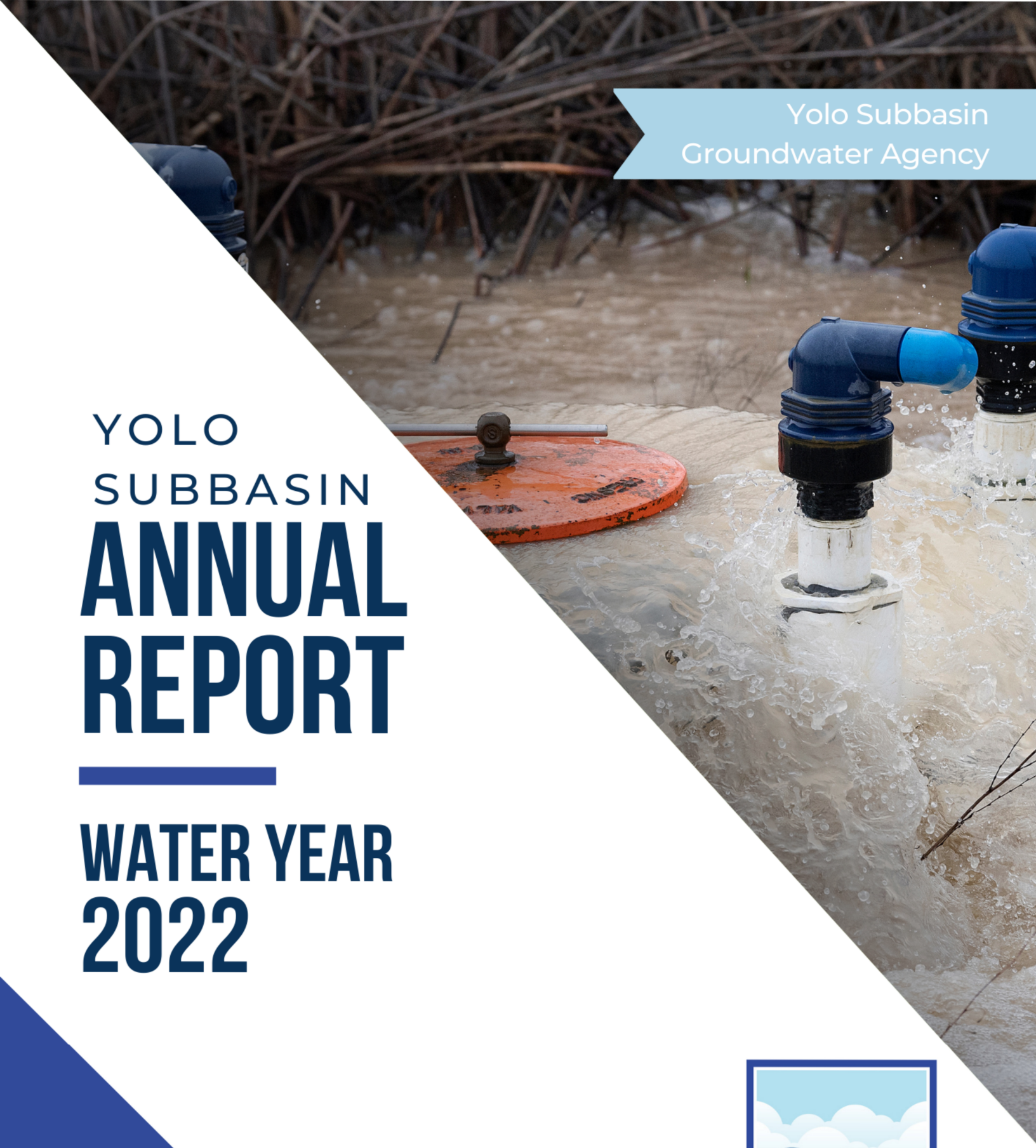
Yolo Subbasin Groundwater Agency



YOLO SUBBASIN ANNUAL REPORT

WATER YEAR 2022

530-662-3211
www.yologroundwater.org
34274 State Hwy 16, Woodland CA

YSGA
Yolo Subbasin Groundwater Agency
YOLOGROUNDWATER.ORG

PAGE LEFT BLANK INTENTIONALLY

Covers: Front: Water flows into a field for multi-benefit groundwater recharge in Dunnigan Water District
Back: "Trickle flow" through Buckeye Creek as part of the Dunnigan Area Groundwater Recharge Program
Photo credit: CA Department of Water Resources

Yolo Subbasin Groundwater Sustainability Plan

2023 Annual Report

Covering Water Year 2022

Prepared by:

YSGA Staff
34274 State Highway 16
Woodland, CA 95695

March 31, 2023

EXECUTIVE SUMMARY

The Yolo Subbasin Groundwater Agency (YSGA) has prepared this report for the Yolo Subbasin Groundwater Sustainability Plan (GSP) in compliance with the Sustainable Groundwater Management Act (SGMA; California Water Code Section 10720 et seq.). SGMA requires Groundwater Sustainability Agencies to submit annual reports to DWR each April 1 following adoption of a GSP, whether or not DWR has officially approved the GSP. DWR's GSP Regulations provide details on the data requirements for annual reports; the annual report must include data and information collected from the monitoring network, including groundwater extractions, surface water supply, total water use, and changes in groundwater storage for the subbasin.

The YSGA adopted the Yolo Subbasin GSP on January 24, 2022 and submitted the GSP to DWR on January 28, 2022. Still in the formidable implementation years, the YSGA considers this annual report as a way to communicate groundwater conditions within the Yolo Subbasin GSP. The annual report template will improve every year as the YSGA obtains additional information and collects additional data to enhance our robust groundwater monitoring network. This annual report covers Water Year 2022 (October 1, 2021 to September 30, 2022).

GSP Implementation in 2022 was focused on GSA organization, drought response, and planning for recharge projects. The YSGA Board of Directors incorporated former WRA duties into the YSGA mission, and staff worked to prepare and submit projects for funding opportunities. The YSGA continued to coordinate with Yolo County about drought conditions, dry domestic wells, and well permitting under Executive Order N-7-22. Dunnigan Water District, the City of Woodland, and YCFC&WCD planned for and implemented successful groundwater recharge projects.

Similar to Water Year 2021, Water Year 2022 was a critical water year, in which precipitation was approximately 16.8" for the County and 83% of the historical average precipitation within the County. Water Year 2022 prevented additional groundwater recovery opportunities and Spring 2022 groundwater levels were approximately equal to Spring 2015 groundwater levels. Fall 2022 measurements illustrated a slightly improved seasonal drawdown (17 ft) when compared to the 2021 seasonal drawdown (18 ft) observed in average groundwater elevations.

The monitoring networks for each Sustainable Management Criteria (SMC) displayed some exceedance of the minimum threshold values. Exceedances are localized and do not translate to the Management Area scale. Projects and management actions in the coming water year will focus on facilitating groundwater recovery in these areas.

This annual report contains estimated acre-feet values for surface water diversions, groundwater extraction, total water use, and change in groundwater storage. Total surface and groundwater use in 2022 (530 TAF) displays a significant reduction from total water use in the past 3 years (720 – 780 TAF), reflecting the large amount of fallowing that was observed due to drought conditions and surface water curtailments. The dry and critical conditions of 2020-22 also caused unprecedented decreases in groundwater storage due to extremely limited precipitation and surface water supplies.

Contents

ATTACHMENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

The Yolo Subbasin Groundwater Agency Joint Powers Agreement (JPA) was officially executed on June 19, 2017 by 19 member agencies and five affiliated parties via memoranda of understandings (MOU). Since the YSGA was formed, three additional member agencies have signed onto the JPA; three other member agencies consolidated into one; and one affiliated party has entered into an MOU with the JPA, which has resulted in 20 member agencies and six affiliated parties for a total of 26 YSGA members.

The Yolo Subbasin Groundwater Sustainability Plan (GSP) was adopted on January 24, 2022 by the YSGA Board of Directors, and submitted to the California Department of Water Resources (DWR) on January 28, 2022 by YSGA staff. The GSP provides an overview of the planning considerations, hydrogeologic properties, and hydrologic conditions of the area from 1970 to 2018. It also outlines a water budget for the Yolo Subbasin, establishes Sustainable Management Criteria, and identifies projects and management actions to maintain sustainability. For a summary of the plan's contents, please refer to the Executive Summary of the Yolo Subbasin GSP[1].

This 2023 Annual Report is intended to provide an update on current activities and conditions within the Subbasin and bring the GSP up to date (as a continuation to the 2022 Annual Report). This report therefore covers Water Year 2022 (October 1, 2021 – September 30, 2022).

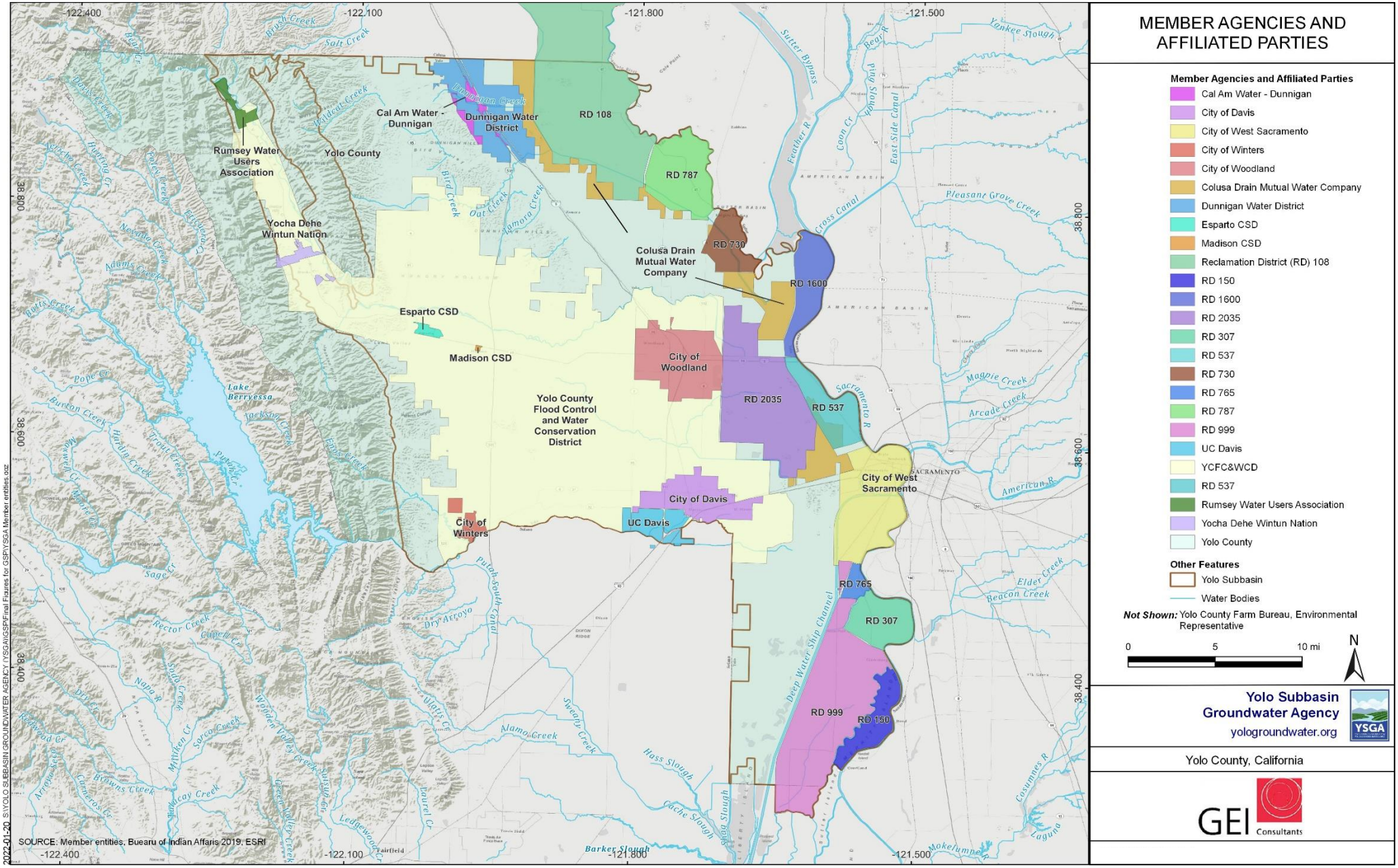
2. PLAN AREA

The Yolo Subbasin (Subbasin) covers approximately 540,700 acres, spanning nearly 845 square miles. The Subbasin is located in the southwestern side of the Sacramento Valley Groundwater Basin and is about 27 miles wide from west to east and up to 45 miles long from north to south. The current Subbasin boundaries are the result of the consolidation of portions of the Capay Valley, Colusa, and Solano subbasins via two applications for jurisdictional modifications of the Subbasin's boundary. Land use designations within the YSGA jurisdictional boundary are predominately agriculture and native vegetation, accounting for approximately 60 and 31 percent, respectively. Approximately six percent of the Subbasin contains managed wetlands, which provide migratory bird habitat and other ecosystem services. Source of water for agricultural lands is a combination of surface water and groundwater. Urban and incorporated land use areas are scattered throughout the Subbasin and account for approximately five percent of the Subbasin. The Yolo Subbasin boundary, member agencies, and affiliated parties are shown in Figure 1.

The Subbasin contains six Management Areas for implementation of project and management actions to achieve groundwater sustainability. In developing these Management Areas, YSGA considered geologic, aquifer, and topographic characteristics. To prevent undesirable results in adjacent Management Areas, consistent minimum thresholds and measurable objectives have been developed as discussed in the Yolo Subbasin GSP (Section 3 – Sustainable Management Criteria)[2]. The six Management Areas are known as the Capay Valley, Dunnigan Hills, North Yolo, Central Yolo, South Yolo, and Clarksburg.

[1] https://www.yologroundwater.org/files/3aac57af3/YoloGSP_Adopted_ExecutiveSummary.pdf
[2] https://www.yologroundwater.org/files/acff83c75/YoloGSP_Adopted.pdf#page=279

FIGURE 1. YOLO SUBBASIN MAP



3. GROUNDWATER MANAGEMENT ACTIVITIES AND MILESTONES

3.1 GSP IMPLEMENTATION PROGRESS

Since adoption of the Yolo Subbasin GSP, YSGA staff has worked to complete this annual report and begin the implementation process. In the second year of GSP implementation, the YSGA Board of Directors have discussed the formal process for preparing and prioritizing projects for grant funding opportunities. YSGA staff and the Board of Directors prepared for and hosted an open solicitation for project submittal and prioritization as part of submitting a SGMA Implementation grant request to DWR. The structure developed for DWR's SGMA Implementation grant solicitation created a solid foundation for prioritizing projects in the future once grant solicitations are announced. YSGA staff and consultants are currently working on developing funding strategies for projects and management actions within the Subbasin.

The YSGA Board of Directors authorized the continuation of supporting the Buckeye Creek Trickle Recharge Project (now known as the Dunnigan Area Recharge Program) in the North Yolo Management Area. In February 2022, an opportunity was provided to conduct a test of the Buckeye Creek Trickle Recharge Project as the Tehama-Colusa Canal developed a small leak in the siphon under Buckeye Creek, immediately downstream of the dewatering gate designated for project use. Approximately 275 and 200 acre-feet of water was discharged into Buckeye and Bird Creeks, respectively. YSGA staff were involved in monitoring activities and completing groundwater recharge estimates, and there was valuable information and lessons learned as part of this initial, fortuitous opportunity. From October 2022 to March 2023, approximately 830 acre-feet of water was diverted for trickle recharge in ephemeral streams within the area and flooding of farmers' fields.

In 2022, the YSGA assisted with dissolving the Water Resources Association of Yolo County (WRA) and incorporating WRA activities (integrated regional water management) into the YSGA's mission, which required revisions to the YSGA JPA, along with a formal dissolution of the WRA by the WRA Board of Directors. The merger of the WRA into the YSGA has increased efficiency by eliminating overlapping meetings and activities and is facilitating the integration of SGMA-related groundwater management activities with broader water resource planning efforts within Yolo County.

The YSGA Board of Directors continued to host ad hoc *Drought Contingency Planning Committee* meetings to advise the Board of Directors on 1) local planning strategies; 2) appropriate management actions for drought conditions; and 3) coordination with the Yolo County Board of Supervisors for management of groundwater resources during drought. Additionally, the *Committee* discussed resources available to mitigate drought impacts, implement sustainability projects, and investigate whether demand management strategies are necessary. The *Committee* directed YSGA staff to develop a joint Yolo County/YSGA Groundwater Communications Plan to provide clarity on the authority and purpose of the YSGA and Yolo County in groundwater resources management. YSGA staff are still working through the *Draft* Communications Plan. As part of the implementation of the Governor's Executive Order N-7-22 on March 28, 2022, the *Committee* convened numerous meetings throughout the year to discuss the development of procedures for providing written verification for well permit applications in Yolo County.

The YSGA has been coordinating closely with the County of Yolo to aid domestic well owners experiencing dry wells from drought conditions. The Yolo County Office of Emergency Services received approximately $560,000 in grant funding to provide water hauling resources to domestic well owners, and the YSGA is continuing to assist with facilitating the availability of those resources. Additionally, YSGA staff is hosting *Drought Task Force* meetings with technical staff to assist the County with developing a Water Shortage Contingency Plan (in compliance with Senate Bill 552).

Lastly, the YSGA has been working with the Yolo County Division of Environmental Health to improve the well permitting data collection process to better understand the true spatial impacts of the drought on subsurface conditions, and to properly carry out the Governor's Executive Order N-7-22 for well permitting activities in the County. As part of this, the YSGA and County are discussing improvements to well permitting requirements that may minimize the impact to domestic wells drilled in the future (i.e., requiring domestic wells to be an appropriate depth to ensure there are no construction/operational constraints in future dry year conditions). The YSGA is also tracking proposed legislation for codifying the Governor's Executive Order N-7-22 and requiring written verification in perpetuity (Assembly Bill 1563).

3.1.1 Groundwater Recharge Projects

The YSGA has coordinated with various local agencies to develop and implement groundwater recharge projects throughout Yolo County in 2022.

The Dunnigan Groundwater Recharge Project, led by Dunnigan Water District, launched in early 2022 as a pilot project with the diversion of about 200 AF from the Tehama-Colusa Canal into Buckeye Creek. The project has successfully expanded to include on-farm recharge and seasonal wetland habitat. The project now plans to recharge 5,000 AF per year into the aquifer and provide 500 acres of shorebird habitat. From October 2022 to March 2023, the project has diverted approximately 830 AF for trickle flow in ephemeral streams and flooding of farmers' fields.

The Dunnigan Groundwater Recharge Project has inspired other trickle flow recharge prospects throughout the County including recharging the upper reach of Oat Creek from a pipeline that extends off of the Yolo County Flood Control & Water Conservation District's (YCFC&WCD) canal system; and recharging China Slough, which could also receive excess flows off the YCFC&WCD's canal system. The YCFC&WCD planned for submitting a temporary permit in 2023 to capitalize on excess flows in Cache Creek for retaining in the YCFC&WCD's 160-mile canal system for groundwater recharge.

The City of Woodland Aquifer Storage and Recovery (ASR) program improves short term drought resiliency and long-term water supply reliability by storing high-quality treated Sacramento River water in the underground aquifer during the winter for use when there is peak demand in the summer or drought. Woodland relies primarily on treated surface water from the Woodland-Davis Clean Water Agency (WDCWA) for its water supply, with augmentation through its ASR program. The addition of a fourth ASR well will increase Woodland's overall injection and pumping capabilities to provide increased reliability of Woodland's highest quality supplemental source to WDCWA. Currently, the City of Woodland can store up to 4.5 million gallons of water per day.

3.2 MONITORING NETWORK REVISIONS

3.2.1 Representative Well Replacements

Representative monitoring wells (RMW) will be replaced when they can no longer be measured with consistency and/or accuracy. The selection of new representative wells prioritizes geographic proximity, consistency in groundwater elevation values and patterns, and similar construction information.

Well 180 (State Well Number (SWN) 12N01W36K002M), in the North Yolo Management Area, has had issues with oil causing questionable measurements for many years. The USBR is now removing the well from the monitoring network. Well 431 (SWN 12N01W26L002M) is approximately 1.3 miles northeast of Well 180, has a period of record dating back to 1964, and displays similar groundwater elevation readings

to Well 180. Table 1 provides the sustainable management criteria and construction information for the current and replacement RMW (Wells 180 and 431, respectively). Replacements of RMWs will be implemented over the course of the following water year.

TABLE 1: REPRESENTATIVE MONITORING WELL REPLACEMENTS

	Current RMW	Replacement RMW
Management Area	North Yolo	North Yolo
RMW Number	180	431
State Well Number	12N01W36K002M	12N01W26L002M
Minimum Threshold, feet DTW[3]	90.2	97.3
Minimum Threshold, feet MSL[4]	-49.7	-43.8
Measurable Objective, feet DTW	48.2	40.4
Measurable Objective, feet MSL	-7.7	13.1
Latitude	38.8436	38.8568
Longitude	-121.9233	-121.9422
Well Use Type	Irrigation	Irrigation
Well Depth, feet	633	240
Perforations, feet	301-633	

3.2.2 Additional Monitoring Sites

Over the course of the 2022 water year, 14 monitoring sites were added to the Yolo Subbasin monitoring network. This includes four real-time sites, two sites equipped with continuous dataloggers, and eight sites that will be measured seasonally in spring and fall of each year. The added sites are summarized in Table 2. Current data for all monitoring wells, including those listed above, is available on the YSGA's groundwater mapping site (sgma.yologroundwater.org). Additionally, data is stored in the Yolo County Water Resources Information Database (WRID; wrid.facilitiesmap.com). As additional data is collected at these sites, representative monitoring wells will be chosen from these locations in data gaps and areas of special concern.

TABLE 2: ADDITIONAL MONITORING SITES

State Well Number	Monitoring Type	Management Area	Latitude	Longitude	Monitoring Start Date
09N01E04Q500M	Real-time	Central Yolo	38.6495	-121.8666	7/31/2021
09N01W29P500M	Spring/fall	Central Yolo	38.5922	-122.0031	8/18/2021
08N01W19R500M	Spring/fall	Central Yolo	38.5213	-122.0113	11/2/2021
10N02W25N500M	Spring/fall	Central Yolo	38.6807	-122.0331	3/21/2022
11N02W35C500M	Real-time	Central Yolo	38.7640	-122.0563	8/11/2022
08N01W31G500M	Continuous	Central Yolo	38.4994	-122.0139	9/29/2022
08N01E11L500M	Spring/fall	Central Yolo	38.5528	-121.8331	10/7/2022
11N02W14Q001M	Spring/fall	Dunnigan Hills	38.7958	-122.0578	9/31/2021
10N01W12R500M	Spring/fall	Dunnigan Hills	38.7244	-121.9164	7/18/2021
11N01W18H501M	Continuous	Dunnigan Hills	38.8061	-122.0078	10/19/2021
11N01W16B500M	Spring/fall	Dunnigan Hills	38.8090	-121.9786	10/19/2021

[3] DTW = Depth to Water
[4] MSL = Mean Surface Level

State Well Number	Monitoring Type	Management Area	Latitude	Longitude	Monitoring Start Date
12N02W26H500M	Real-time	Dunnigan Hills	38.8635	-122.0482	4/22/2022
08N02E14L500M	Real-time	N/A - Solano Subbasin	38.5346	-121.7223	7/19/2022
10N01E11K500M	Spring/fall	North Yolo	38.7249	-121.8272	9/8/2022

3.3 UPCOMING ACTIVITIES FOR WATER YEAR 2023

In 2023, the YSGA will investigate alternative funding mechanisms and voting structures for the long-term implementation of groundwater sustainability in the Yolo Subbasin. The YSGA will also develop Advisory Committees for the six Management Areas within the Subbasin to proceed with local implementation of projects and management actions. These Advisory Committees will be created based on the premise of Article 8 of the YSGA JPA. YSGA staff will work with stakeholders to properly define the roles and responsibilities of the Advisory Committees, defining the authorities provided along with their relationship to the YSGA Board of Directors. In addition, staff will assist with formally documenting the representation and membership of each Management Area Advisory Committee and the level of public involvement by beneficial users within the Subbasin. Once the Advisory Committees are convened, the first task for review and discussion will be an update on current groundwater conditions and the status of sustainability indicators to determine whether any near-term projects or management actions should be implemented to avoid minimum threshold exceedances.

In 2023, the YSGA will participate in a pilot project opportunity to partner with Environmental Defense Fund and California Water Data Consortium in the Groundwater Accounting Platform to assist the YSGA in water budget planning, and scenario planning for multi-water year allotments.

