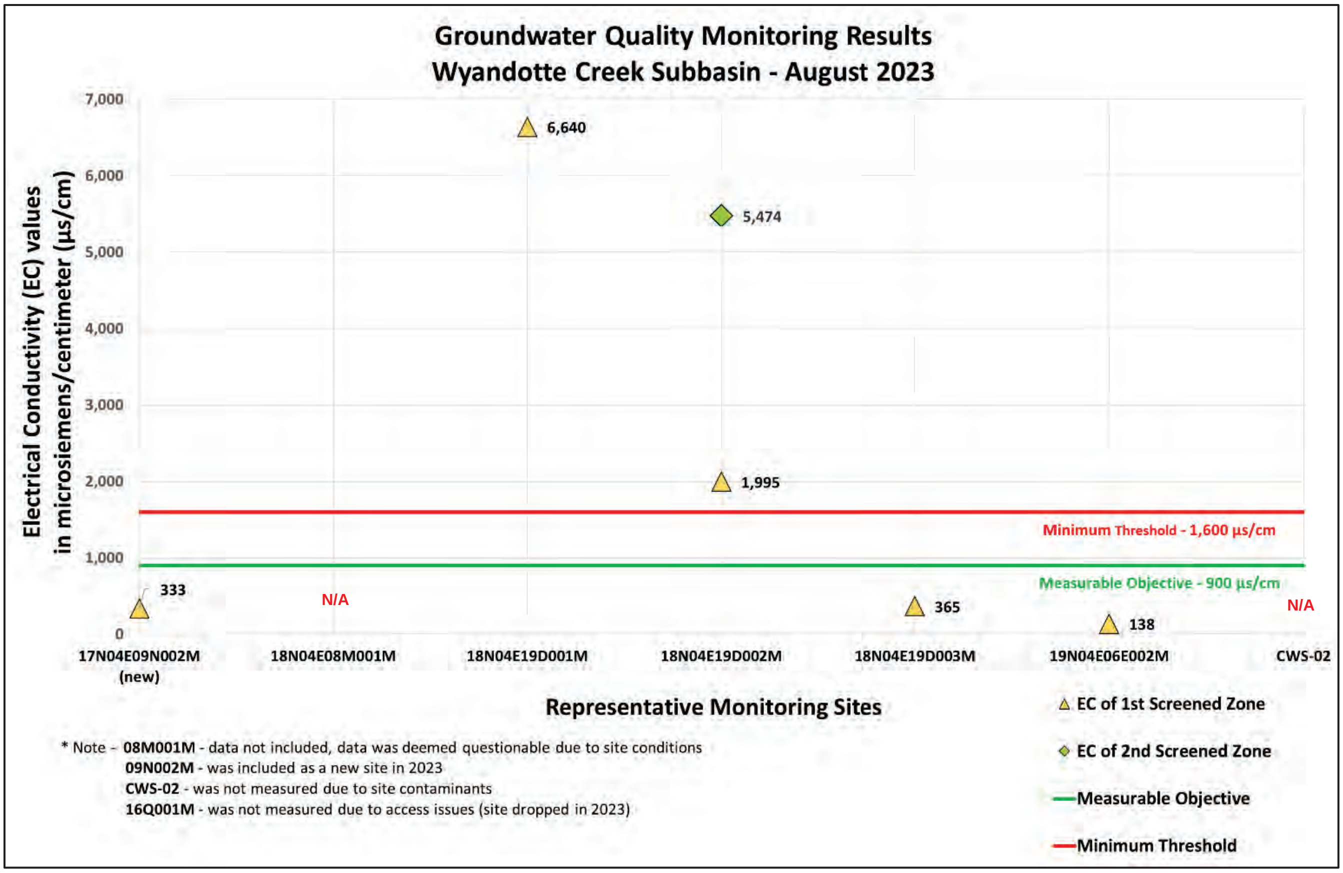

Figure 8. Groundwater quality monitoring results in the Wyandotte Creek Subbasin for the 2023 water year