Additionally in 2023, the YSGA welcomes comments and opportunities for improving the 2022 Yolo Subbasin GSP and making progress towards the 5-year update. The YSGA intends to partner with other GSAs in the Sacramento Valley with the facilitation services of the Northern California Water Association to improve the interconnected surface waters sustainability indicators and to establish a more robust monitoring network for preserving and protecting interconnected surface waters and groundwater dependent ecosystems.

The YSGA will continue to coordinate with the County of Yolo to assist them in complying with SB 552 and assist with the thoughtful development of a domestic well mitigation program for the Yolo Subbasin. YSGA staff plan to provide the County and water managers with frequent updates on projected groundwater conditions to best prepare for and manage expectations of Fall 2023 conditions. YSGA staff hope to report back on many dry wells recovering in the deluge of 2023. Additionally, YSGA staff and member agencies are preparing for capture and retention of any excess winter flows for groundwater recharge in Winter 2022/2023.

Lastly, the YSGA looks forward to learning more about DWR's SGMA Implementation Grant Funding award announcements and all future partnerships with state agencies.

4. MONITORING AND CONDITIONS ASSESSMENT

4.1 HYDROLOGIC CONDITIONS

Table 3 provides a summary of Water Years 2019 to 2022 describing water year type, annual precipitation values, and observed changes in groundwater levels. Two critical dry years (2021-2022) following a dry year (2020) resulted in declining groundwater levels as observed in the Yolo Subbasin RMWs updated hydrograph (Figure 2). The wet conditions of 2019 provided for 5 feet of groundwater recovery between Fall 2018 and 2019. The dry and critical conditions of 2020, 2021, and 2022 led to 4 feet, 13 feet, and 5 feet of groundwater decline, consecutively.

TABLE 3: HYDROLOGIC CONDITIONS

Water Year	Sacramento Valley Index[5]	Sac Valley Water Year Type	Yolo County Precipitation[5]	Percent of County Average[6]	Annual Groundwater Change (Fall to Fall)
2019	10.2	Wet	31.8”	157%	+5 ft
2020	6.0	Dry	11.5”	57%	-4 ft
2021	3.8	Critical	7.6”	38%	-13 ft
2022	4.6	Critical	16.8”	83%	-5 ft

4.2 GROUNDWATER ELEVATIONS AND STORAGE

Figure 2 displays the historical average depth to water in the representative monitoring network for Water Year 2022, which includes 62 RMWs. This historical average depth to water hydrograph covers Spring 1975 to Fall 2022. With wet hydrologic conditions, Water Year 2019 provided significant recovery in groundwater levels, showing the highest spring groundwater level in the past eleven years (2011- 2022). A dry Water Year 2020 prevented additional recovery of groundwater levels and stunted a successful 2020 irrigation season. Critical conditions in Water Year 2021 and 2022 led to very limited spring recovery and resulted in an average Spring-to-Fall depth to water decline of 18 feet and 17 feet, respectively.

Figure 3 and Figure 4 display the seasonal high and low groundwater elevation contours for Water Year 2022.

[5] https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance
[6] 20.06” based on 1901-2000 Base Period

FIGURE 2: YOLO SUBBASIN AVERAGE DEPTH TO WATER

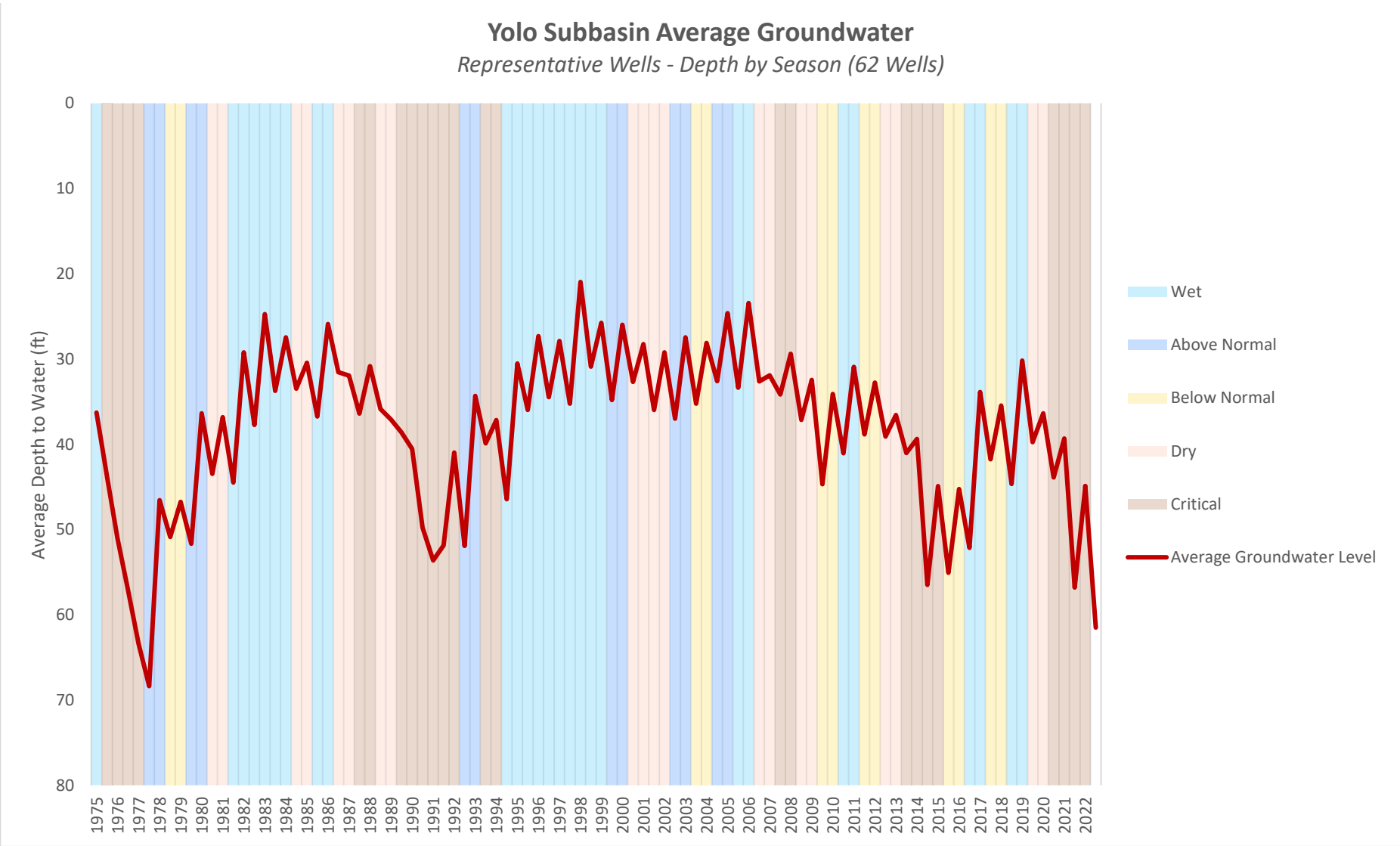


FIGURE 3: GROUNDWATER ELEVATION CONTOUR – SPRING 2022

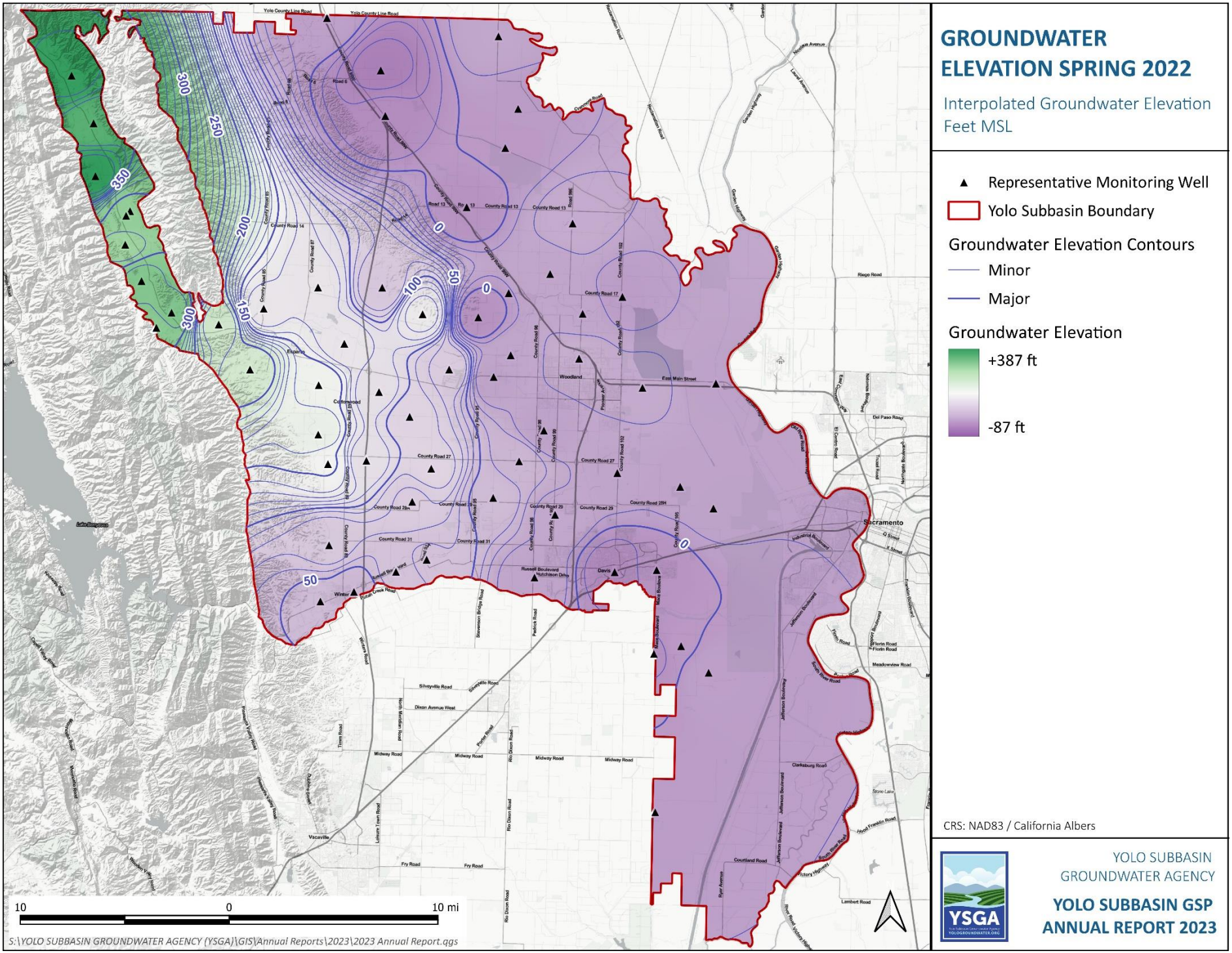


FIGURE 4: GROUNDWATER ELEVATION CONTOUR – FALL 2022

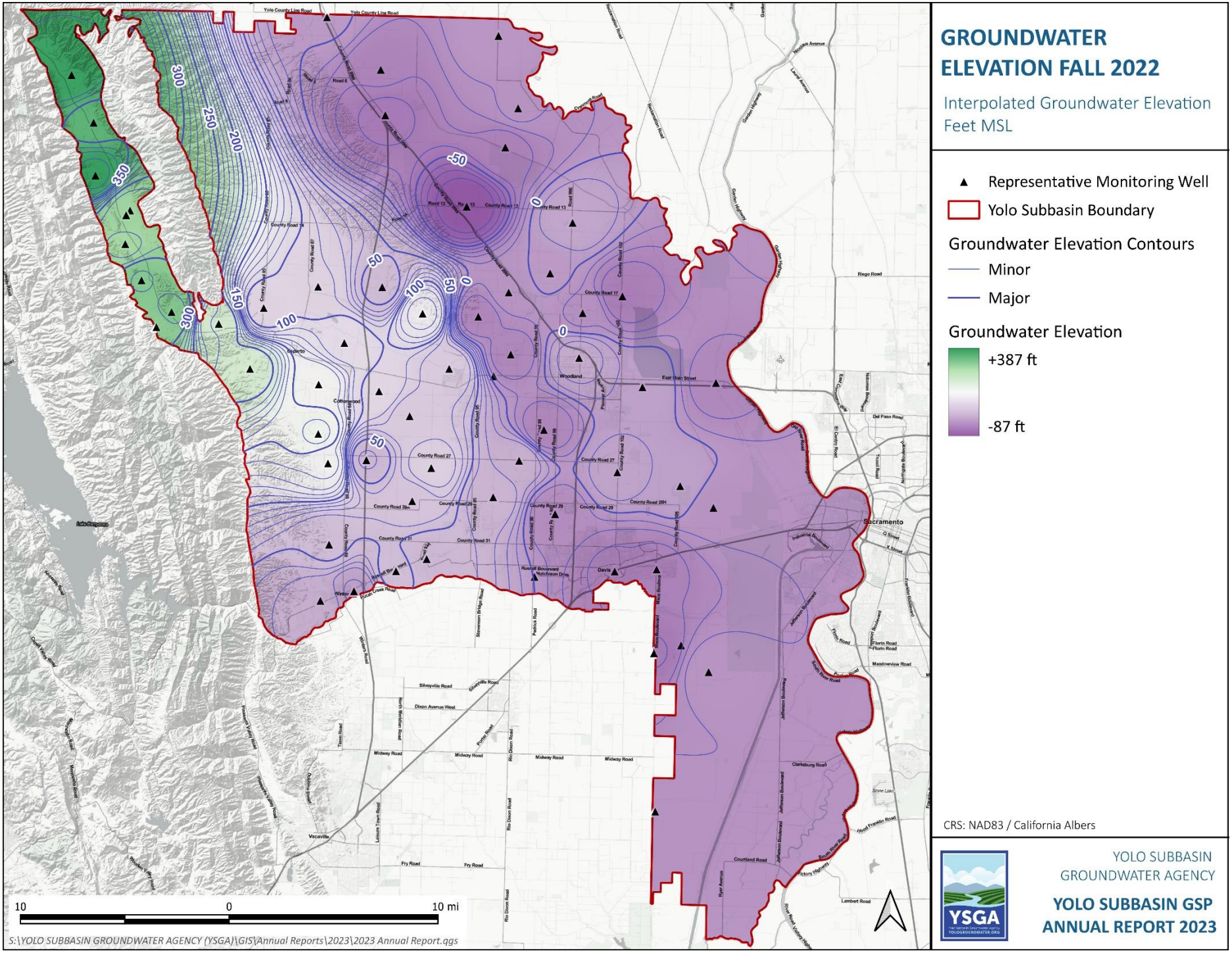


Table 4 through Table 8 show spring and fall groundwater elevation values in the RMWs for each management area and provide a comparison to the sustainable management criteria values as established in the Yolo Subbasin GSP. These RMWs, and the sustainable management criteria assigned to them, represent both the groundwater levels and groundwater storage sustainability indicators. The hydrograph of each of these RMWs is provided in Attachment A.

As stated in the GSP, *"An undesirable result occurs when the minimum threshold criteria is exceeded in 51 percent or more of representative monitoring wells in two (2) MAs."* No basin-wide undesirable results occurred during the 2022 water year according to these criteria. The GSP also establishes an "undesirable result watch area", which is a Management Area "that has triggered the exceedance criteria for an undesirable result for a given sustainability indicator, but where the number of MAs exceeding the criteria has not been reached. An undesirable result watch area triggers responses from the YSGA and its member agencies to address the local conditions of exceeding minimum threshold values to avoid triggering the criteria for a basin-wide undesirable result."

The minimum threshold values listed in Table 4 through Table 8 provide a minimum groundwater level established by the YSGA for each RMW. At a single RMW, the well violates the minimum threshold when the groundwater elevation falls below the designated threshold value for two consecutive years. Fall measurements in which the groundwater elevation fell below the minimum threshold value are highlighted in orange. Five RMWs exceeded the minimum threshold in consecutive years, and three additional RMWs exceeded the minimum threshold for the first time in 2022. Figure 5 provides a map of the representative wells that exceeded the minimum threshold value in Fall 2022.

The measurable objective values provide a single value at each well that the YSGA intends to manage towards in the long term. Also as stated in the GSP, "*Performance of the measurable objective will be measured as the five (5) year running average of the minimum fall (Sep.-Dec.) groundwater elevation."* The last two columns in Table 4 through Table 8 provide the five-year (2018-2022) fall average groundwater elevation, and the difference in feet between the measurable objective value and the five-year average. Due to the historic drought conditions, levels at most RMWs are currently below the measurable objective.

TABLE 4: CAPAY VALLEY REPRESENTATIVE MONITORING WELL GROUNDWATER ELEVATIONS

State Well Number	Representative Well Number	Measurable Objective	Minimum Threshold	Fall 2018	Spring 2019	Fall 2019	Spring 2020	Fall 2020	Spring 2021	Fall 2021	Spring 2022	Fall 2022	5 yr Fall Average	Distance to Measurable Objective
DWR assigned well number	*YSGA GSP Well Number*	*Groundwater Elevation*	*Groundwater Elevation*	*Groundwater Elevation, ft. MSL* *Shaded values are below the minimum threshold value* **** represents no measurement*									*Fall 2018-Fall 2022*	*5-year average minus MO*
10N02W16R001M	276	215.0	207.7	217.0	219.9	216.7	216.2	214.6	214.2	211.2	215.2	209.9	213.9	-1.1
10N02W18F001M	277	315.6	304.2	325.6	312.9	318.5	317.8	325.9	314.8	311.2	314.8	312.2	318.7	3.0
10N03W02R002M	280	319.5	308.2	312.7	322.5	316.6	316.7	313.3	313.4	309.3	312.5	310.2	312.5	-7.0
11N03W09Q001M	285	383.7	355.8	382.2	394.4	384.9	389.3	382.3	381.6	377.6	387.4	382.4	381.9	-1.8
11N03W23L001M	287	296.0	287.6	298.5	301.0	298.9	298.7	298.2	***	285.9	298.6	286.0	293.5	-2.5
11N03W23N001M	288	287.3	271.0	295.3	301.6	298.3	297.5	294.5	289.3	284.4	297.4	286.7	291.9	4.6
11N03W33F001M	289	351.1	341.2	351.5	356.2	351.6	352.0	351.3	351.2	344.4	351.4	345.8	349.0	-2.1
12N03W20D001M	293	382.8	376.4	383.4	387.1	382.4	383.6	382.0	382.4	380.0	383.6	378.0	381.2	-1.6
11N03W35D003M	415	280.7	273.0	***	293.1	282.1	284.1	281.2	283.1	275.9	286.1	278.1	279.3	-1.4
10N03W24B002M	416	324.8	281.1	327.8	345.9	343.7	339.6	327.2	326.6	310.4	305.2	303.1	322.5	-2.4

TABLE 5: NORTH YOLO REPRESENTATIVE MONITORING WELL GROUNDWATER ELEVATIONS

State Well Number	Representative Well Number	Measurable Objective	Minimum Threshold	Fall 2018	Spring 2019	Fall 2019	Spring 2020	Fall 2020	Spring 2021	Fall 2021	Spring 2022	Fall 2022	5 yr Fall Average	Distance to Measurable Objective
DWR assigned well number	*YSGA GSP Well Number*	*Groundwater Elevation*	*Groundwater Elevation*	*Groundwater Elevation, ft. MSL* *Shaded values are below the minimum threshold value* **** represents no measurement*									*Fall 2018-Fall 2022*	*5-year average minus MO*
11N01E02D001M	127	-13.3	-88.3	-17.4	16.2	-10.3	7.6	-27.2	5.6	-37.1	0.5	-33.1	-25.0	-11.7
11N01E16P001M	128	-33.1	-129.8	0.4	26.3	-24.1	17.3	-25.9	10.5	-58.5	-8.0	-86.9	-39.0	-5.9
12N01E03R002M	129	9.1	-44.3	-1.0	20.6	3.5	19.2	-9.0	15.3	-12.9	16.3	-2.9	-4.5	-13.6
12N01E26A002M	131	-4.2	-46.1	-5.0	19.3	-2.0	13.0	-12.5	5.6	-29.7	3.3	-8.6	-11.6	-7.4
10N03E33B011M	153	3.8	-73.3	8.6	***	7.5	14.2	3.1	11.3	1.7	10.8	-23.4	-0.5	-4.3
12N01W14M001M	178	10.5	-30.9	-7.5	19.3	-7.5	10.8	-14.9	-5.9	-29.5	-33.7	-28.5	-17.6	-28.1
12N01W26L002M	431	13.1	-43.8	-12.8	10.5	-5.6	6.0	-16.3	-9.2	-35.3	-17.3	-41.7	-22.4	-35.4
10N01E02Q002M	251	32.1	-32.6	17.1	40.4	20.3	32.6	17.6	22.5	***	***	-6.4	12.1	-20.0
10N02E06B001M	405	26.0	-85.7	18.6	37.6	28.6	29.6	23.6	25.0	-8.1	15.6	1.7	12.9	-13.2
12N01W05B001M	411	49.5	-25.3	18.7	30.5	20.6	25.6	15.5	16.5	4.4	8.6	0.9	12.0	-37.5
10N02E09N001M	410	12.9	-63.7	7.3	36.6	23.0	28.0	17.1	23.2	-3.4	15.7	-11.3	6.5	-6.4
10N02E03R002M	420	12.2	-39.2	-9.8	31.8	6.5	22.3	***	15.7	***	4.4	-36.7	-13.4	-25.6
11N02E20K004M	421	28.8	-31.6	25.7	33.4	29.5	32.9	26.8	29.1	20.9	24.4	17.1	24.0	-4.9

TABLE 6: CENTRAL YOLO REPRESENTATIVE MONITORING WELL GROUNDWATER ELEVATIONS

State Well Number	Representative Well Number	Measurable Objective	Minimum Threshold	Fall 2018	Spring 2019	Fall 2019	Spring 2020	Fall 2020	Spring 2021	Fall 2021	Spring 2022	Fall 2022	5 yr Fall Average	Distance to Measurable Objective
DWR assigned well number	*YSGA GSP Well Number*	*Groundwater Elevation*	*Groundwater Elevation*	*Groundwater Elevation, ft. MSL* *Shaded values are below the minimum threshold value* **** represents no measurement*									*Fall 2018-Fall 2022*	*5-year average minus MO*
08N02E15A002M	114	-25.1	-61.3	***	***	0.4	16.8	-9.6	10.0	-28.6	-15.8	-31.2	-17.3	7.9
08N03E07N001M	132	-22.0	-78.0	***	***	***	***	***	***	-28.9	-7.5	-32.3	***	***
09N03E33B002M	151	4.7	-35.3	4.8	19.0	3.6	15.0	-2.1	12.9	-4.2	11.4	-9.3	-1.5	-6.2
08N02E18M002M	170	20.4	1.5	18.5	30.1	27.7	***	20.9	22.5	8.9	14.1	5.5	16.3	-4.1
08N01E07R001M	220	82.3	16.5	60.5	87.6	74.1	72.2	***	65.1	46.5	59.6	42.5	55.9	-26.3
08N01W09C001M	222	110.9	40.3	72.0	92.6	78.2	82.6	85.4	88.6	69.0	73.9	51.9	71.3	-39.6
08N01W13G003M	224	80.0	47.8	70.9	***	78.4	77.8	71.8	73.3	58.8	61.4	53.3	66.6	-13.4
08N01W20R005M	229	72.8	36.4	44.7	75.4	60.9	72.0	45.0	59.6	31.2	47.2	26.1	41.6	-31.2
10N01E34A003M	430	27.6	-47.4	11.0	42.0	28.0	35.5	18.6	25.9	***	11.1	***	19.2	***
09N01E07D001M	231	111.1	68.3	102.4	109.6	104.7	104.5	99.2	97.2	76.5	93.0	75.7	91.7	-19.4
09N01E20E001M	233	104.8	67.1	106.7	108.8	106.0	105.0	105.7	98.9	91.7	94.7	85.7	99.2	-5.6
09N01E24D001M	234	52.2	7.6	41.5	51.5	49.5	47.3	45.3	40.7	29.1	36.4	27.4	38.6	-13.6
09N01E31D001M	235	104.6	68.3	103.7	111.3	106.1	100.7	101.8	92.6	70.9	79.0	64.8	89.4	-15.2
09N01W08Q001M	239	185.1	152.2	185.7	186.3	184.7	178.3	184.5	174.9	172.9	168.9	161.1	177.8	-7.3
09N01W21E001M	240	163.4	144.7	160.4	171.1	153.7	165.1	162.4	159.4	149.5	150.3	141.9	153.6	-9.8
09N02E07L001M	246	24.7	-45.4	2.2	37.6	18.4	28.2	***	23.4	-19.6	10.2	-26.8	-6.5	-31.1
09N02E32M001M	248	29.1	-7.0	16.2	44.2	27.1	32.7	21.6	27.2	-2.7	18.4	-18.1	8.8	-20.3
09N03E19R002M	250	6.7	-14.1	2.5	18.7	3.3	15.0	-0.6	12.9	-6.0	12.7	9.8	1.8	-4.9
10N01E23Q002M	254	26.8	-43.0	16.8	44.9	31.7	37.7	23.0	29.6	-12.2	16.0	-25.0	6.9	-20.0
10N01E29K001M	256	77.8	58.4	80.0	87.2	81.8	80.8	80.2	79.5	77.2	79.4	77.5	79.3	1.5
10N01W08B001M	261	139.5	73.3	136.0	144.9	141.9	140.5	137.3	135.7	106.9	123.3	90.4	122.5	-17.1
10N01W21J001M	265	127.5	90.9	127.5	137.0	130.6	131.2	129.7	129.3	115.4	124.4	106.1	121.9	-5.7
10N01W32E001M	268	169.9	144.5	169.6	174.9	169.6	167.1	168.6	164.1	152.0	158.2	146.8	161.3	-8.6
10N01W35Q001M	269	120.5	93.0	121.9	128.7	124.0	116.2	123.3	110.0	104.8	113.4	98.8	114.5	-6.0
10N02W14A001M	275	137.8	91.1	136.0	148.7	138.4	138.8	137.2	134.1	104.8	125.4	91.3	121.6	-16.2
10N02W26P001M	279	241.7	212.7	220.6	225.6	219.7	221.4	211.2	***	***	207.7	207.0	214.6	-27.2
10N02E29A001M	406	35.7	9.9	29.6	38.3	35.9	37.4	***	***	***	26.5	23.7	29.7	-6.0
09N02E22H002M	400	22.9	-24.8	22.4	28.6	26.8	28.4	23.3	24.2	14.0	14.3	13.2	19.9	-3.0
10N02E36E001M	401	22.1	9.0	20.4	28.7	19.8	25.8	19.6	23.6	14.1	22.0	9.4	16.6	-5.5
09N01E26N001M	403	71.7	32.2	53.5	76.3	66.1	64.8	61.0	58.7	46.3	46.6	35.4	52.4	-19.3
09N01W23D001M	404	135.8	82.9	119.7	136.0	128.6	122.1	122.8	121.6	67.9	113.2	39.5	95.7	-40.1
08N01W22G500M	419	71.9	6.5	39.5	79.5	58.5	78.5	47.5	62.5	16.5	41.5	9.5	34.3	-37.6

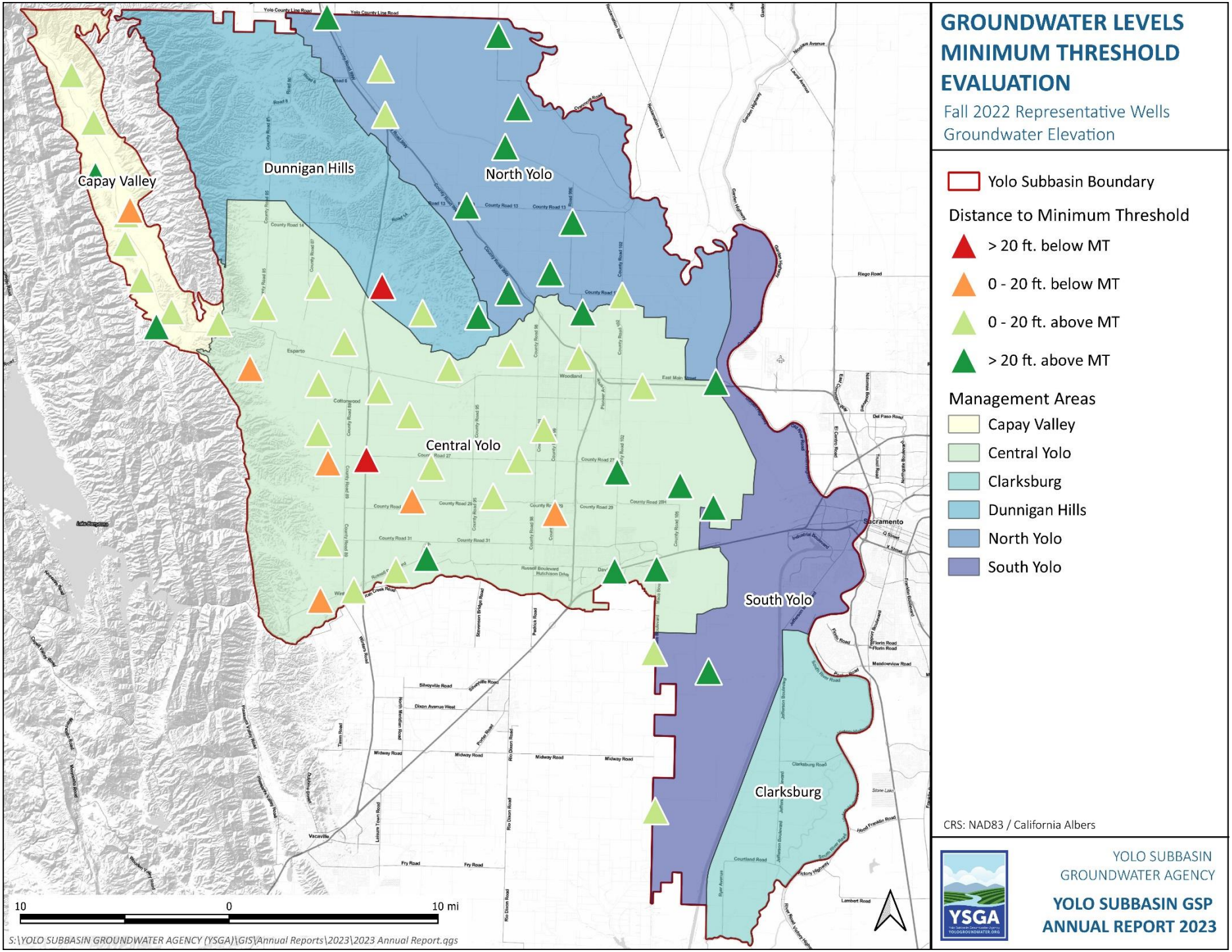
TABLE 7: SOUTH YOLO REPRESENTATIVE MONITORING WELL GROUNDWATER ELEVATIONS

State Well Number	Representative Well Number	Measurable Objective	Minimum Threshold	Fall 2018	Spring 2019	Fall 2019	Spring 2020	Fall 2020	Spring 2021	Fall 2021	Spring 2022	Fall 2022	5 yr Fall Average	Distance to Measurable Objective
DWR assigned well number	*YSGA GSP Well Number*	*Groundwater Elevation*	*Groundwater Elevation*	*Groundwater Elevation, ft. MSL* *Shaded values are below the minimum threshold value* **** represents no measurement*									*Fall 2018-Fall 2022*	*5-year average minus MO*
08N03E32L001M	122	-1.9	-71.8	-10.1	16.4	-56.5	8.8	-18.4	2.9	-31.1	-0.6	***	-29.0	-27.1
06N03E07M001M	160	9.9	-10.8	-2.8	14.7	-2.0	12.2	-5.4	***	-7.0	4.7	-7.9	-5.0	-14.9
08N03E31N001M	422	-7.0	-49.3	-10.2	14.3	-9.0	2.9	-20.8	***	-34.2	-12.1	-40.3	-22.9	-15.8
07N03E04Q001M	423	0.5	-27.1	-1.4	16.9	-0.9	7.7	***	***	-7.7	7.4	-6.0	-4.0	-4.5

TABLE 8: DUNNIGAN HILLS MONITORING WELL GROUNDWATER ELEVATIONS

State Well Number	Representative Well Number	Measurable Objective	Minimum Threshold	Fall 2018	Spring 2019	Fall 2019	Spring 2020	Fall 2020	Spring 2021	Fall 2021	Spring 2022	Fall 2022	5 yr Fall Average	Distance to Measurable Objective
DWR assigned well number	*YSGA GSP Well Number*	*Groundwater Elevation*	*Groundwater Elevation*	*Groundwater Elevation, ft. MSL* *Shaded values are below the minimum threshold value* **** represents no measurement*									*Fall 2018-Fall 2022*	*5-year average minus MO*
10N01E18C001M	253	143.1	132.8	137.8	138.0	140.1	137.5	138.5	135.4	134.5	133.8	132.9	136.8	-6.3
10N01W02Q001M	260	128.3	73.6	76.8	94.6	86.0	91.0	79.8	78.4	46.2	71.6	46.1	67.0	-61.3
10N01E15D001M	402	17.5	-69.6	-53.0	6.3	5.1	17.7	-2.3	7.4	-23.6	-9.6	-26.6	-20.1	-37.6

FIGURE 5: GROUNDWATER LEVELS MINIMUM THRESHOLD EVALUATION



4.3 GROUNDWATER QUALITY

Groundwater quality data for arsenic, boron, nitrate, and total dissolved solids (TDS) are summarized in Figure 5 through Figure 13. Each figure visualizes measured values for each constituent in 2022 along with the percentage change in each constituent from 2020 to 2022 (where applicable). Groundwater quality measurements were aggregated from the SWRCB's Groundwater Ambient Monitoring and Assessment Program (GAMA) dataset[7].

4.3.1 Arsenic

A total of 46 wells were measured for arsenic concentration in the Yolo Subbasin in 2022, and five wells exceeded the maximum contaminant level (MCL) of 10 µg/L. Of those five, two were in the Monument Hill area, one was within the Yolo County central landfill, one was in Knights Landing, and one was in the Dunnigan Hills area (Figure 6).

22 wells were measured for arsenic more than once between 2020 to 2022 and could be used to calculate percentage change in arsenic over that time period. The largest single well increase was 85% from a well in southern Dunnigan, and another well in the immediate vicinity increased by 67%. Neither increase represents an exceedance of the MCL, as the most recent measured arsenic concentrations for each site are 5 µg/L and 4 µg/L, respectively. The other major increase over this period did, however, translate to an exceedance of the arsenic MCL, as one of the wells in the Monument Hill area rose by 83% to climb to a maximum of 13 µg/L in 2022 (Figure 7).

4.3.2 Boron

There is no established MCL for boron, but any measurement over 1 mg/L exceeds the California State Notification Level (NL). Higher than average boron concentrations in the Yolo Subbasin appear to be clustered in the Knights Landing area and in the areas along Cache Creek between Esparto and Woodland. Each of the wells measured in these areas in 2022 surpass the NL of 1 mg/L (Figure 8).

11 wells were measured for boron in both 2020 and 2022, and most of them were located within the City of Davis. Overall, boron concentrations appear to be slightly increasing in the City, with a maximum increase of 11% between 2020 and 2022 (Figure 9). Throughout the entire Subbasin, boron concentrations have increased by around 3% from 2020 to 2022.

4.3.3 Nitrate

114 wells were measured for nitrate at least once in 2022, and 14 of these wells exceeded the nitrate MCL of 10 mg/L. Wells that exceed the MCL are scattered in numerous places within the Yolo Subbasin, but many of them seem to be clustered in rural areas on the outskirts of cities like Davis and Winters (Figure 10).

96 wells have nitrate concentration measurements for both 2020 and 2022. It is difficult to determine a pattern in the rise and fall of nitrate concentrations within the Subbasin, as many wells with significant increases also have nearby wells with large decreases over the same time period. Major increases like the 1750% increase in the City of Woodland and the 1575% increase in southern Dunnigan do not represent violations of the MCL, rather they represent a very small value rising to a value that comes close to surpassing the MCL (7.4 mg/L and 6.7 mg/L respectively). Many wells in the City of Davis and

[7] https://www.waterboards.ca.gov/gama/

the surrounding area have experienced 40-50% decreases in nitrate concentrations, with some wells decreasing by up to 75%. (Figure 11).

4.3.4 Total Dissolved Solids

Sustainable management criteria were established for total dissolved solids (TDS) in the Yolo Subbasin GSP as follows:

> *A representative monitoring well violates the minimum threshold when the total dissolved solids concentration exceeds 1,000 ppm over a three (3) year rolling average.*
>
> *A representative monitoring well violates the measurable objective when the total dissolved solids concentration exceeds 750 ppm over a three (3) year rolling average.*

Of the 33 wells measured for TDS in the Subbasin during the 2022 water year, none exceeded the 1000 ppm TDS minimum threshold, and only five wells exceeded the 750 ppm measurable objective value. Of these five, one is violating the measurable objective as it has exceeded 750 ppm each time it has been measured in 2020, 2021, and 2022 (Figure 12).

14 wells in the Subbasin were measured for TDS concentration more than once between 2020 to 2022 and could be used to calculate percentage change in TDS concentration over time. The largest TDS increase for a single well over the two-year period was 77%, and the largest decrease was -34%. The average percentage change throughout the whole Subbasin was an increase of about 2% (Figure 13).