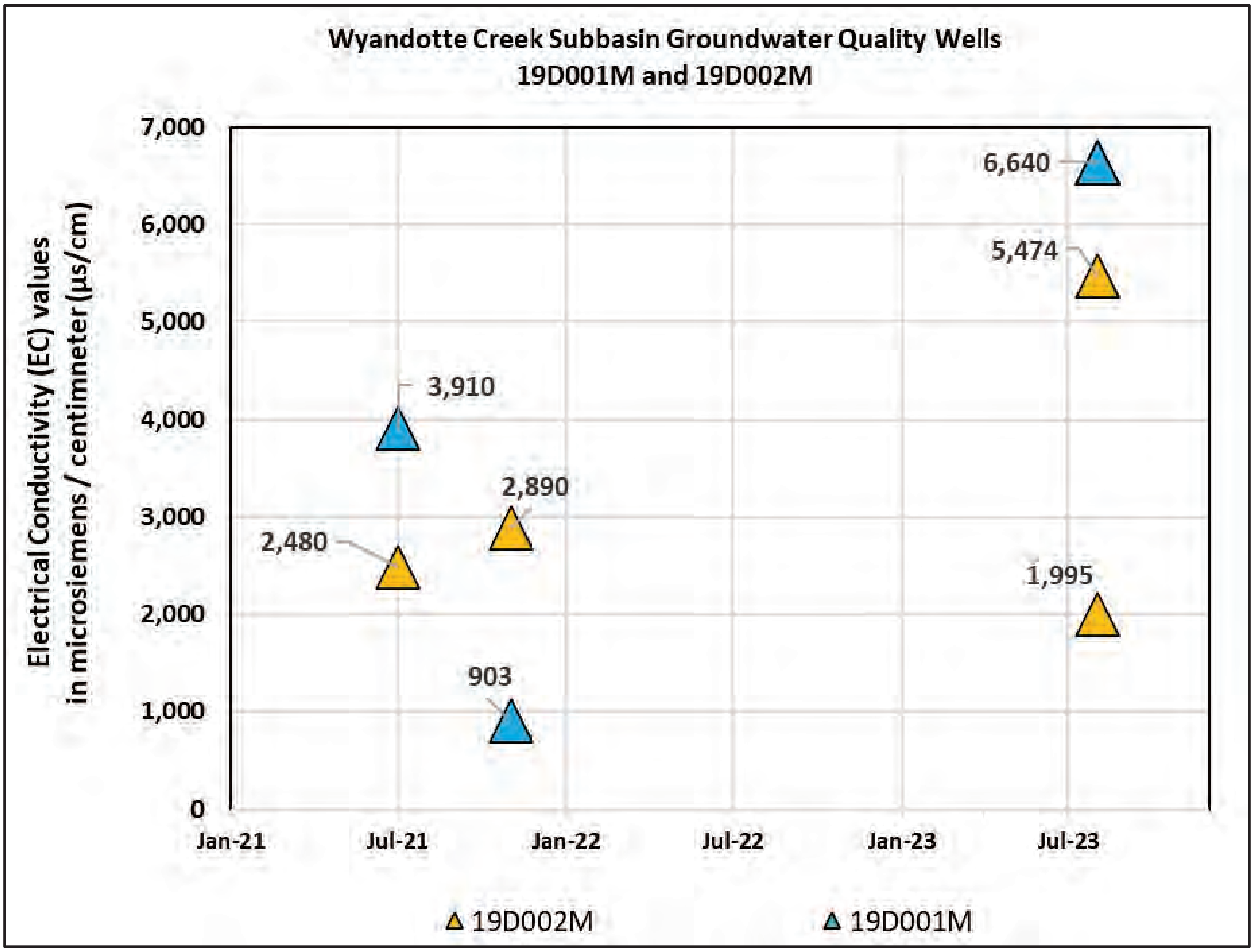

Figure 9. Groundwater quality monitoring results for wells 19D001M and 19D002M in the Wyandotte Creek Subbasin for the 2023 water year

Discussion

Groundwater quality monitoring serves to establish baseline levels for EC throughout the Subbasins so that any future changes may be identified and further investigation and or monitoring can subsequently be developed. There were no RMS wells in exceedance of any MTs in the Vina Subbasin. While there were some concentrated EC levels in one well within the Butte Subbasin and two wells within the Wyandotte Creek Subbasin over the first two years of monitoring for EC as part of GSP implementation, there were no indications of Undesirable Results as defined in the GSPs. In the Butte Subbasin, 2023 was the first year any RMS wells exceeded an MT. Undesirable Results in both the Vina and Wyandotte Creek Subbasins are tied to non-dry water year types and 2022 was a dry water year type. Next year is likely to be a non-dry year and as such there may be indications of Undesirable Results in the Wyandotte Creek Subbasin as defined the GSP, if wells there continue to show elevated levels of EC. Better characterization of naturally occurring salinity is needed to help improve appropriate monitoring and management of groundwater with respect to groundwater quality in this Subbasin.

Additional monitoring will continue to be conducted by DWR and other agencies to track constituents not managed under the current GSPs, including a variety of minerals, metals, pesticides and herbicides. Data from ongoing monitoring by various state and federal agencies will be available to the GSAs to augment local datasets and understanding of groundwater quality and can be found on the State Board's Groundwater Ambient Monitoring and Assessment (GAMA) program at https://www.waterboards.ca.gov/gama.

The County will work with the GSAs to address modifications to the monitoring networks, conduct monitoring to support data collection, and ensure that data is submitted to DWR as required by SGMA.

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