FIGURE 6: WATER QUALITY – ARSENIC, 2022

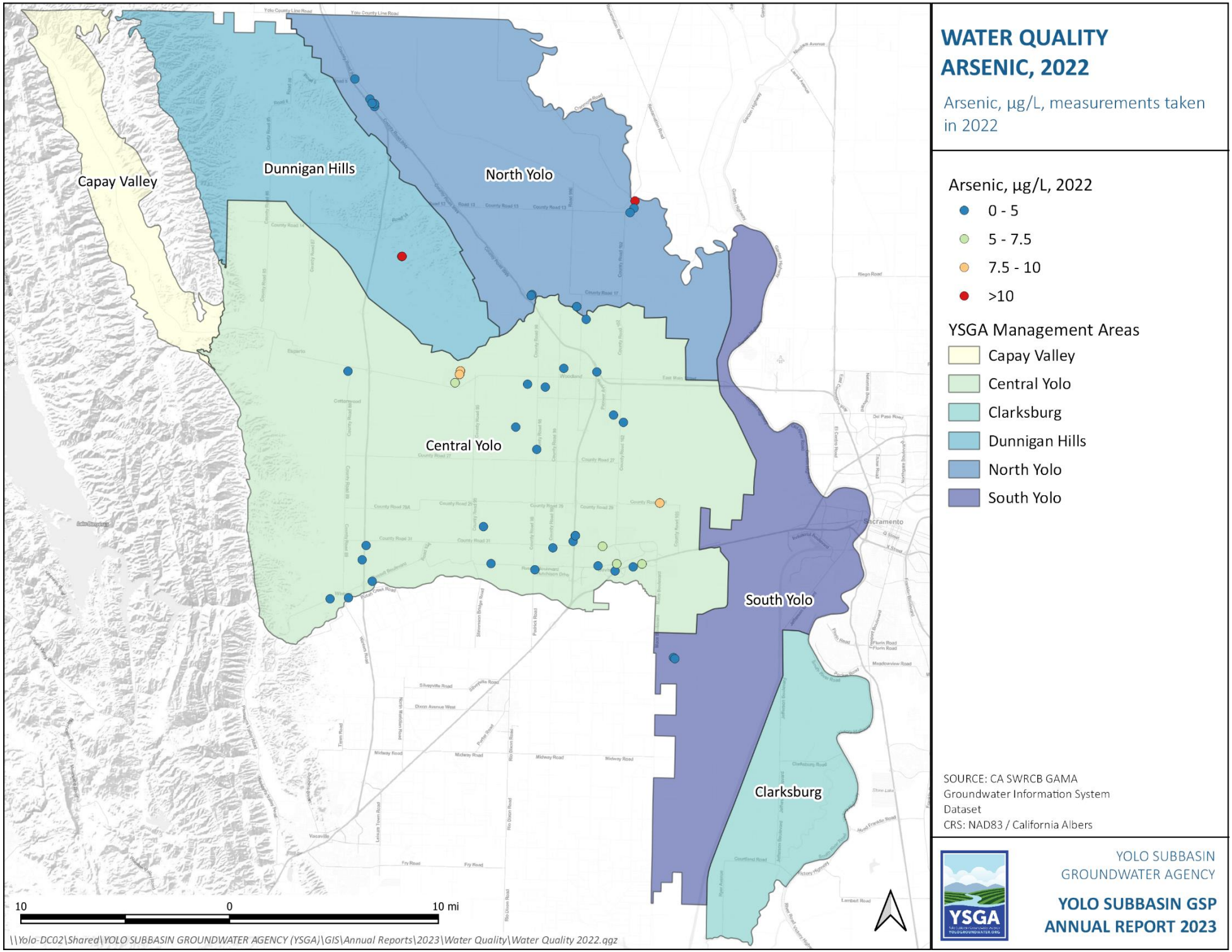


FIGURE 7: WATER QUALITY – ARSENIC, % CHANGE 2020-2022

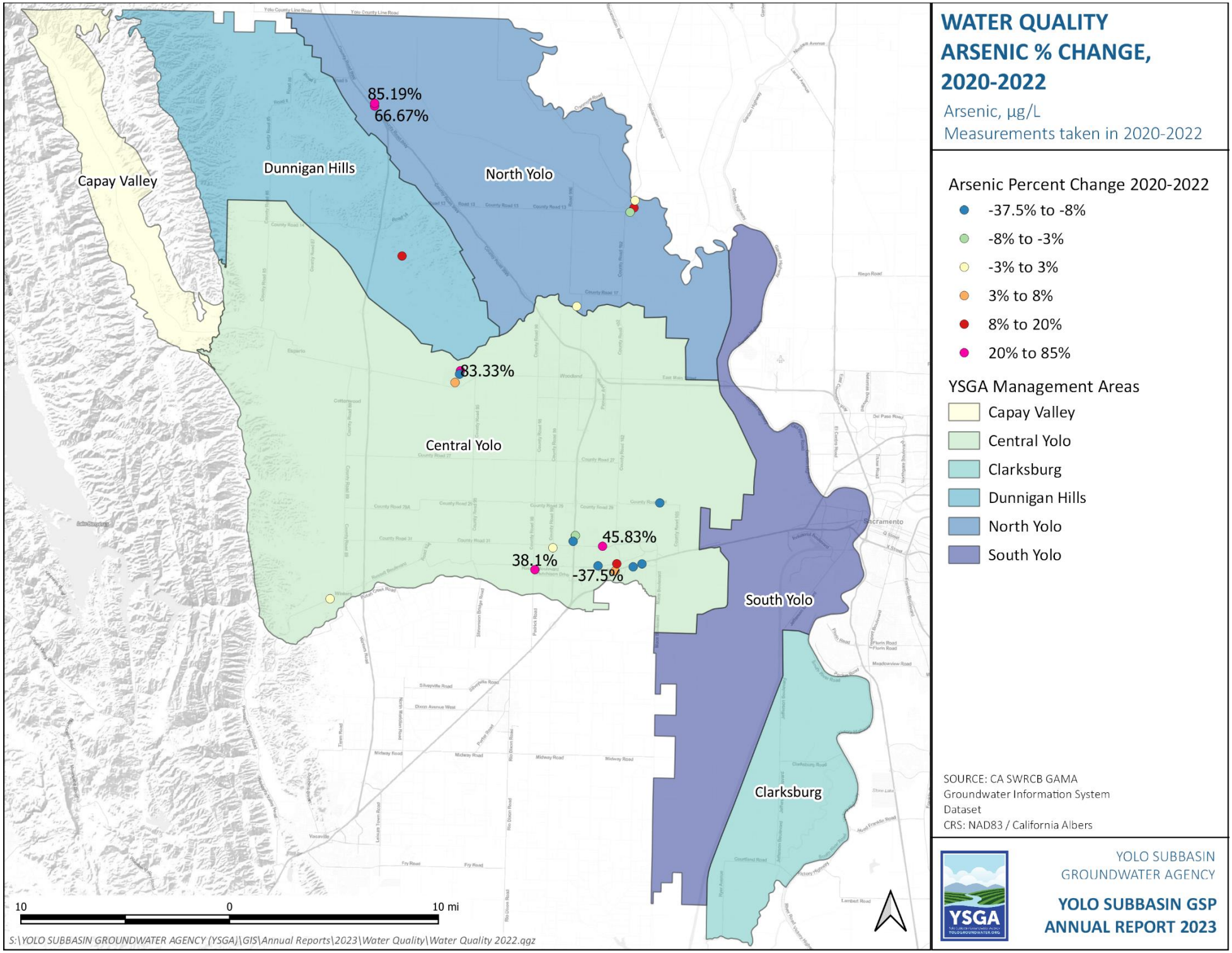


FIGURE 8: WATER QUALITY – BORON, 2022

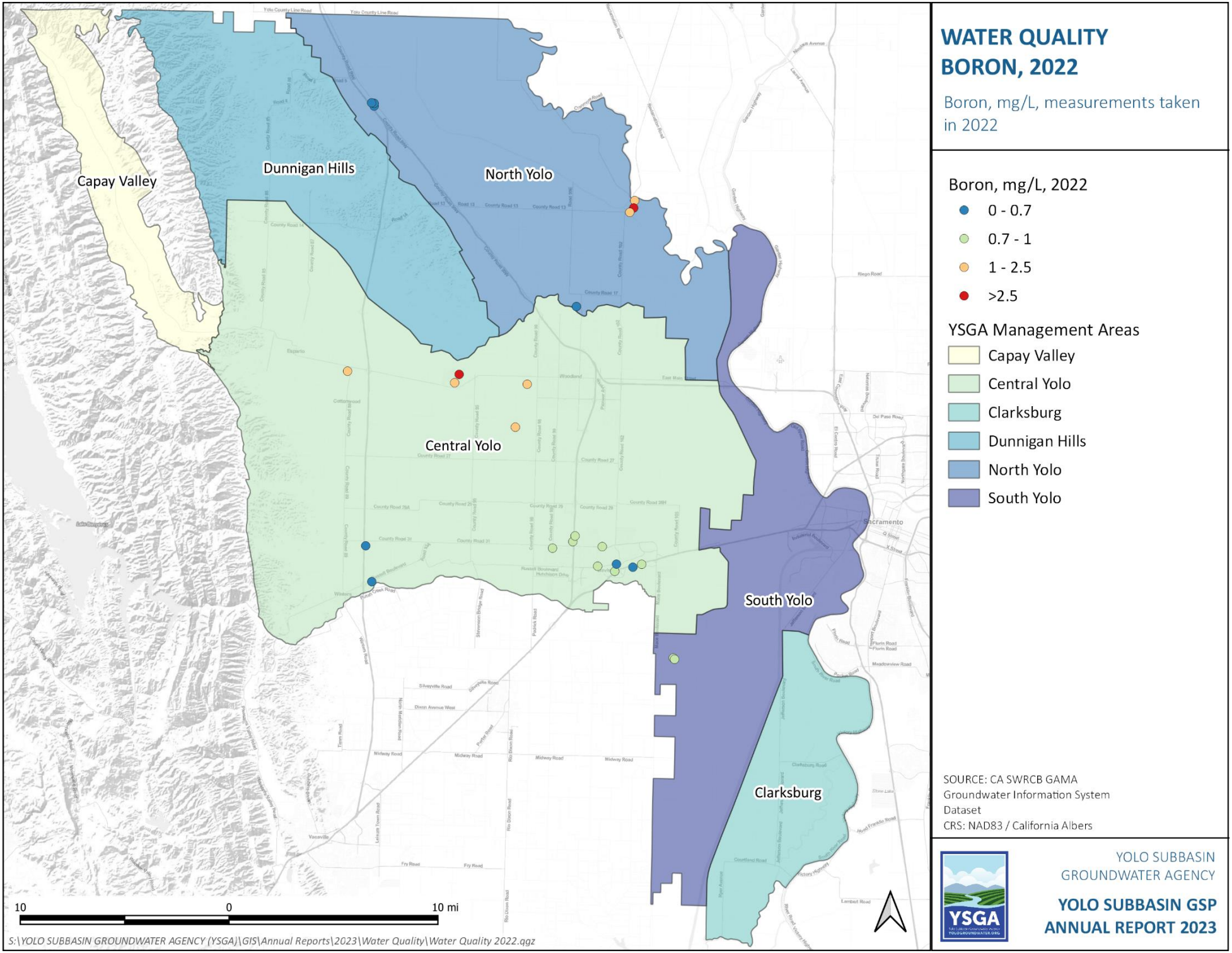


FIGURE 9: WATER QUALITY – BORON, % CHANGE 2020-2022

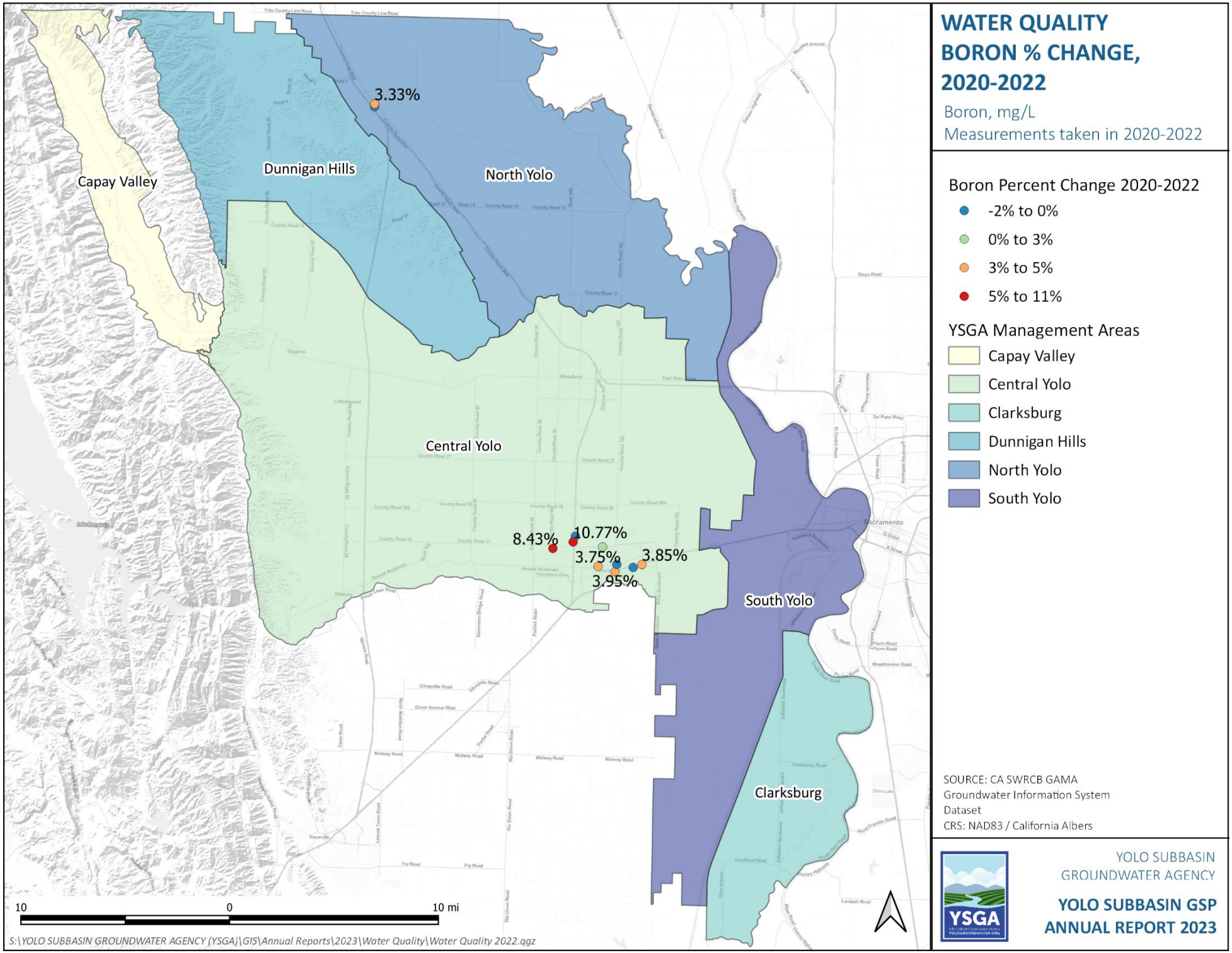


FIGURE 10: WATER QUALITY – NITRATE (AS N), 2022

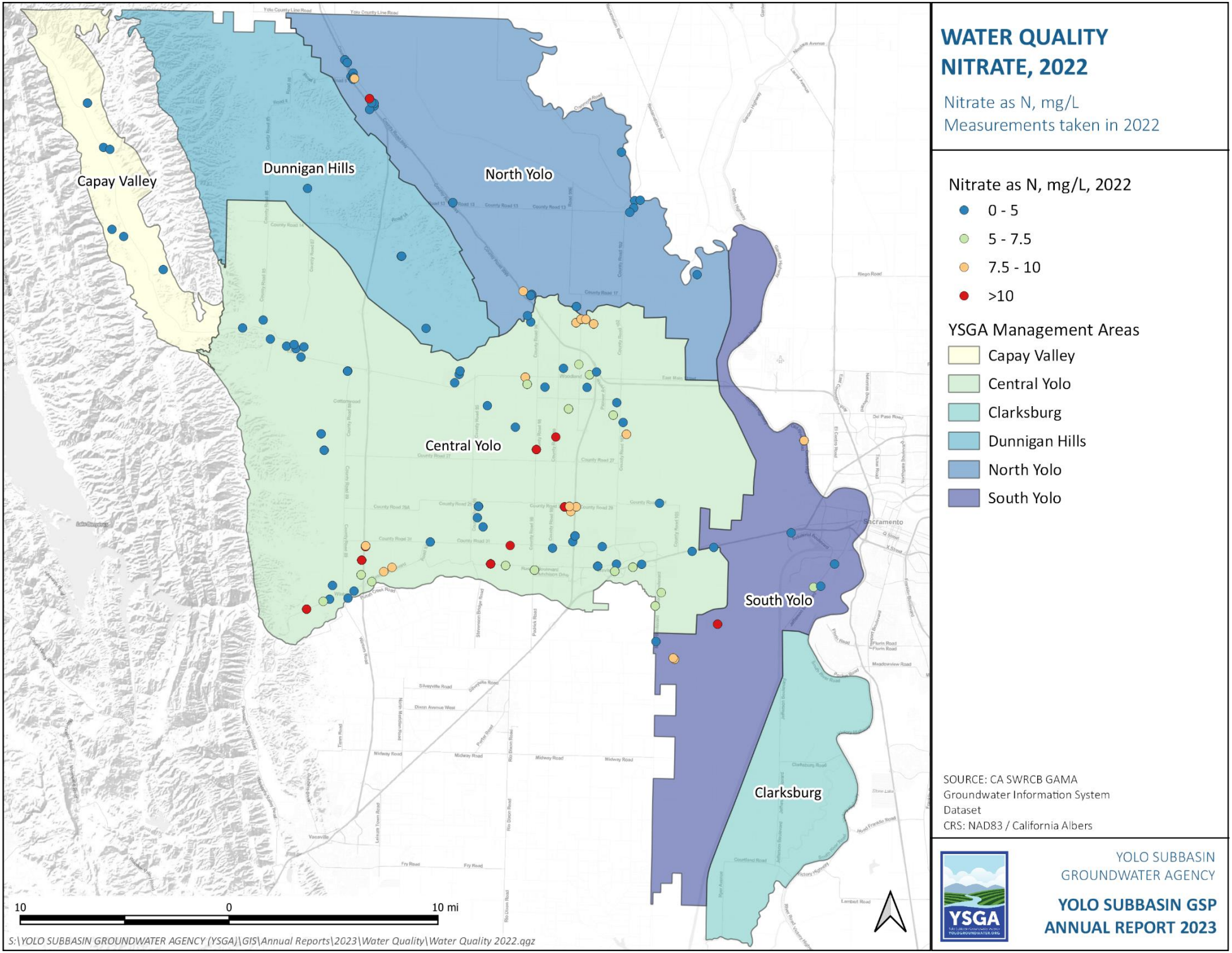


FIGURE 11: WATER QUALITY – NITRATE (AS N), % CHANGE 2020-2022

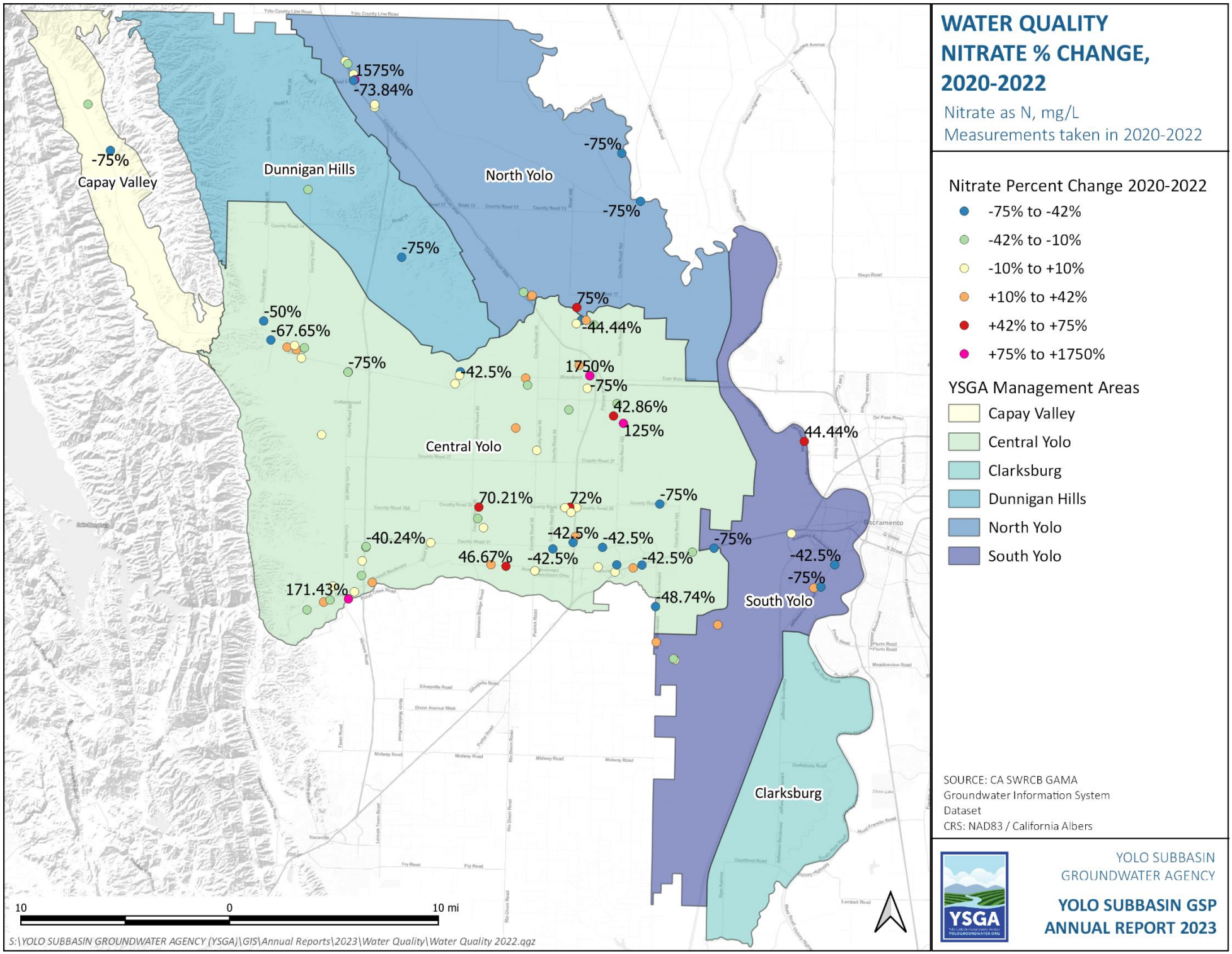


FIGURE 12: WATER QUALITY -- TDS, 2022

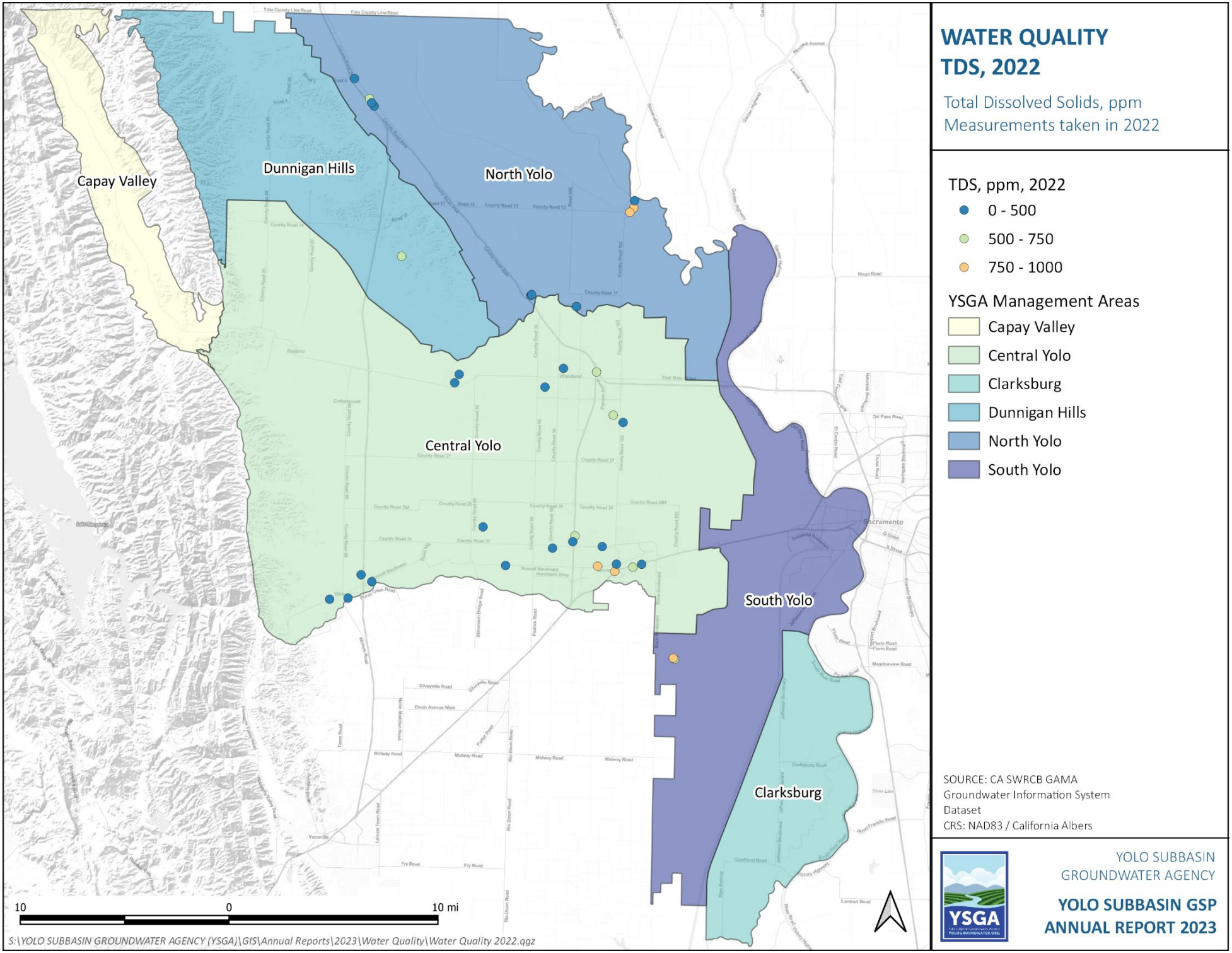
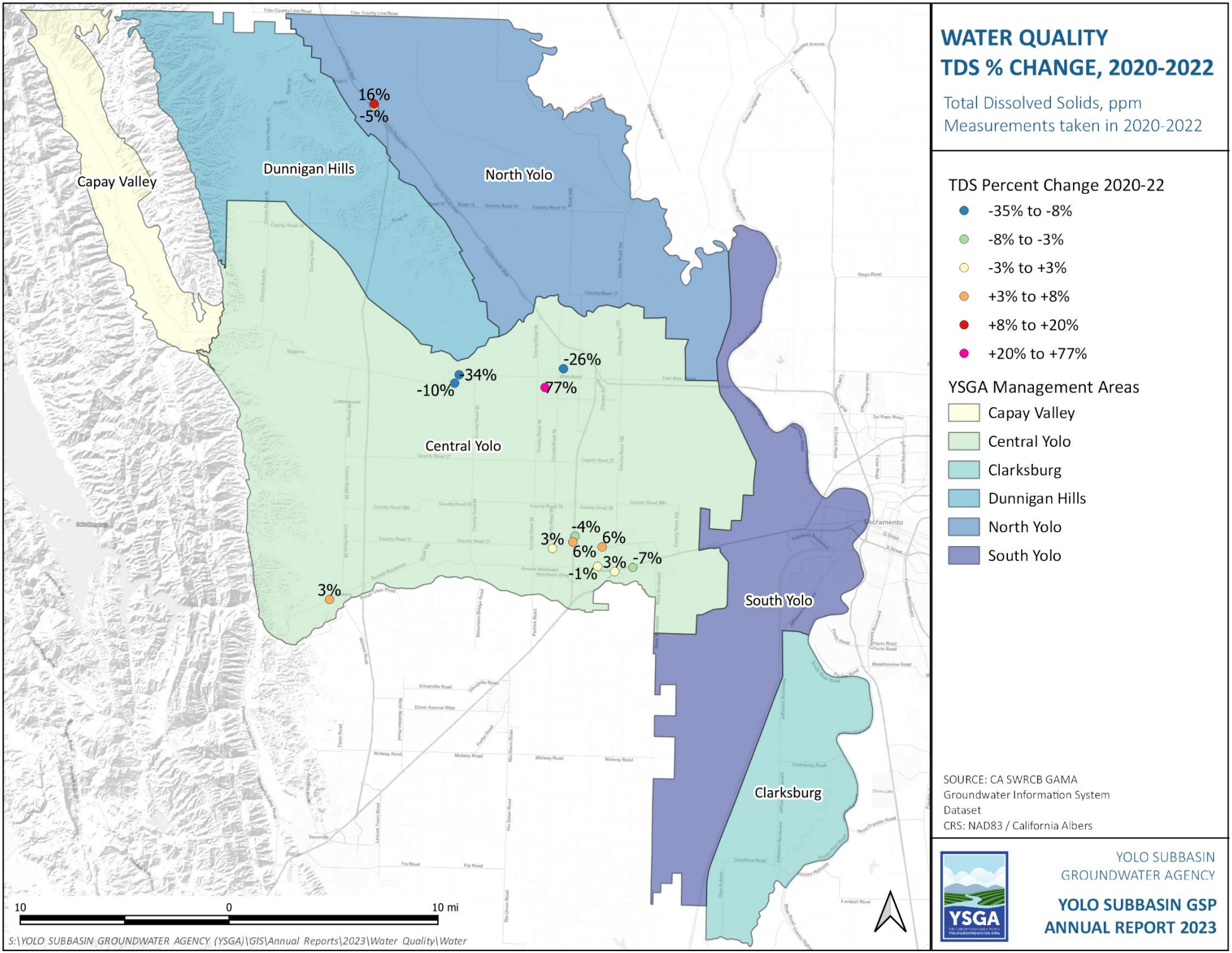


FIGURE 13: WATER QUALITY – TDS, % CHANGE 2020-2022



4.4 LAND SUBSIDENCE

Land deformation occurs as both surface subsidence and surface uplifting and the Yolo Subbasin experiences both processes. Historically, steady levels of subsidence have been documented in the east portion of the Central Yolo Management Area and almost the entire portion of the North Yolo Management Area. A slight amount of uplift has been observed in the western portion of the Central Yolo Management Area.

The source of the land subsidence data discussed below is the TRE Altamira InSAR Vertical Displacement dataset provided by DWR, available on SGMA Data Viewer. This data uses radar data from the Sentinel-1 satellites to calculate changes in land surface elevation (known as vertical displacement). The reported statewide accuracy of the data is 18 mm, or 0.059 feet[8]. The dataset shows several pockets in the Yolo Subbasin where there are indications of subsidence and changes in the Subbasin's surface elevation.

Figure 14 shows the remotely sensed vertical displacement from Water Year 2022. The larger region of subsidence in the central portion of the Subbasin was newly detected in Water Year 2021. With the extenuating drought, this region continued to subside in Water Year 2022. Deformation peaked in July 2022, with subsidence rates up to 0.4 ft/year in the areas of highest severity – County Road 95 between State Highway 16 and County Road 29, the southwestern base of the Dunnigan Hills, and the North Yolo Management Area east of the town of Dunnigan. Since July 2022 it appears there has been stabilization of the subsidence trend. The full extent and potential elasticity of the subsidence observed in Water Years 2021 and 2022 will be determined from subsequent analyses using data provided by DWR's future updates, and any local ground-based GPS surveys.

According to the Yolo Subbasin GSP, land subsidence measurable objective values are to be evaluated against the rolling 3-year average vertical displacement. Figure 15 shows the calculated 3-year average vertical displacement between Water Years 2020 and 2022, and Figure 16 provides a comparison between this calculated value and the established measurable objective values. The newly observed region of subsidence in the center of the Subbasin, as well as the region east of Dunnigan, are the primary areas showing exceedance of the measurable objectives.

Minimum threshold values are to be evaluated against the rolling 5-year average vertical displacement. Figure 17 shows the calculated 5-year average vertical displacement between Water Years 2017 and 2022, and Figure 18 provides a comparison between this calculated value and the established minimum threshold values. The areas of highest severity east of the town of Dunnigan, along the base of the Dunnigan Hills, and along County Road 95 (between State Highway 16 and County Road 29) are beginning to show exceedance of the minimum threshold values.

[8] https://data.cnra.ca.gov/dataset/5e2d49e1-9ed0-425e-9f3e-2cda4a213c26/resource/a1949b59-2435-4e5d-bb29-7a8d432454f5/download/insar-data-accuracy-report-towill.pdf

FIGURE 14: VERTICAL DISPLACEMENT – WATER YEAR 2022

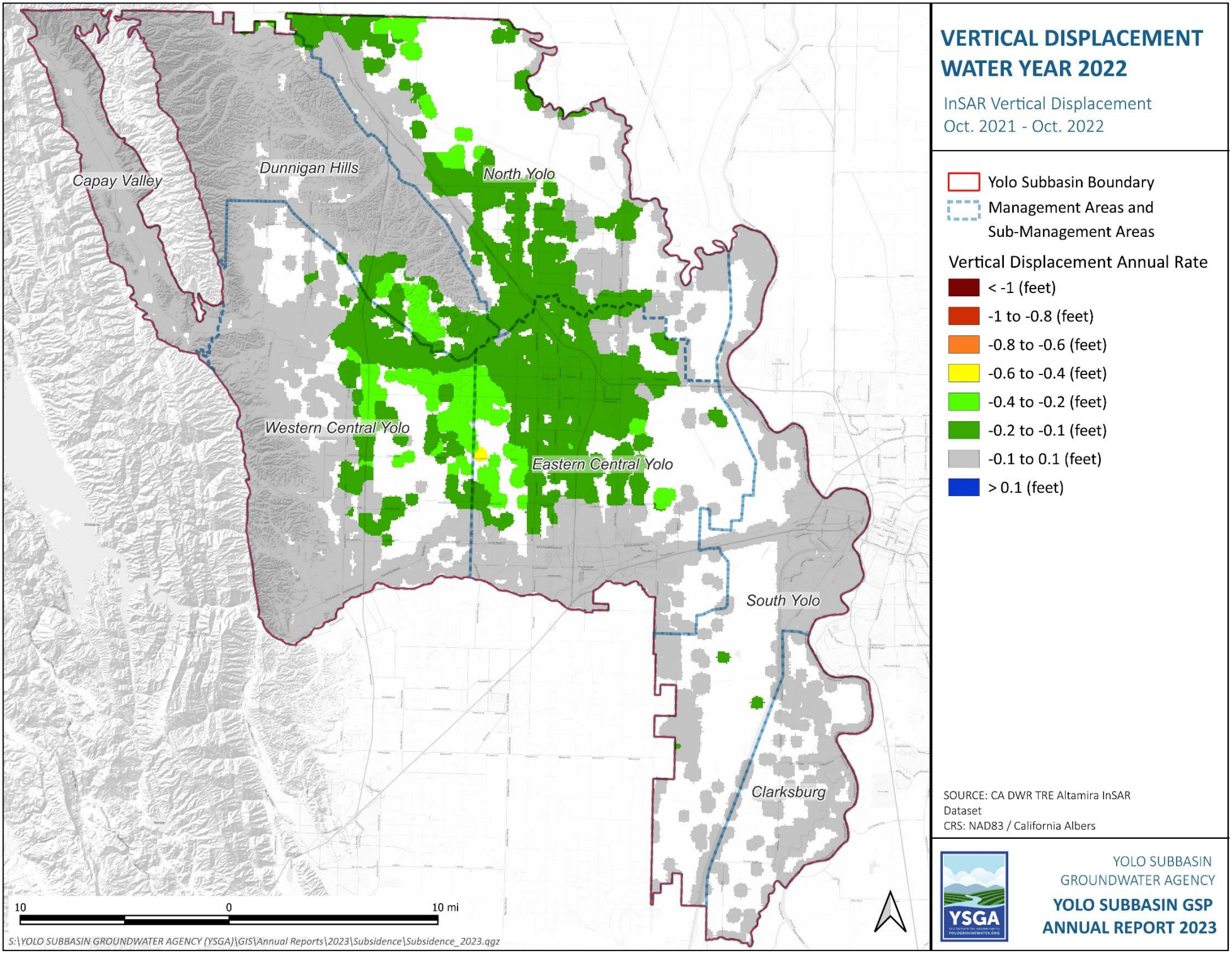


FIGURE 15: VERTICAL DISPLACEMENT – 3 YEAR AVERAGE

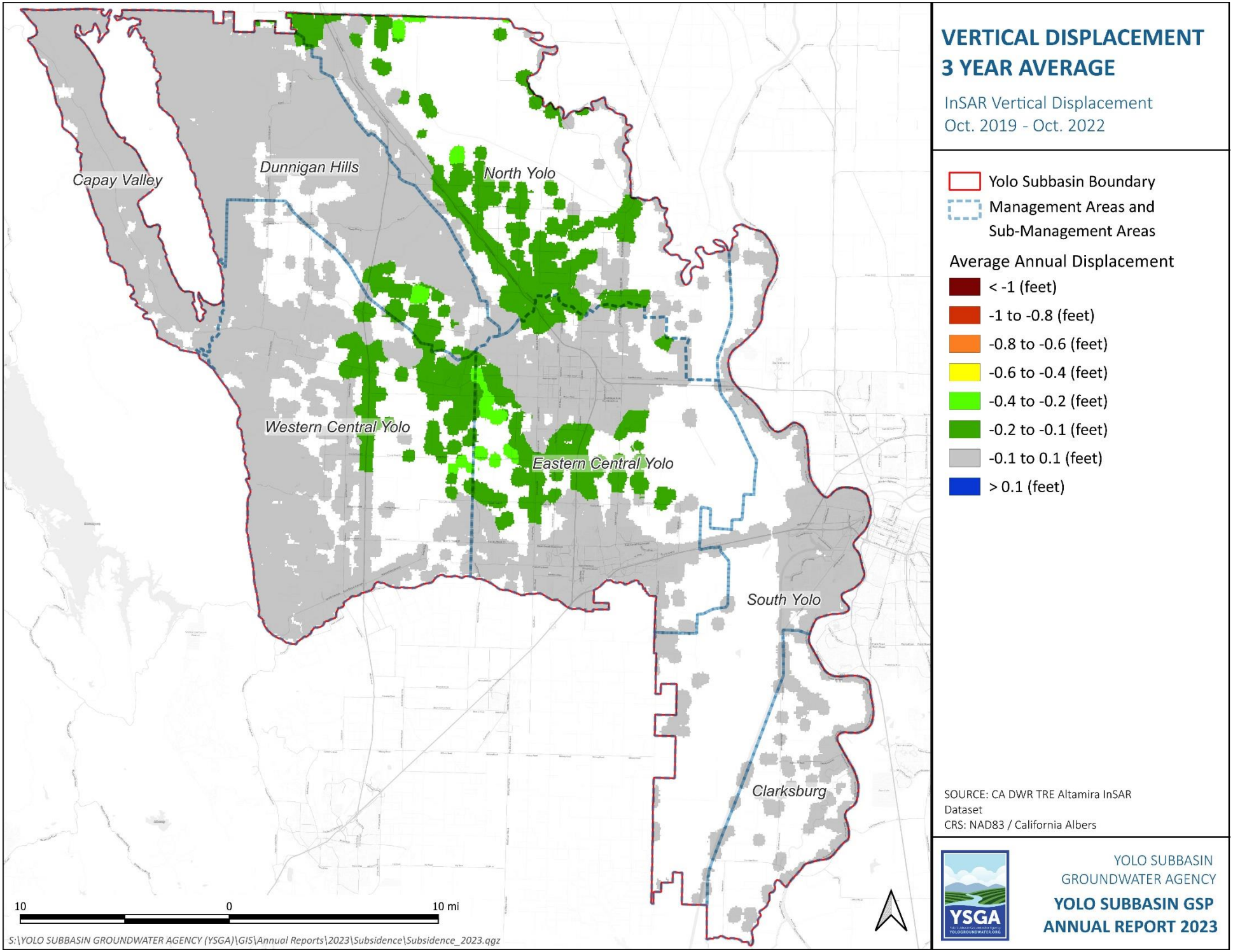


FIGURE 16: LAND SUBSIDENCE MEASURABLE OBJECTIVE EVALUATION

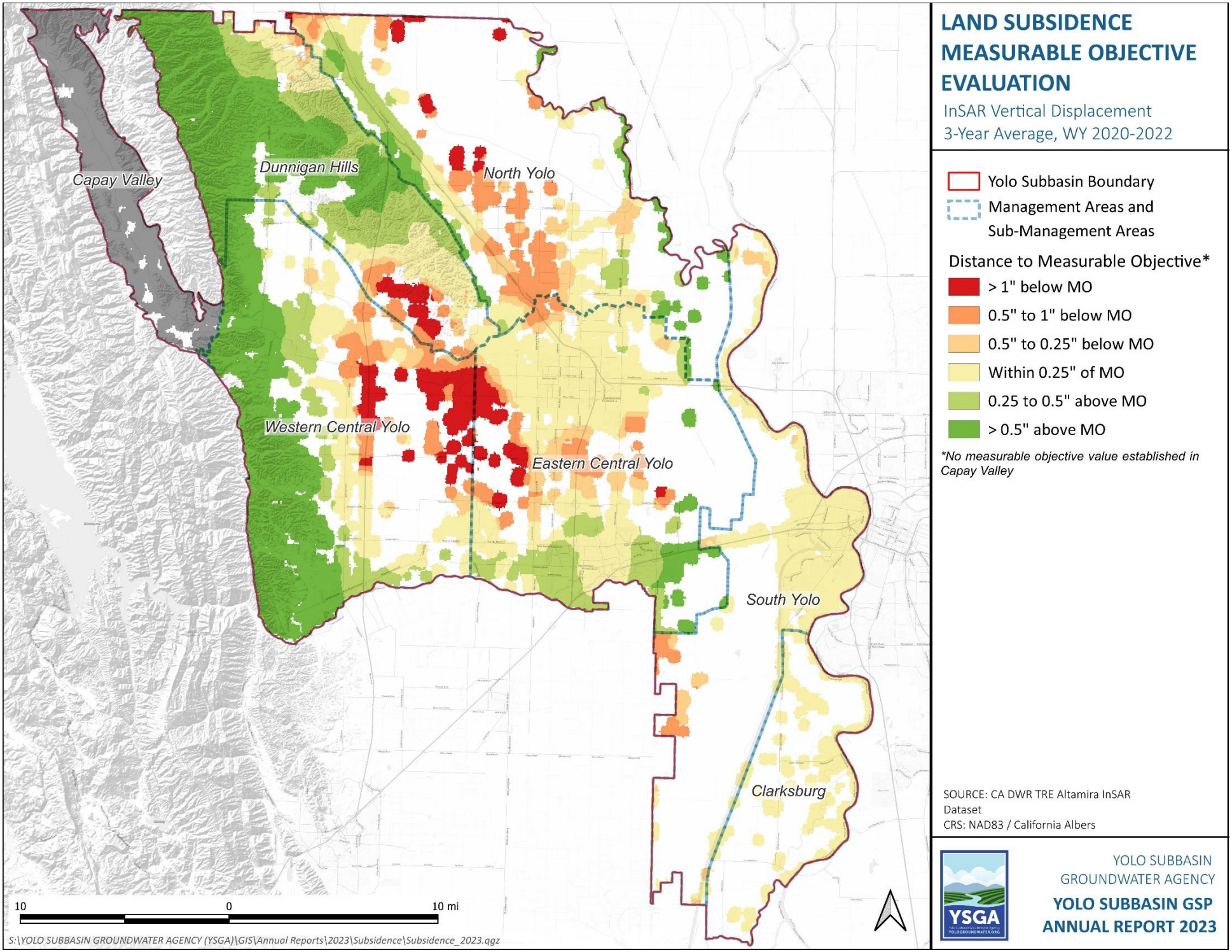


FIGURE 17: VERTICAL DISPLACEMENT – 5 YEAR AVERAGE

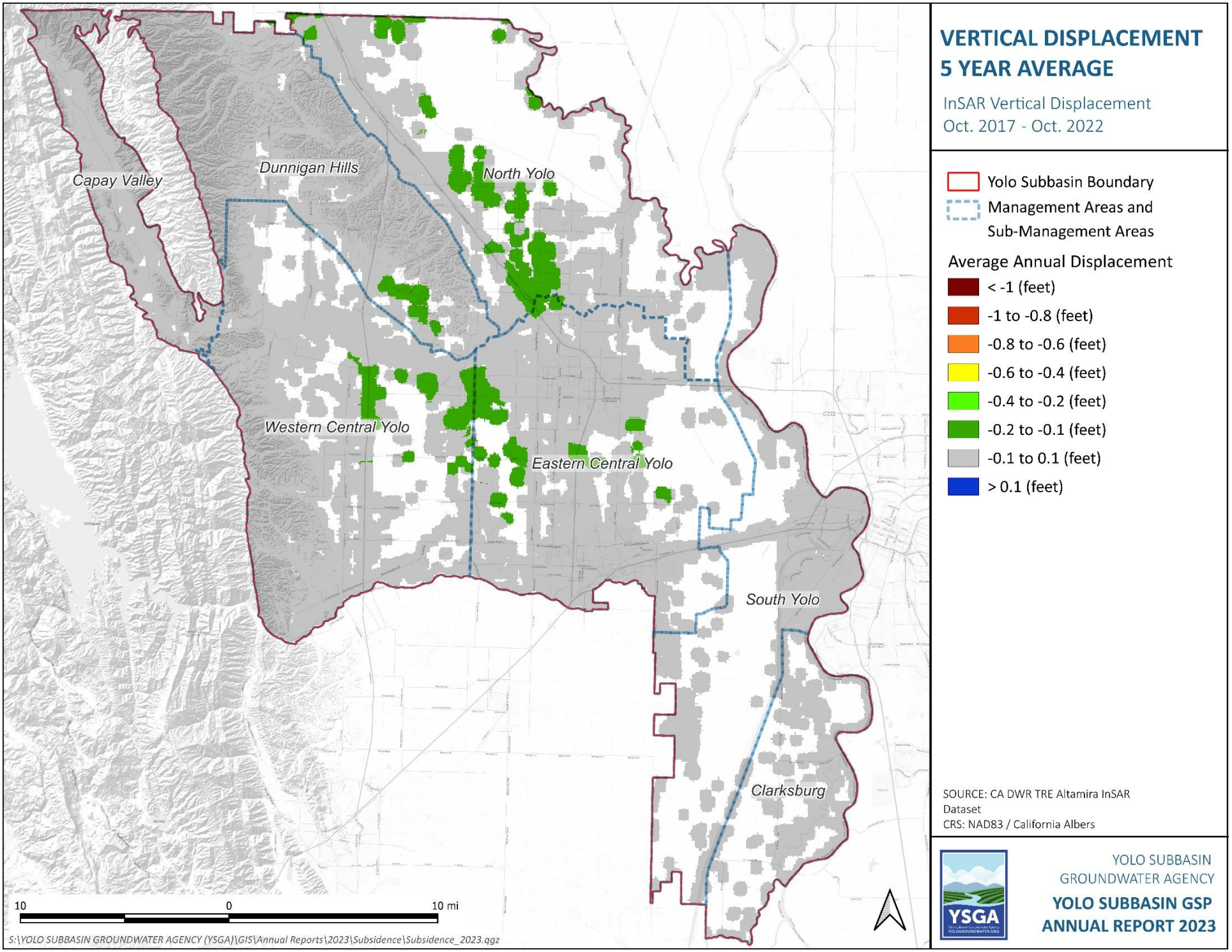
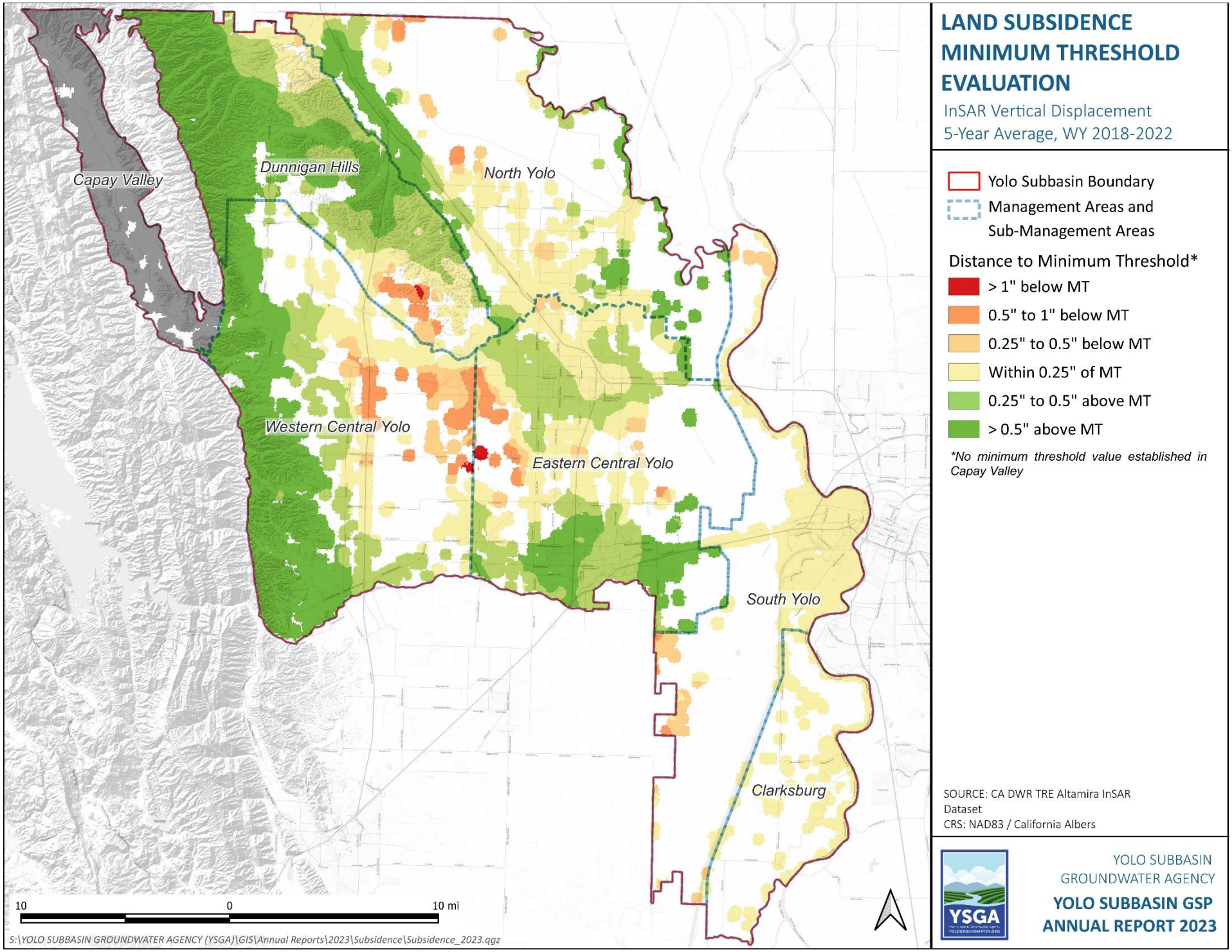


FIGURE 18: LAND SUBSIDENCE MINIMUM THRESHOLD EVALUATION



4.5 INTERCONNECTED SURFACE WATERS

The Yolo Subbasin GSP designates minimum thresholds for the depletion of major interconnected surface water bodies in the Yolo Subbasin as follows:

> Upper Cache Creek, Putah Creek, and Lower Sacramento River: *Minimum Threshold value is equal to the minimum elevation for the period of record at the RMW, exceeded in 2 consecutive years.*
>
> Upper Sacramento River: *Exceedance of the historic minimum elevation in the period of record of each RMW plus 20 percent of the depth between the historic maximum and historic minimum elevation for the period of record of the RMW in 2 consecutive years.*
>
> Lower Cache Creek: *The Minimum Threshold for depletion of interconnected surface water is the recurrence of the spring (March-May) average measurement for 1975 to present in at least one spring in every seven (7) years.*

Groundwater levels in RMWs for Upper Cache Creek, Upper Sacramento River, Lower Sacramento River, and Putah Creek are compared to the minimum thresholds in Table 9. During the critical conditions of Water Year 2022, there was one exceedance at Upper Cache Creek and one exceedance at Putah Creek. Both wells, Well 229 and Well 289, have exceeded their minimum threshold value for two consecutive years.

Table 10 provides a comparison of representative groundwater levels around Lower Cache Creek to the minimum threshold value. Each well must remain below the minimum threshold value for seven years to violate its minimum threshold. While all wells are currently below the minimum threshold value, Spring 2019 allowed for sufficient recovery to prevent the violation of minimum thresholds as defined in the GSP.

Table 9 and Table 10 also provide a comparison of the five-year running average of spring groundwater elevations to the measurable objectives. Due to historic drought conditions, almost all wells are currently below their measurable objective. The individual hydrographs of each of these wells are provided in Attachment B.

TABLE 9: INTERCONNECTED SURFACE WATERS REPRESENTATIVE GROUNDWATER ELEVATIONS

ISW Management Zone	State Well Number	Representative Well Number	Measurable Objective Value	Minimum Threshold Value	Fall 2018	Spring 2019	Fall 2019	Spring 2020	Fall 2020	Spring 2021	Fall 2021	Spring 2022	Fall 2022	5-year Spring Average	Distance to Measurable Objective
Upper Cache Cree	11N03W23L001M	287	298.7	287.6	298.5	301.0	298.9	298.7	298.2	***	285.9	298.6	286.0	299.1	0.4
Upper Cache Cree	11N03W33F001M	289	354.3	341.2	351.5	356.2	351.6	352.0	351.3	351.2	344.4	351.4	345.8	352.5	-1.8
Upper Cache Cree	12N03W20D001M	293	385.2	376.4	383.4	387.1	382.4	383.6	382.0	382.4	380.0	383.6	378.0	384.0	-1.3
Upper Sac River	10N02E03R002M	420	23.9	-39.2	-9.8	31.8	6.5	22.3	***	15.7	***	4.4	-36.7	17.5	-6.4
Upper Sac River	12N01E03R003M	427	29.3	-35.4	14.1	28.7	14.7	23.4	6.4	20.6	-26.7	18.6	-19.5	20.5	-8.8
Upper Sac River	11N02E20K004M	421	33.5	-31.6	25.7	33.4	29.5	32.9	26.8	29.1	20.9	24.4	17.1	28.9	-4.5
Lower Sac River	09N03E33B002M	151	15.7	-35.3	4.8	19.0	3.6	15.0	-2.1	12.9	-4.2	11.4	-9.3	13.4	-2.3
Lower Sac River	10N02E36E001M	401	26.8	9.0	20.4	28.7	19.8	25.8	19.6	23.6	14.1	22.0	9.4	23.8	-3.0
Lower Sac River	08N04E19N001M	428	8.7	-1.3	3.3	11.2	3.5	7.5	2.0	6.9	2.0	7.1	1.4	7.7	-1.0
Putah Creek	08N02E18M002M	170	29.7	1.5	15.5	30.1	23.5	***	13.5	22.5	8.9	14.1	5.5	21.3	-8.3
Putah Creek	08N01W20R005M	229	91.6	36.4	44.7	75.4	60.9	72.0	45.0	59.6	31.2	47.2	26.1	61.9	-29.8
Putah Creek	08N01E17F001M	429	76.0	56.1	63.2	78.5	66.6	***	63.7	64.4	***	***	***	69.8	-6.2

TABLE 10: LOWER CACHE CREEK REPRESENTATIVE GROUNDWATER ELEVATIONS

ISW Management Zone	State Well Number	Representative Well Number	Measurable Objective Value	Minimum Threshold Value	Fall 2018	Spring 2019	Fall 2019	Spring 2020	Fall 2020	Spring 2021	Fall 2021	Spring 2022	Fall 2022	Years Below MT Value	5-year Spring Average	Distance to Measurable Objective
Lower Cache Cree	10N01W21J001M	265	132.7	131.6	127.5	137.0	130.6	131.2	129.7	129.3	115.4	124.4	106.1	3.5	129.6	-3.1
Lower Cache Cree	10N02W14A001M	275	145.4	143.2	136.0	148.7	138.4	138.8	137.2	134.1	104.8	125.4	91.3	3.5	135.9	-9.6
Lower Cache Cree	10N01W23P001M	424	115.8	116.7	113.4	118.4	***	112.2	111.8	115.7	106.3	114.1	***	2.5	115.0	-0.8
Lower Cache Cree	10N01E22H500M	425	61.2	55.1	52.8	65.5	53.1	57.3	54.4	50.1	38.4	41.2	***	2	49.6	-11.6
Lower Cache Cree	10N01W16G500M	426	138.0	132.6	129.6	139.5	133.0	133.0	129.5	130.2	102.7	123.2	102.8	2.5	131.5	-6.5

5. WATER BUDGET ASSESSMENT

An assessment of the Yolo Subbasin water budget was conducted using the YSGA Model developed by Stockholm Environment Institute (SEI). Additional details about the YSGA Model can be found in the Water Budget[9] and Model Documentation[10] Appendices to the Yolo Subbasin GSP.

This annual report contains estimated acre-feet values for four metrics: surface water diversions, groundwater extraction, total water use, and change in groundwater storage. Values presented for water budget variables in Water Years 2019, 2020, and 2021 differ from those reported in the 2021 Annual Report[11]. The 2021 report used OpenET to estimate agricultural water demand and an analytical approach to determine the rest of the budget. This report uses a modeling approach to extend the YSGA Model developed as part of the Yolo Subbasin GSP to the current period. As such, the values reported for Water Years 2019, 2020, and 2021 differ, but the described trends in water use remain largely the same.

The line-by-line water budget numbers are provided in Table 11. Values are reported in acre-feet (AF) and rounded to the nearest hundred AF. The following sections provide an explanation of the reasoning and methodology in providing these estimates, referencing the row number on the left of the table for ease of understanding. For further details on each calculation, please see the referenced section.

TABLE 11: WATER BUDGET ASSESSMENT

	Variable	WY 2019	WY 2020	WY 2021	WY 2022	See Text
1	Agricultural ETa	893,000	751,000	700,000	561,000	Section 5.2
2	Total Ag Demand	736,800	737,300	680,200	494,000	Section 5.4.2
3	Agricultural SW Diversion	436,000	462,300	296,500	155,200	Section 5.3.2
4	Agricultural GW Extraction	300,800	275,100	383,700	338,800	Section 5.4.2
5	**Agricultural Total Water Use**	**736,800**	**737,300**	**680,200**	**494,000**	Section 5.5
6	Urban SW Use	29,500	31,700	27,700	29,700	Section 5.3.1
7	Urban GW Extraction	9,600	10,500	15,500	10,100	Section 5.4.1
8	**Urban Total Water Use**	**39,000**	**42,200**	**43,200**	**39,800**	Section 5.5
9	**Urban Aquifer Storage**	**2,200**	**2,400**	**1,400**	**2,600**	Section 5.4.1
10	Total SW Diversion	465,500	494,000	324,200	184,900	Section 5.3
11	Total GW Extraction	310,400	285,500	399,200	348,900	Section 5.4
12	**Total Water Use**	**775,900**	**779,500**	**723,400**	**533,800**	Section 5.5

[9] https://www.yologroundwater.org/files/cc7d08fed/Yolo+GSP_AppendixF.pdf
[10] https://www.yologroundwater.org/files/b90061148/Yolo+GSP_AppendixE.pdf
[11] https://www.yologroundwater.org/files/1bc812769/5-021.67_WY_2021.pdf

5.1 ACCURACY ESTIMATE

Table 12 provides the estimated accuracy of each data source. To estimate changes in groundwater storage and other water budget components, several different data sources were compiled. Each of these data sources have some level of uncertainty. The table below qualitatively describes the estimated accuracy for the model inputs used for climate data, stream flows, surface water diversions, reservoir storage, and land use.

TABLE 12: DATA SOURCES AND ACCURACY

Variable	Data Source	Certainty
Climate	CIMIS[12], PRISM[13]	High
Stream Flows	USGS[14]	High
Surface Water Diversions	eWRIMS[15], Direct Reporting	Medium
Reservoir Storage	CDEC[16]	High
Groundwater Levels	YSGA	High
Land Use	See Section 5.2	Low

The largest source of uncertainty is land use data. DWR-provided land use data from Land IQ was only available through Water Year 2019 at the time of this report. Alternative datasets have inconsistent crop classification and reporting methods that make them susceptible to error. Assumptions using the best available data and methods were used to estimate land use in Water Years 2020, 2021, and 2022. Modeled water use estimates are highly sensitive to changes in land use, making land use the largest source of uncertainty in this report. In future years, the YSGA will focus reporting improvement efforts on sourcing consistent, reliable, and prompt land use information.

5.2 LAND USE ESTIMATES

Water Year 2019 land use was modeled using DWR's 2019 Statewide Cropping[17] dataset. For Water Years 2020 and 2021, land use was modeled using GIS data from the County of Yolo[18], along with corrections from local agencies. 2022 land use was initially kept constant with 2021 land use; corrections were then provided by local agencies to reflect significant fallowing that occurred in 2022.

The following information was provided by local agencies and incorporated into the modeled land use information:

- RD 787 and RD 108 provided estimates of rice acreage and fallowing in 2019-2022

[12] https://cimis.water.ca.gov/
[13] http://www.prism.oregonstate.edu/explorer/
[14] https://waterdata.usgs.gov/nwis/sw
[15] https://www.waterboards.ca.gov/waterrights/water_issues/programs/ewrims/
[16] https://cdec.water.ca.gov/
[17] https://data.cnra.ca.gov/dataset/i15-crop-mapping-2019
[18] https://yodata-yolo.opendata.arcgis.com/search?groupIds=8880e638e44f4fab8b2aaca6633f2ced

- Dunnigan Water District provided crop information for WY 2019-21
- RD 2035 provided crop information for WY 2019-22
- YCFC&WCD provided anecdotal information to remove rice acreage and reduce irrigated pasture and alfalfa in WY 2022. Almond irrigation was also reduced during summer 2022 due to a late frost that damaged the crop in the YCFC&WCD area.

In addition to these data sources, estimated evapotranspiration data from OpenET[19] was used to partially fill in crucial missing cropping information for WY 2022, since no spatial land-use map was available. After modification of cropping patterns, simulated groundwater levels at all representative wells were then compared to measured values, and cropping patterns were further modified if necessary.

Table 13 provides the modeled acreage of each major land use type for 2019-2022. Land use is used to estimate actual agricultural evapotranspiration (ET_a; line 1) using the MABIA Method[20], which represents the amount of water consumed by crops.

TABLE 13: ESTIMATED LAND USE 2019-2022

	2019	**2020**	**2021**	**2022**
	Acres	*Acres*	*Acres*	*Acres*
Native Vegetation & Fallow Land	**334,777**	**367,005**	**384,482**	**418,292**
Urban	**35,460**	**35,460**	**35,460**	**35,460**
Open Water	**5,372**	**5,372**	**5,372**	**5,372**
Total Irrigated Acres	**263,481**	**231,253**	**213,776**	**179,966**
Deciduous Fruits & Nuts	70,946	76,113	69,504	65,987
Field Crops	30,572	33,221	25,744	16,517
Grain	19,658	19,585	23,506	20,137
Managed Wetlands	55	55	55	55
Pasture	3,662	10,082	10,381	7,627
Rice	32,714	35,470	24,230	12,387
Subtropical	4,394	5,835	6,211	6,223
Truck Crops	41,137	30,035	33,930	30,812
Vine	20,340	20,857	20,215	20,221

5.3 SURFACE WATER DIVERSIONS

5.3.1 Urban Surface Water Diversions

Urban surface water diversions were reported directly by the following municipalities. The reported values were used to constrain urban surface water deliveries in the YSGA Model.

- City of Davis
- City of Woodland and Woodland-Davis Clean Water Agency (WDCWA)
- City of West Sacramento

[19] https://openetdata.org/
[20] See https://www.yologroundwater.org/files/b90061148/Yolo+GSP_AppendixE.pdf#page=20

- University of California, Davis

5.3.2 Agricultural Surface Water Diversions

To estimate surface water diversion in agricultural areas (Table 11, line 3), data reported from agricultural water purveyors was used with data extracted from eWRIMS. The reported values were used to constrain agricultural surface water deliveries in the YSGA Model.

YSGA member agencies, as water purveyors, generally represent the largest water diverters in the Subbasin. The following agricultural water purveyors provided estimates of surface water diversions for Water Years 2019 through 2022:

- Yolo County Flood Control & Water Conservation District
- Colusa Drain Mutual Water Company
- Dunnigan Water District
- Reclamation District (RD) 108[21]
- RD 150
- RD 787
- RD 999
- RD 2035

The remainder of the agricultural surface water used in the Subbasin was estimated using the State Water Resources Control Board's eWRIMS database[22]. The eWRIMS database provides reported water use amounts for each SWRCB permit. The entities who had reported directly to the YSGA, listed above, were removed from the total diversion amount to prevent double counting. Values clearly reported in the incorrect units were also removed.

Because the SWRCB's reporting deadline for Water Year 2022 was February 1, 2023, data for Water Year 2022 may be incomplete. Data for Water Year 2022 was last downloaded for this report on March 3, 2023. Values reported for Water Year 2022 are less than those reported for Water Year 2021 by about 73,000 AF. It is currently not possible to determine to what extent this difference is due to drought conditions and curtailments as opposed to missing/late water use reports; therefore, this value may be slightly under-reported.

5.3.3 Total Surface Water Diversions

Total surface water diversions (Table 11, line 10) are modeled by the WEAP portion of the YSGA Model, using reported urban surface water diversions, reported agricultural surface water diversions, and agricultural surface water use from eWRIMS to constrain modeled water availability.

Major storm events in Water Year 2019 provided increased reservoir storage, allowing for an additional 29,000 AF of surface water diversions going forward into Water Year 2020. However, critical Water Year 2021 brought historic drought conditions, leading to curtailments and a significant reduction

[21] RD 108 spans both Yolo and Colusa Subbasins; to estimate use in the Yolo Subbasin, the amount reported by RD 108 was multiplied by the proportionable amount of district area within the Yolo Subbasin.
[22] https://www.waterboards.ca.gov/waterrights/water_issues/programs/ewrims/

(approximately 170,000 AF) in surface water diversions. Water Year 2022's critical conditions worsened drought conditions and reduced available surface water diversions by approximately another 139,000 AF from 2021.

5.4 GROUNDWATER EXTRACTION

5.4.1 Urban Groundwater Extraction

Extraction of groundwater for urban delivery was reported directly by the following entities, representing most urban water purveyors (Table 11, line 7). This number may be slightly under-reported due to the YSGA's inability to collect data from smaller urban water suppliers in the Subbasin.

- City of Davis
- City of Woodland
- City of Winters
- University of California, Davis
- Esparto Community Services District (CSD)
- Madison CSD
- Knights Landing CSD
- Cacheville CSD
- California American Water Company, Dunnigan

Pump-to-waste was reported separately by the Cities of Davis, Woodland, and Winters. For the purposes of this report, pump-to-waste was modeled as additional groundwater extraction.

The City of Woodland also injects surface water into the aquifer using aquifer storage and recovery (ASR) wells; this water is accounted for in line 9. Water recovered from the aquifer using the ASR wells is included within line 7.

5.4.2 Agricultural Groundwater Extraction

Agricultural groundwater extraction is not directly measured in the Yolo Subbasin. Groundwater extraction, shown in Table 11, line 4, is modeled by the YSGA model using land use estimates, estimated crop water demand, irrigation efficiency, and available surface water supplies.

The model uses precipitation, existing soil moisture, and irrigation efficiency to calculate total agricultural water demand (line 2) from agricultural ET_a (line 1). This value represents the amount of surface and/or groundwater applied to the field to supply the calculated ET_a. Finally, groundwater extraction is determined by subtracting available surface water supplies (line 3) from the total agricultural water demand.

5.4.3 Total Groundwater Extraction

Total groundwater extraction (Table 11, line 11) is found by adding urban groundwater extraction (line 7) and agricultural groundwater extraction (line 4).

As an estimate of the Subbasin's condition relative to the GSP's sustainability goal, annual groundwater extraction can be compared to the sustainable yield. The sustainable yield represents the amount of groundwater that can be withdrawn annually without causing undesirable results. The estimated annual

pumping in the Subbasin varies widely over the historical period, from 197-519 TAF/year. Note that SGMA does not incorporate sustainable yield estimates directly into sustainable management criteria. "Basinwide pumping within the sustainable yield estimate is neither a measure of, nor proof of, sustainability. Sustainability under SGMA is only demonstrated by avoiding undesirable results for the six sustainability indicators" (DWR 2017).

The GSP lists the sustainable yield of the Yolo Subbasin as approximately 346,000 AF. Table 14 presents the annual groundwater extraction estimates from Table 11 relative to the sustainable yield of 346 TAF, in which a negative number represents pumping in exceedance of the sustainable yield.

5.5 TOTAL WATER USE

Total water use (Table 11, line 12) is estimated at the Yolo Subbasin scale as the sum of surface water diversions (line 12) and groundwater extraction (line 13). Water use in 2022 (530 TAF) displays a significant reduction from total water use in the past 3 years (720 – 780 TAF), reflecting the large amount of fallowing that was observed due to drought conditions and surface water curtailments.

5.6 CHANGE IN GROUNDWATER STORAGE

Estimates of changes in groundwater storage for Water Years 2019-2022 are included in this section. Changes in groundwater storage were modeled by the MODFLOW portion of the YSGA model. Changes in groundwater storage over time are the aggregate (net) outcome of the individual inflows and outflows from the aquifer. Table 14 shows the results of this analysis as changes in groundwater water storage.

Table 14: ESTIMATED GROUNDWATER EXTRACTION AND CHANGE IN GROUNDWATER STORAGE

Water Year	**2019**	**2020**	**2021**	**2022**
Groundwater Extraction, AF	310,000	286,000	399,000	349,000
Difference to Sustainable Yield, AF	+36,000	+60,000	-53,000	-3,000
Estimated Change in Storage, AF	-115,000	-150,000	-272,000	-192,000

Figure 19, Figure 20, and Figure 21 show the cumulative change in groundwater storage, annual groundwater extraction, and annual change in storage values, along with the corresponding water year type. The dry and critical conditions of Water Years 2020-22 caused unprecedented decreases in groundwater storage due to extremely limited precipitation and surface water supplies. Despite reduced groundwater pumping in 2022, recharge from precipitation, deep percolation, and boundary flows was extremely limited, causing continued reduction in groundwater storage.

Figure 22 provides a map of estimated change in storage at the Yolo Subbasin level. Estimates are provided for each MODFLOW cell, which each have an area of 1 square mile. Groundwater depletion is most severe in the Dunnigan Hills Management Area and the western portion of the Central Yolo Management Area. Groundwater storage showed some recovery in the North Yolo Management Area, likely due to fallowing of rice acreage that occurred during Water Year 2022.

FIGURE 19. CUMULATIVE CHANGE IN GROUNDWATER STORAGE

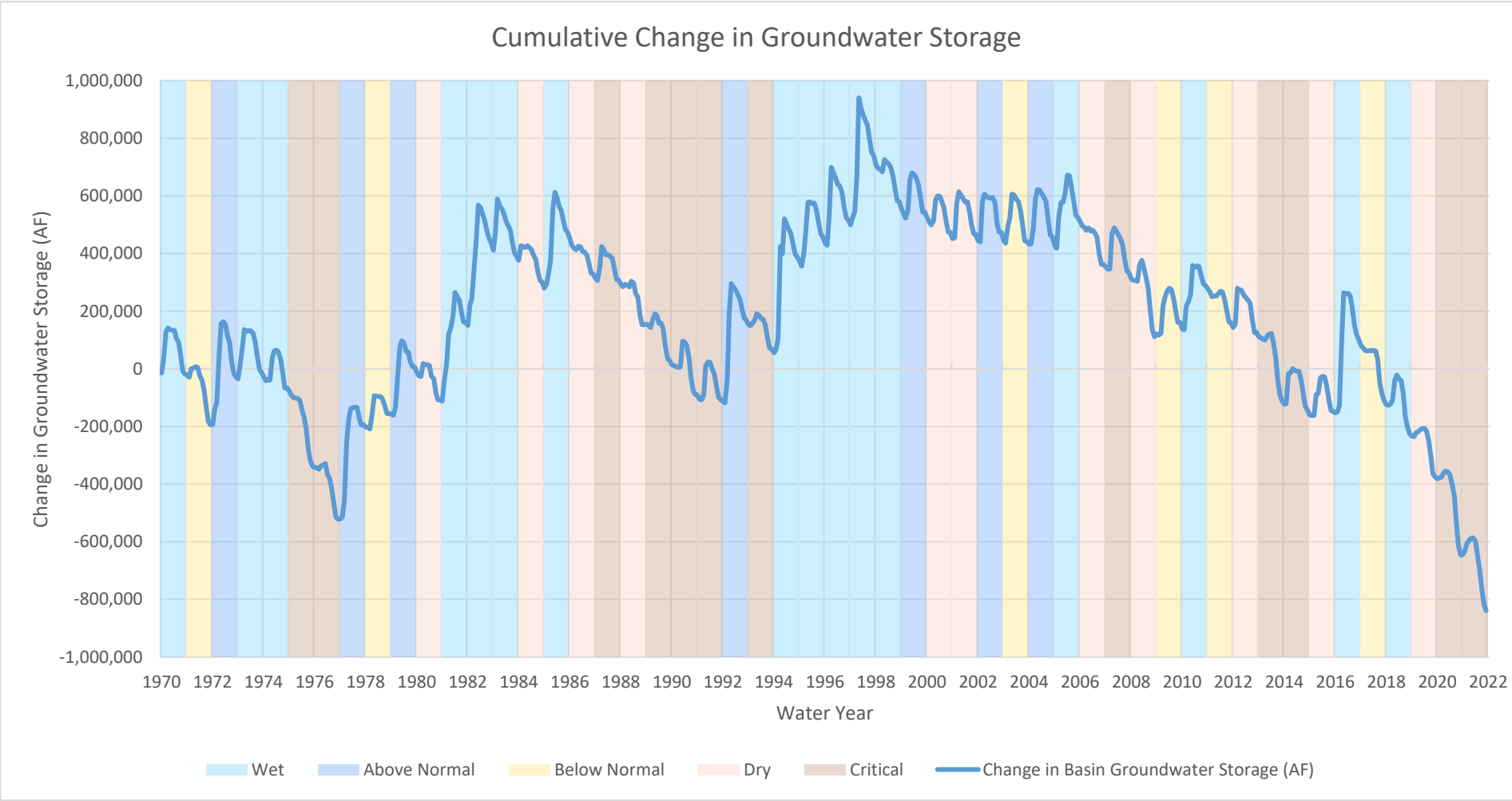


FIGURE 20. ANNUAL GROUNDWATER EXTRACTION

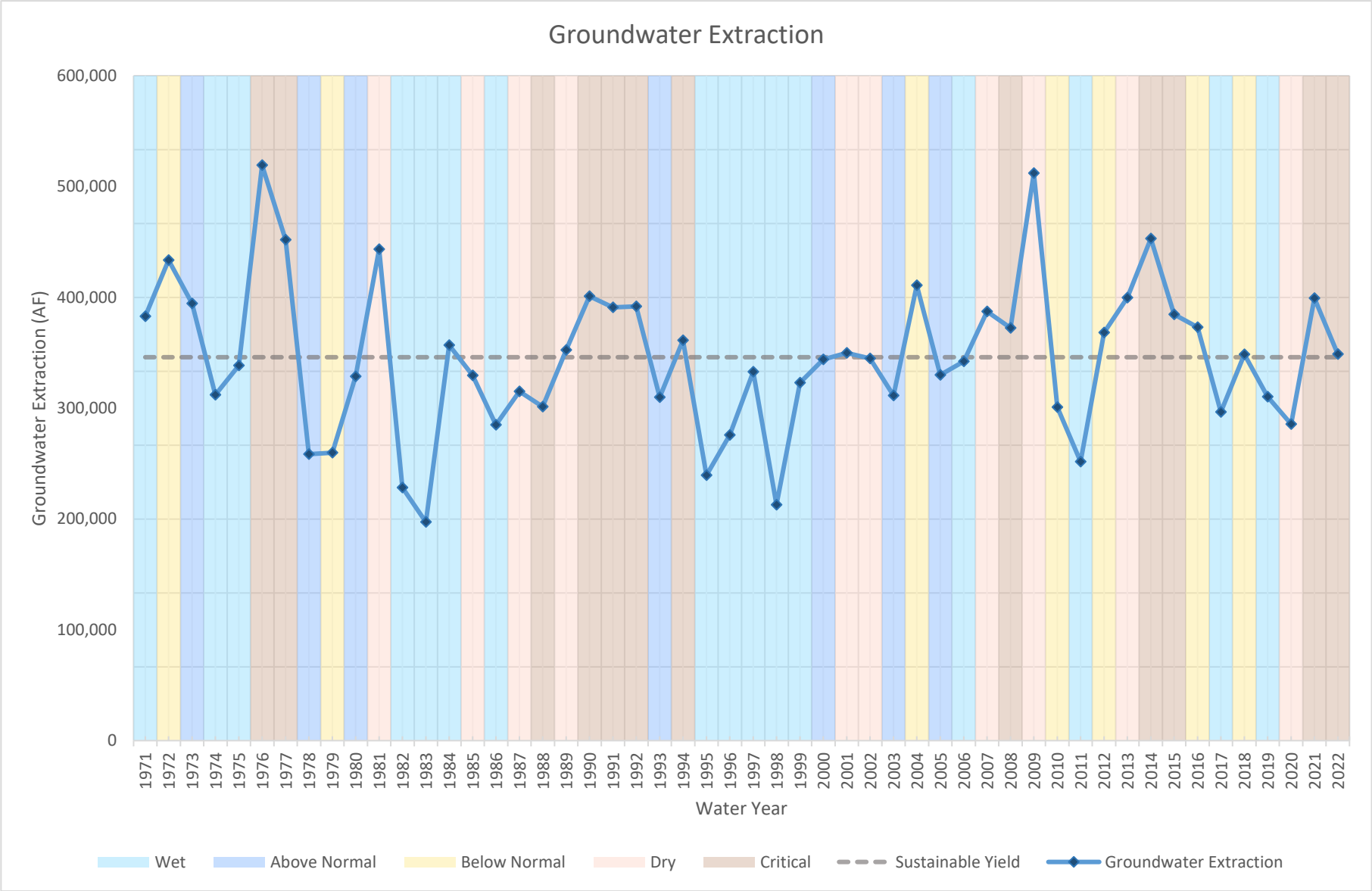


FIGURE 21. ANNUAL CHANGE IN GROUNDWATER STORAGE

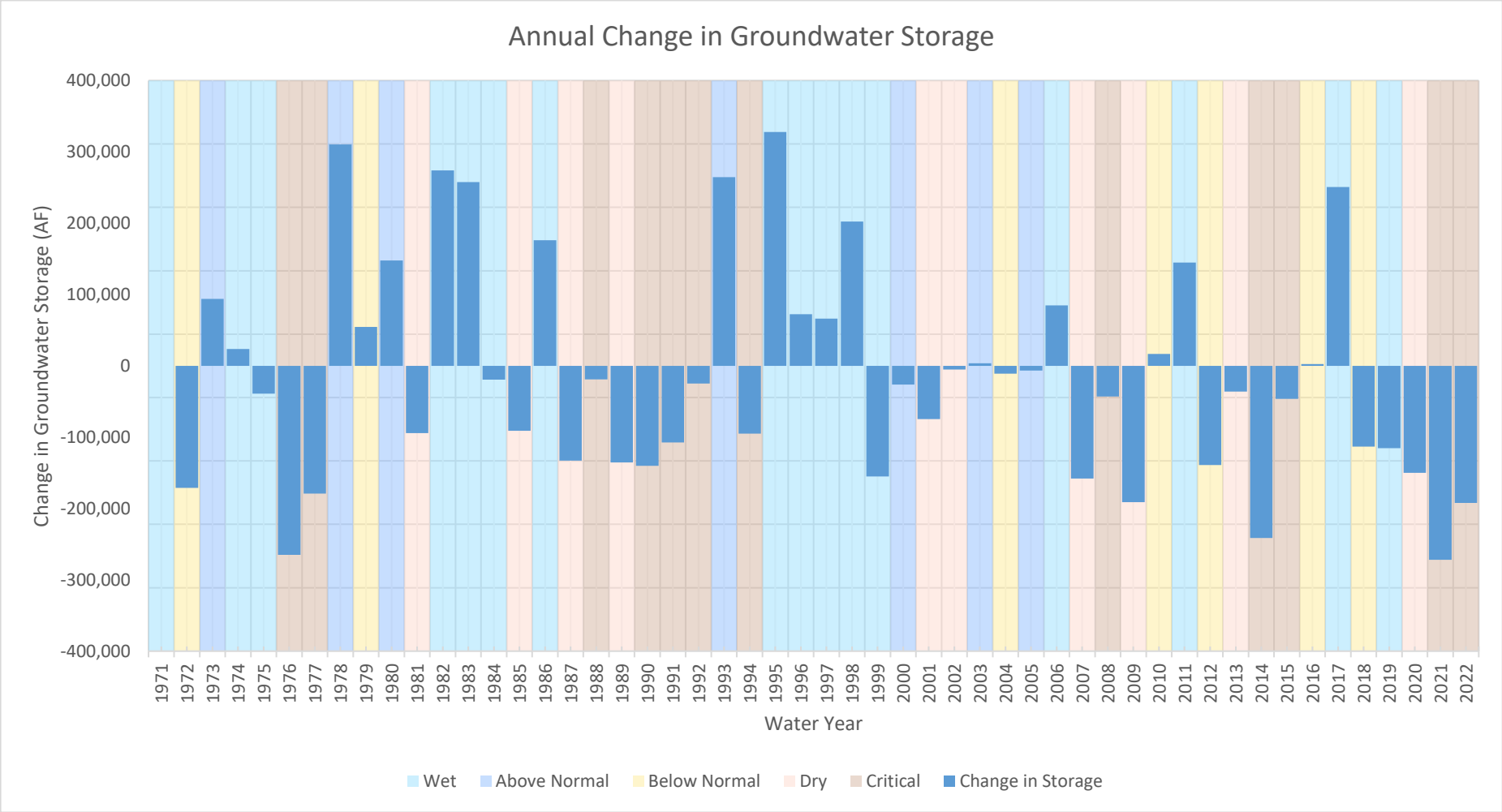
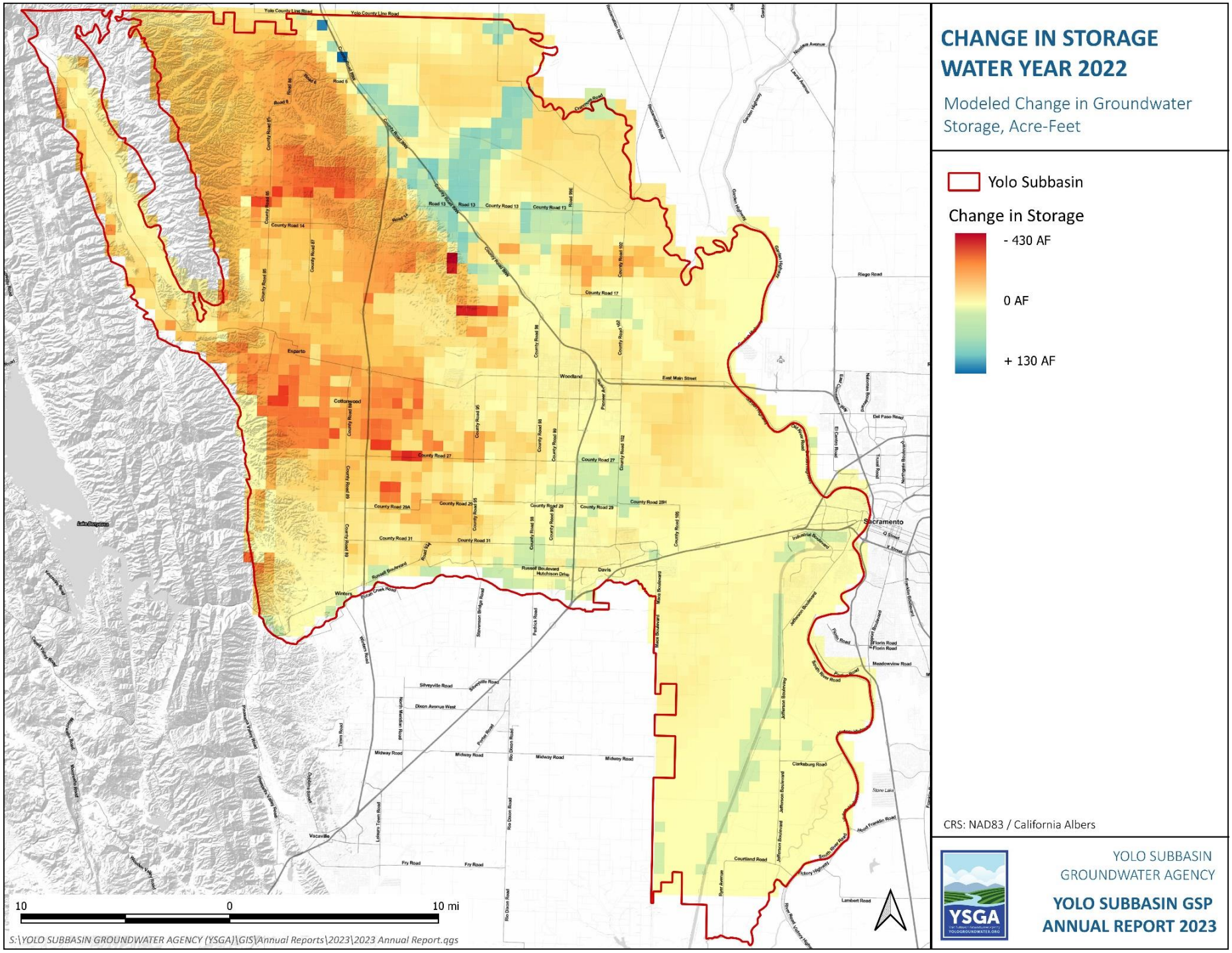


FIGURE 22. CHANGE IN GROUNDWATER STORAGE – WATER YEAR 2022



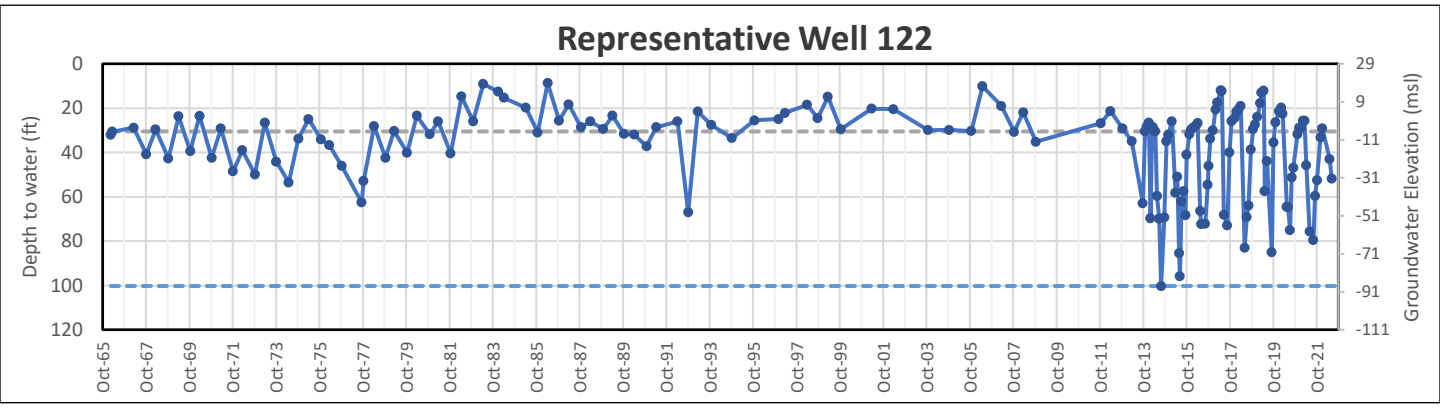
YOLO SUBBASIN GSP ANNUAL REPORT 2023

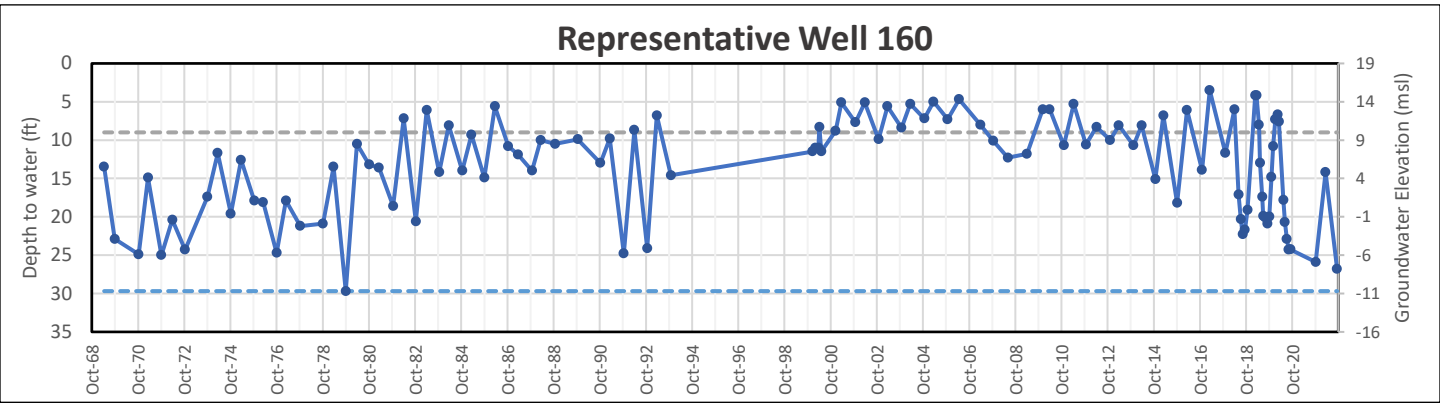
ATTACHMENT A

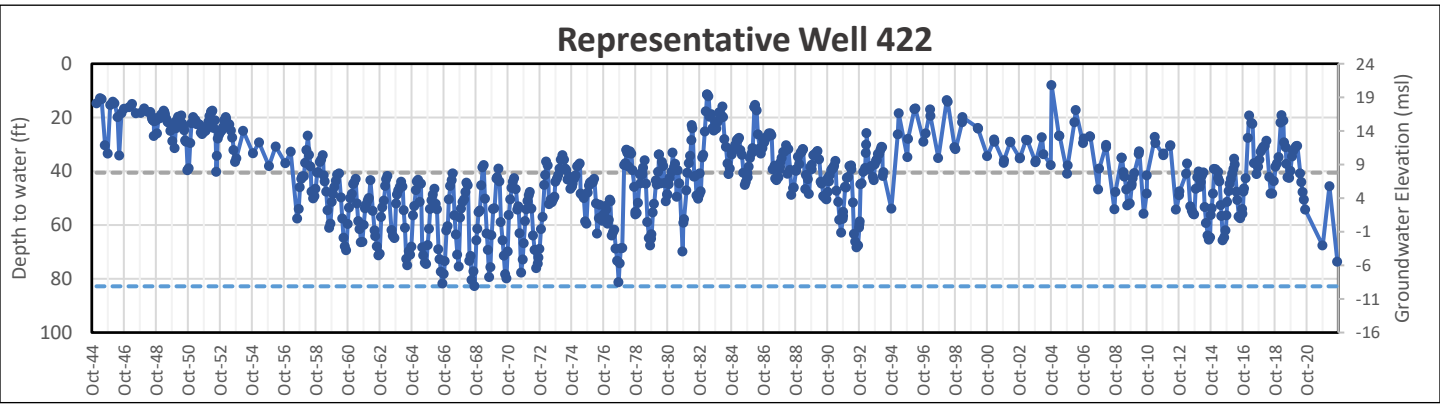
GROUNDWATER ELEVATION REPRESENTATIVE WELL HYDROGRAPHS

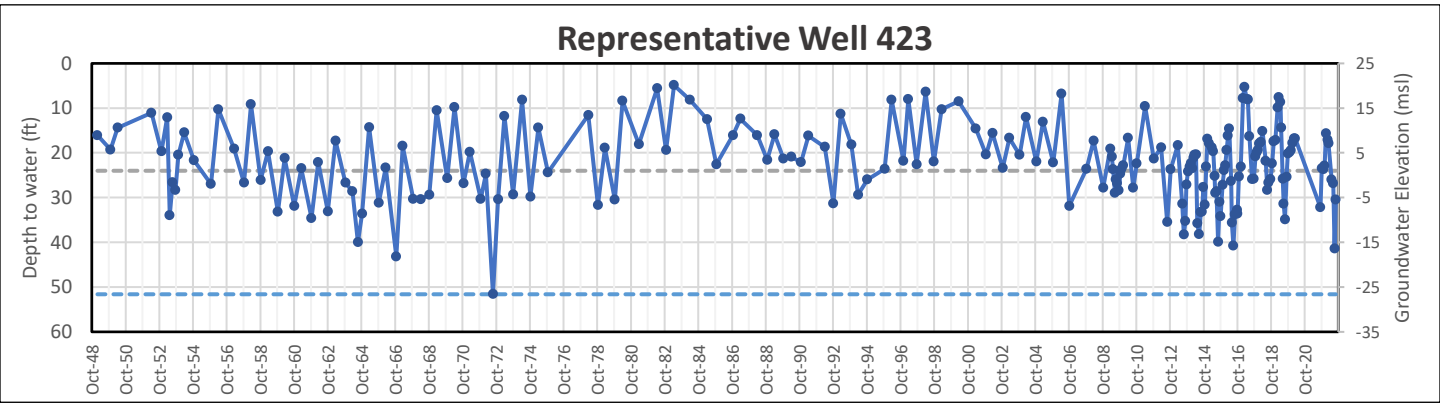
SOUTH YOLO REPRESENTATIVE HYDROGRAPHS

Minimum Threshold | Measurable Objective | Groundwater Elevation

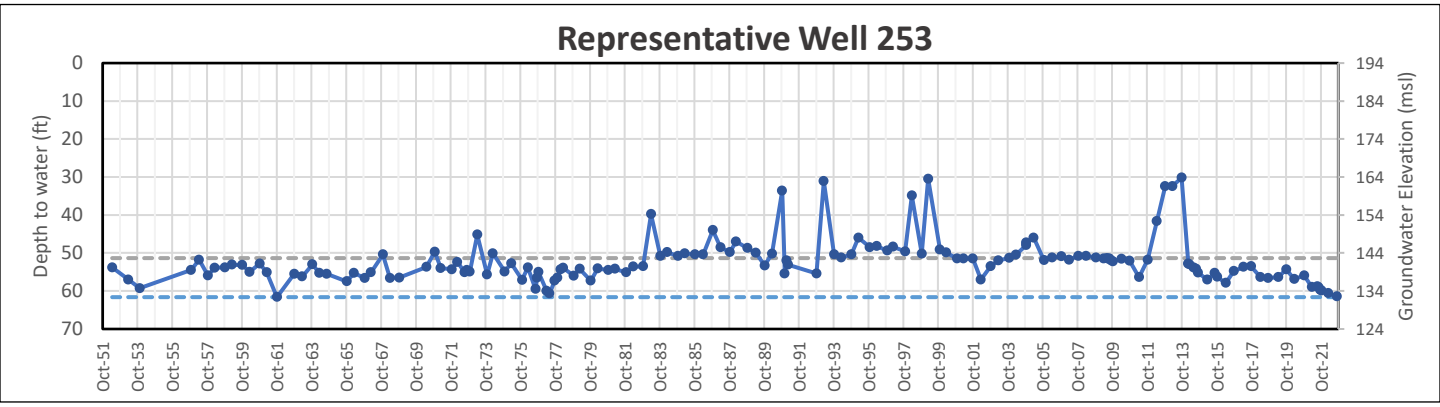


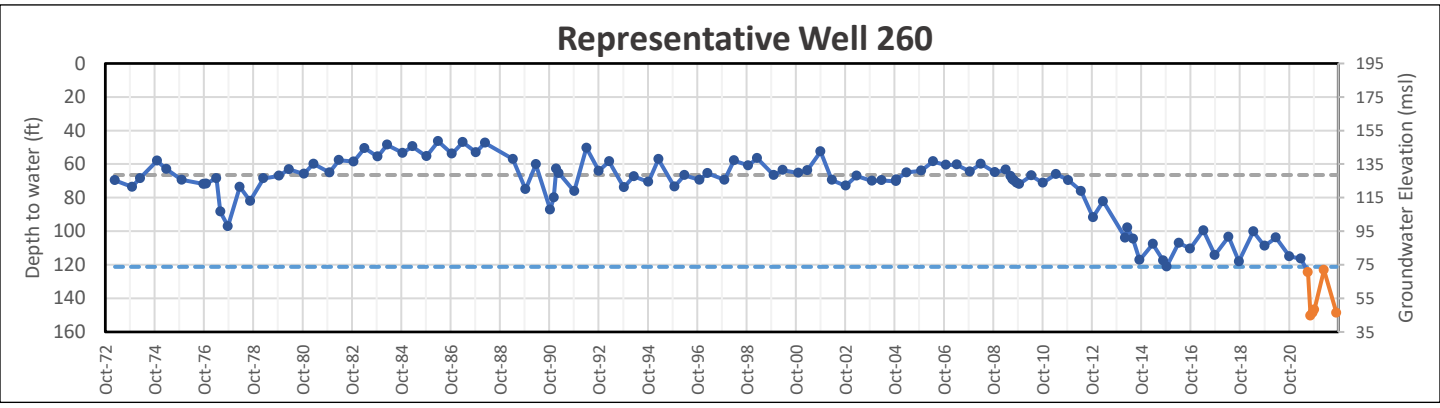


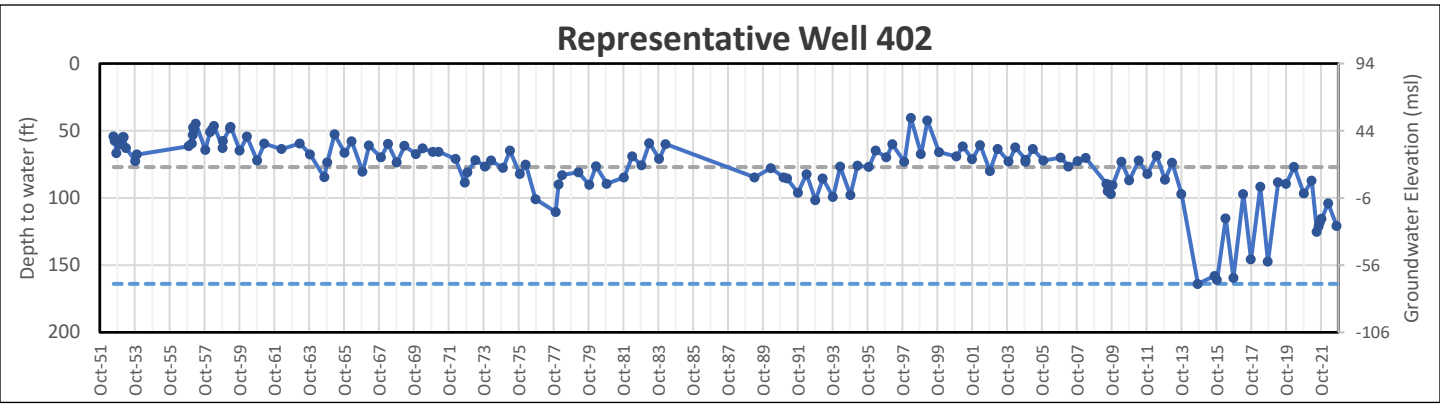




DUNNIGAN HILLS REPRESENTATIVE HYDROGRAPHS

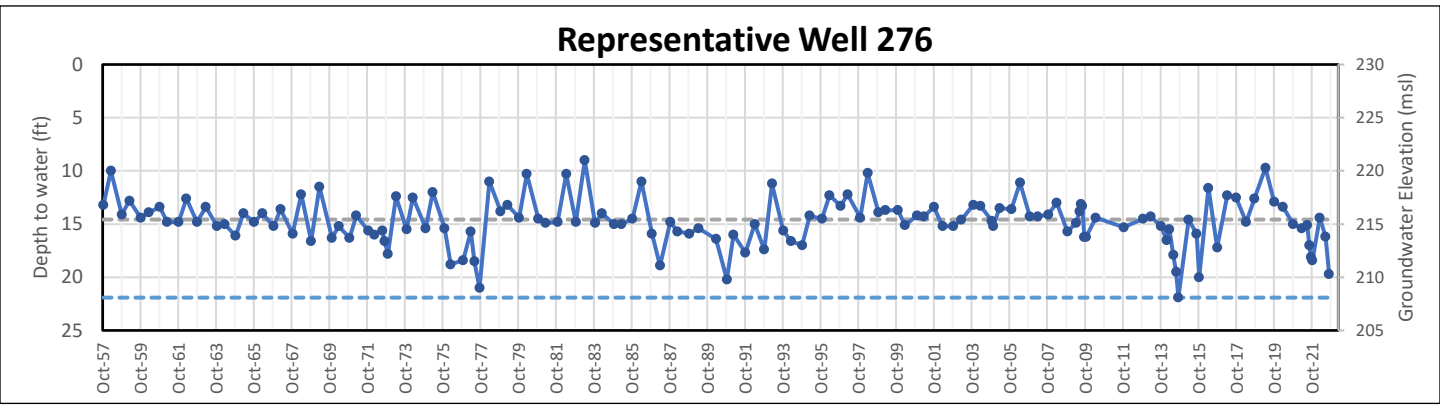


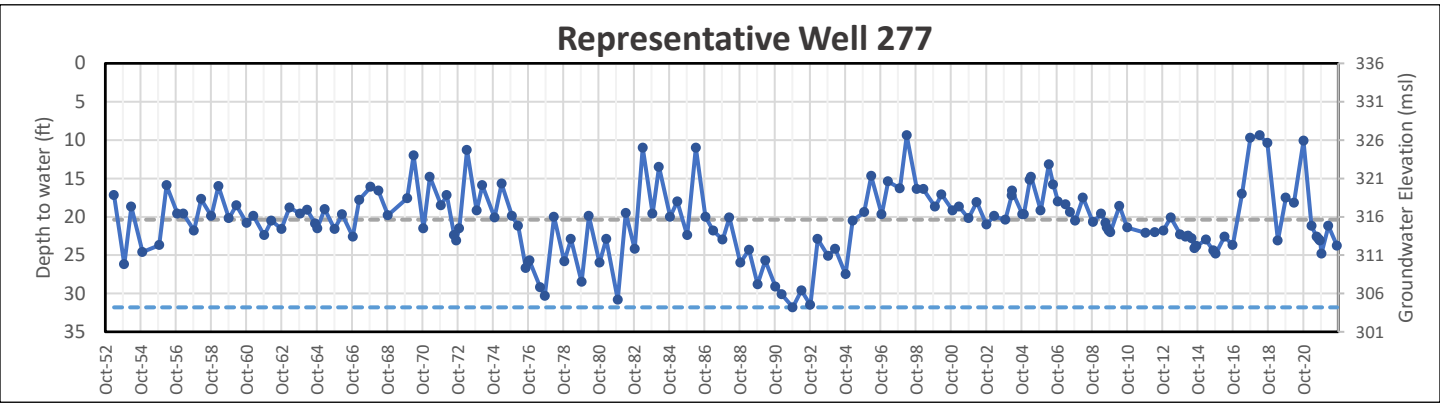


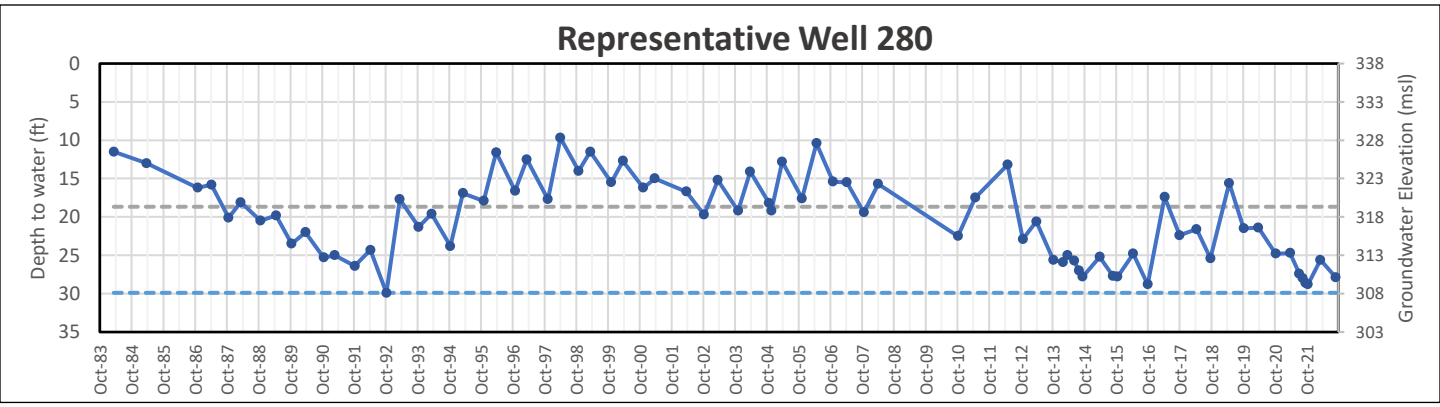


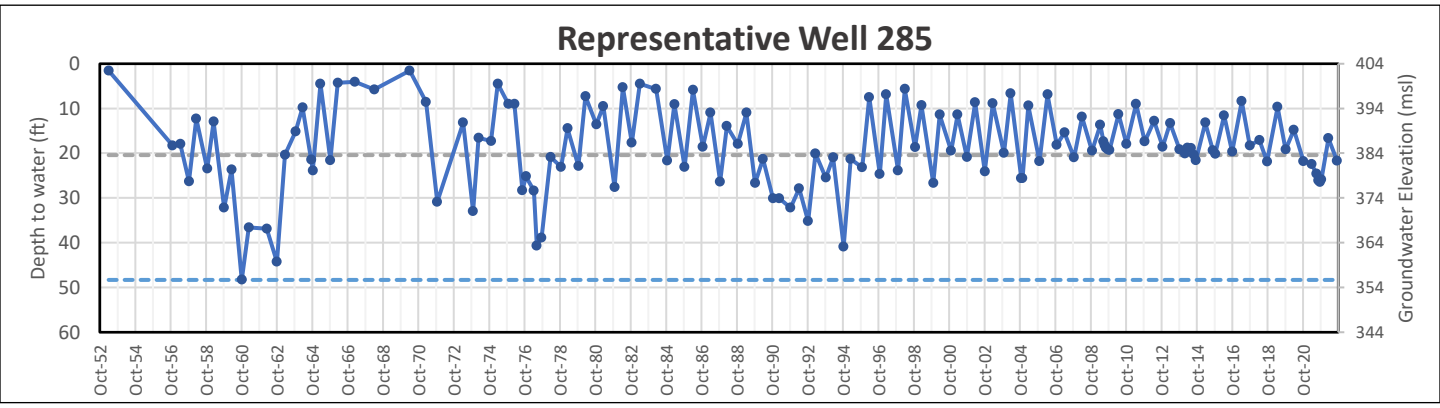
CAPAY VALLEY REPRESENTATIVE HYDROGRAPHS

Minimum Threshold | Measurable Objective | Groundwater Elevation



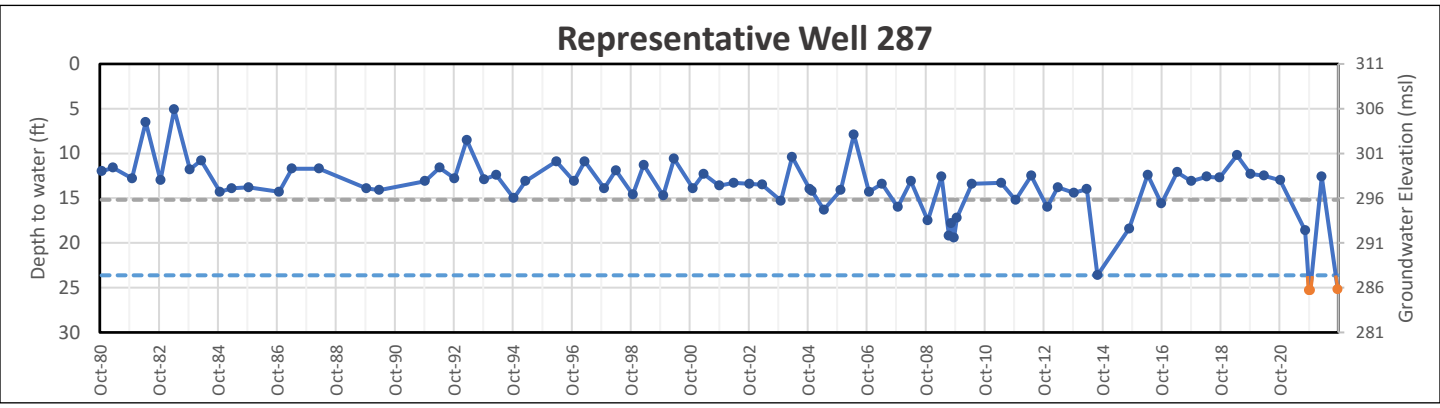


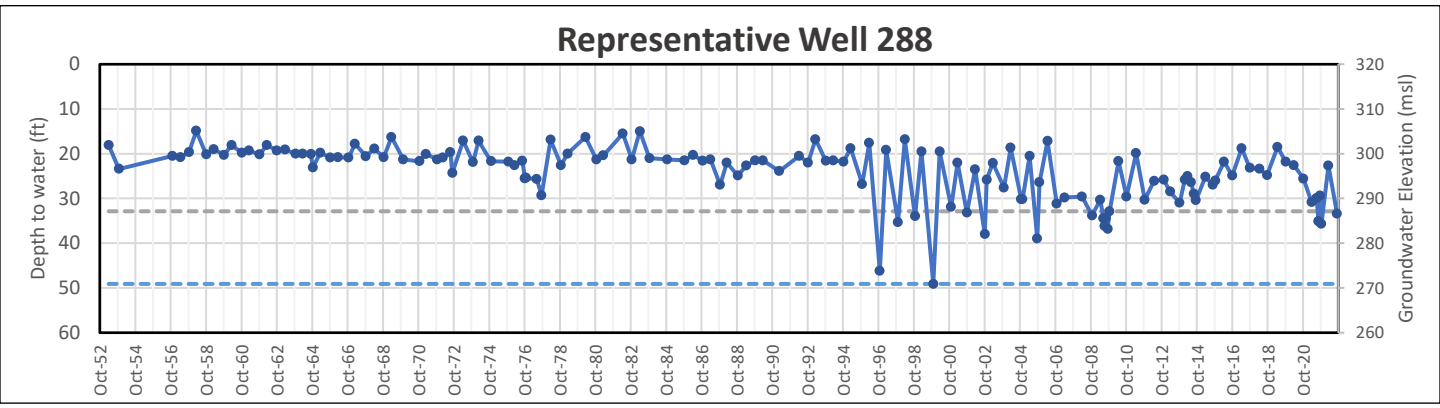


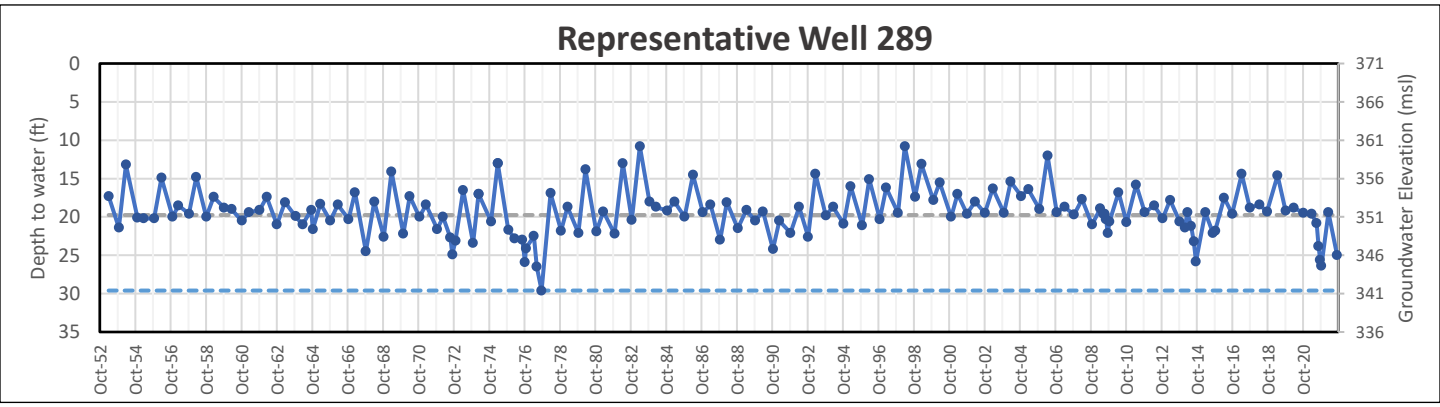


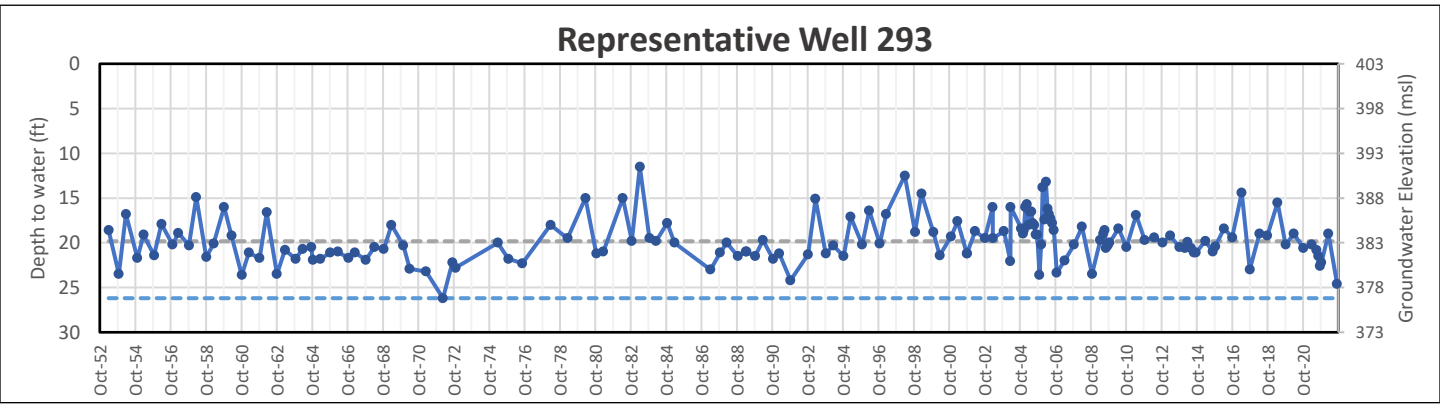
CAPAY VALLEY REPRESENTATIVE HYDROGRAPHS

Minimum Threshold | Measurable Objective | Groundwater Elevation

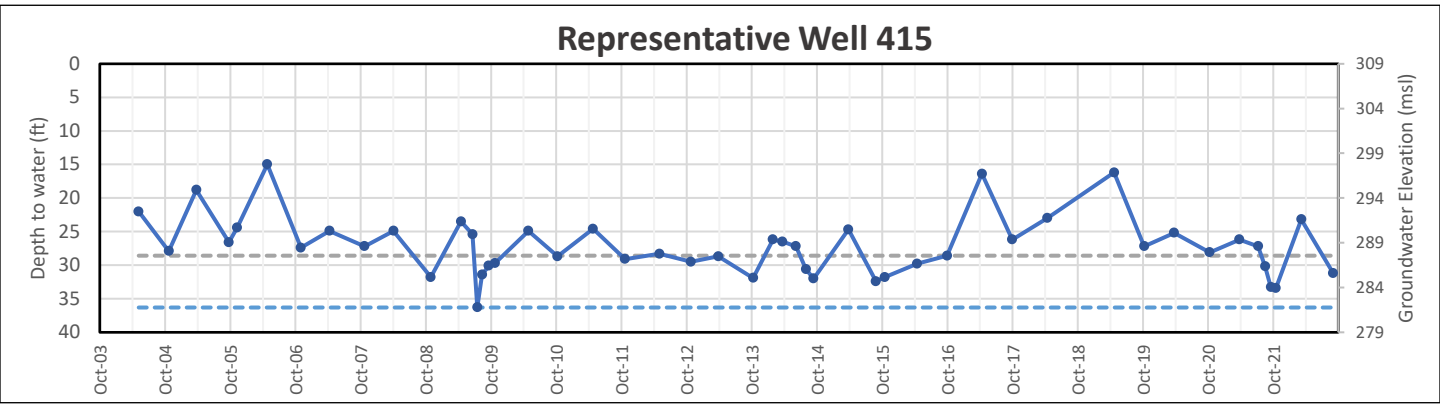


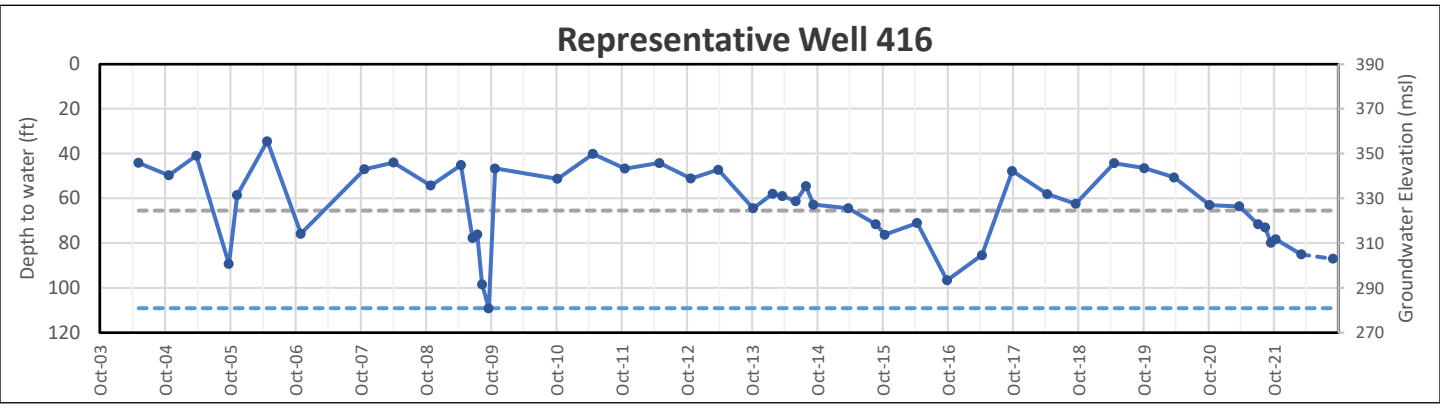






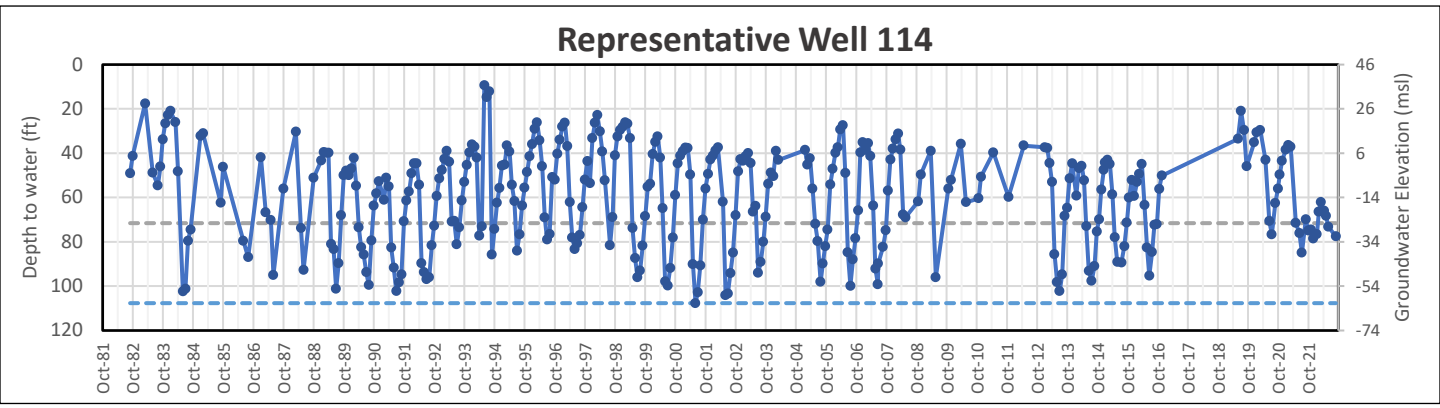
CAPAY VALLEY REPRESENTATIVE HYDROGRAPHS

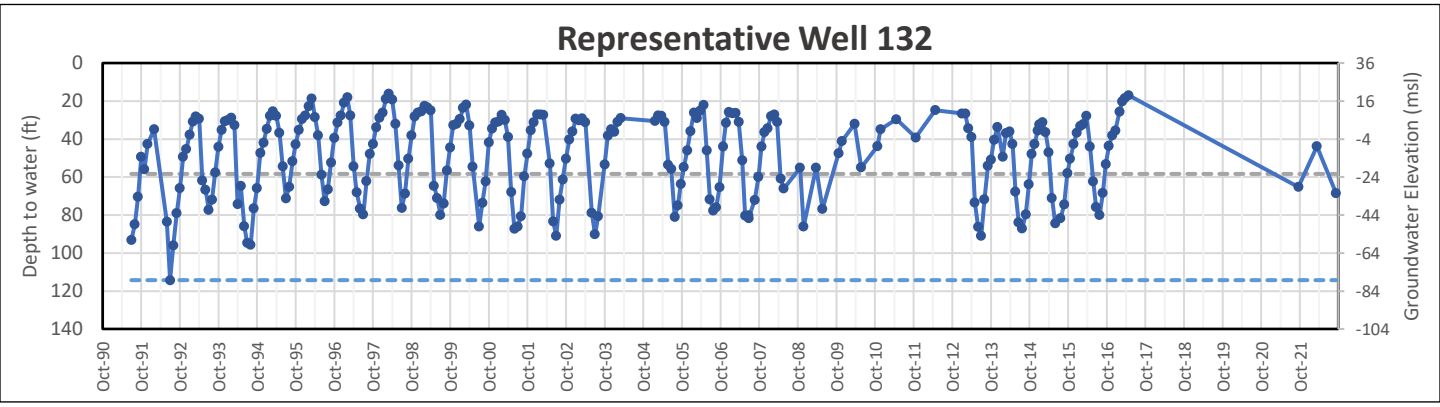


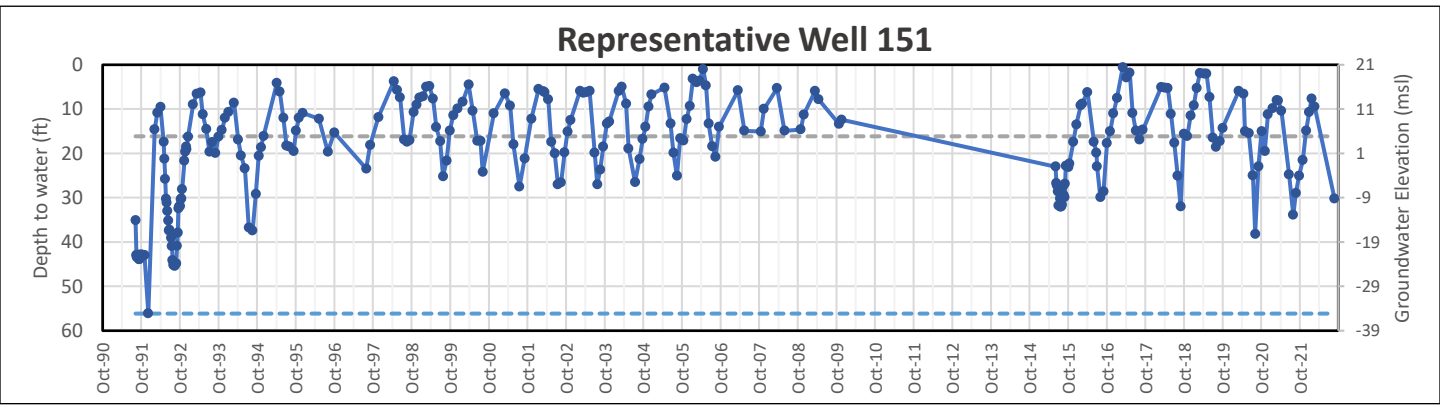


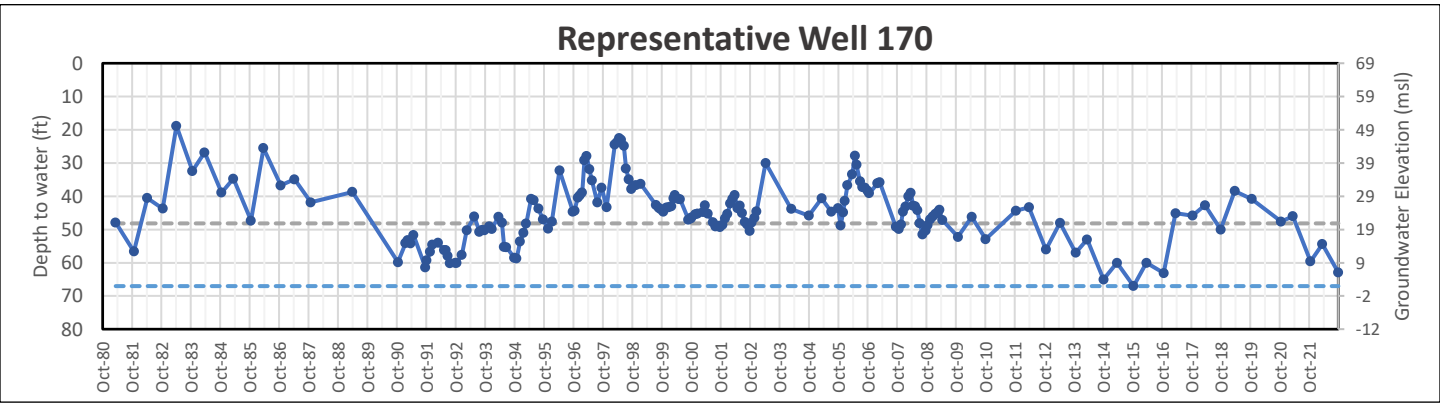
CENTRAL YOLO REPRESENTATIVE HYDROGRAPHS

Minimum Threshold | Measurable Objective | Groundwater Elevation



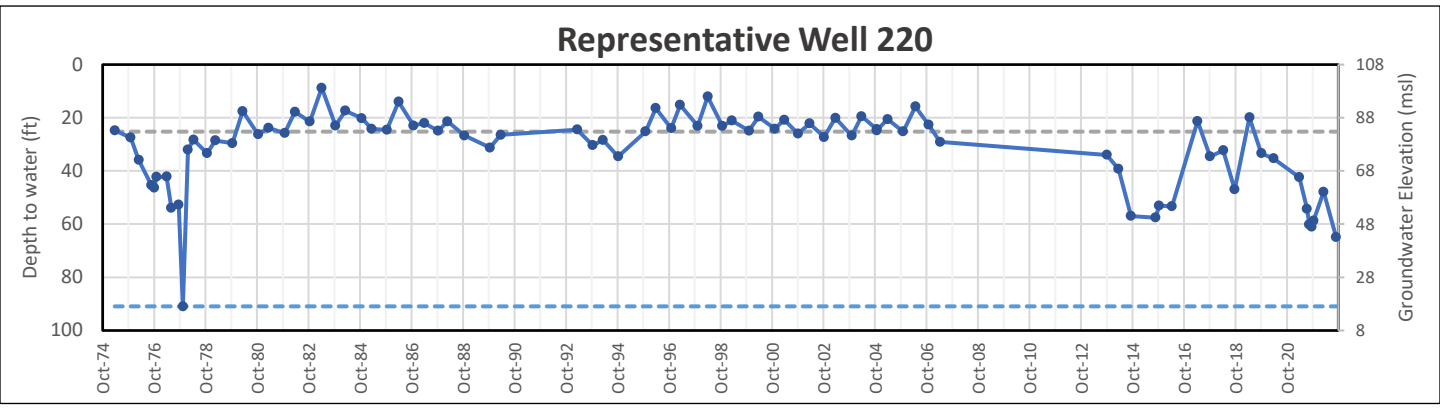


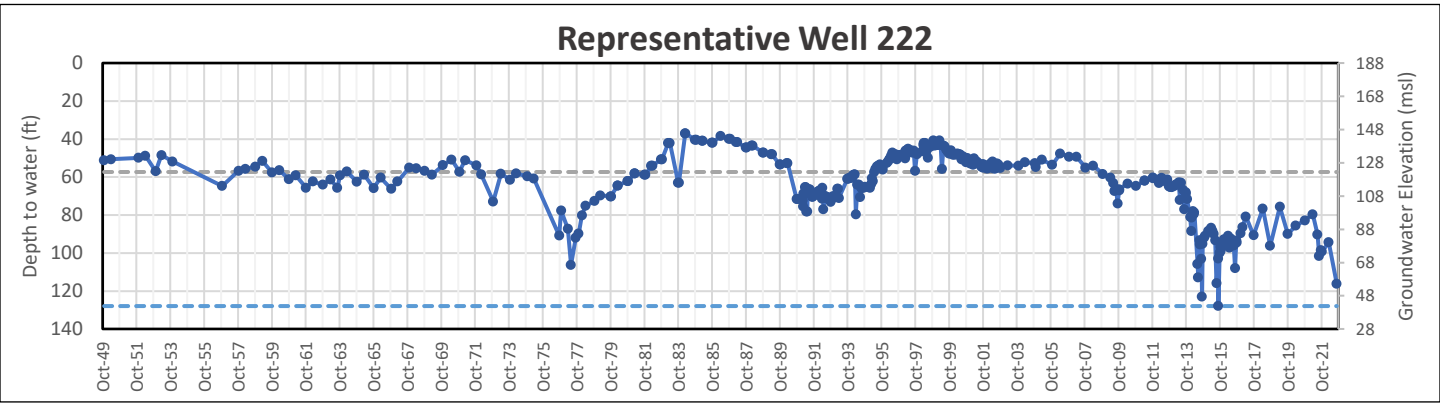


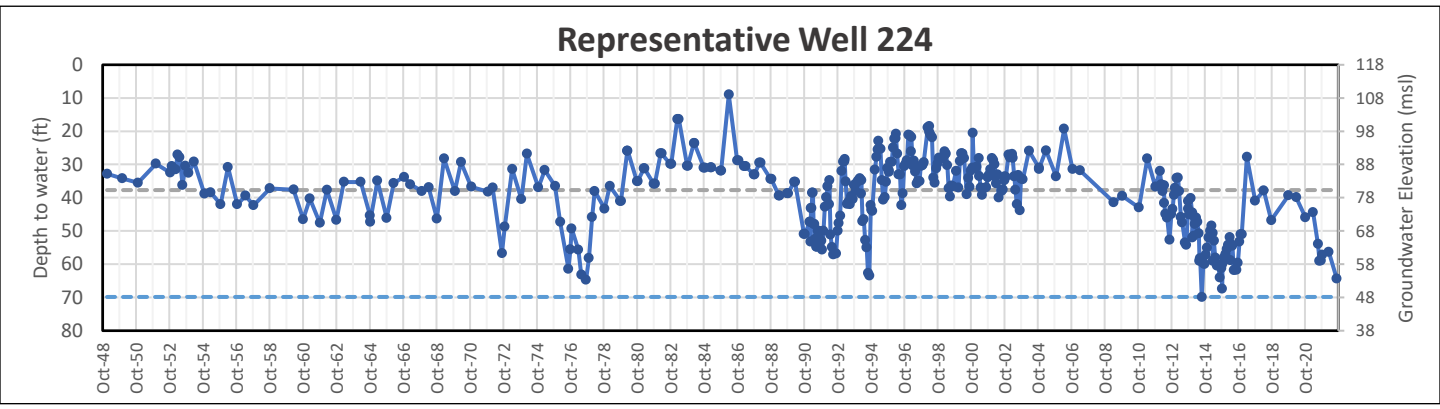


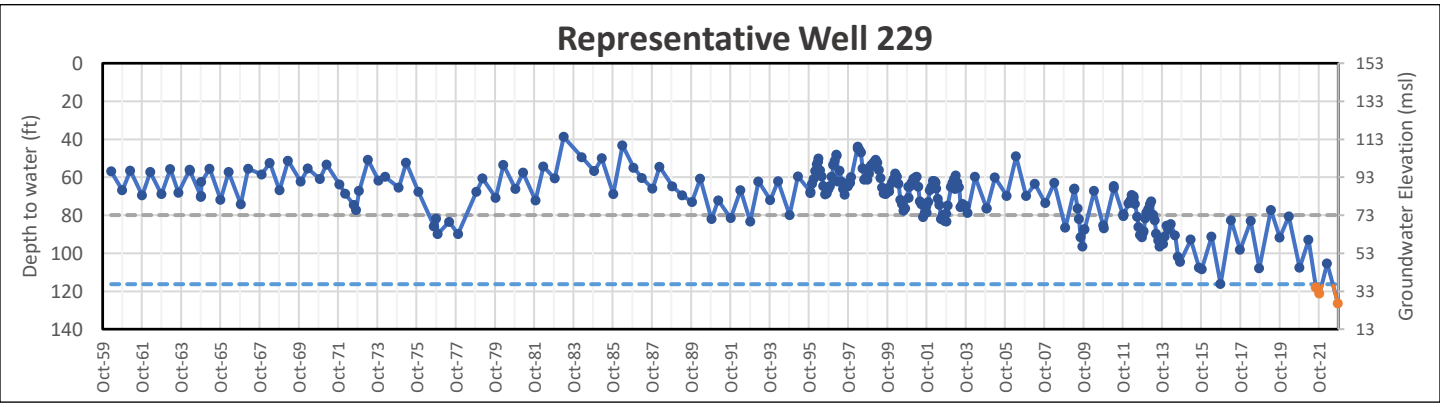
CENTRAL YOLO REPRESENTATIVE HYDROGRAPHS

Minimum Threshold | Measurable Objective | Groundwater Elevation



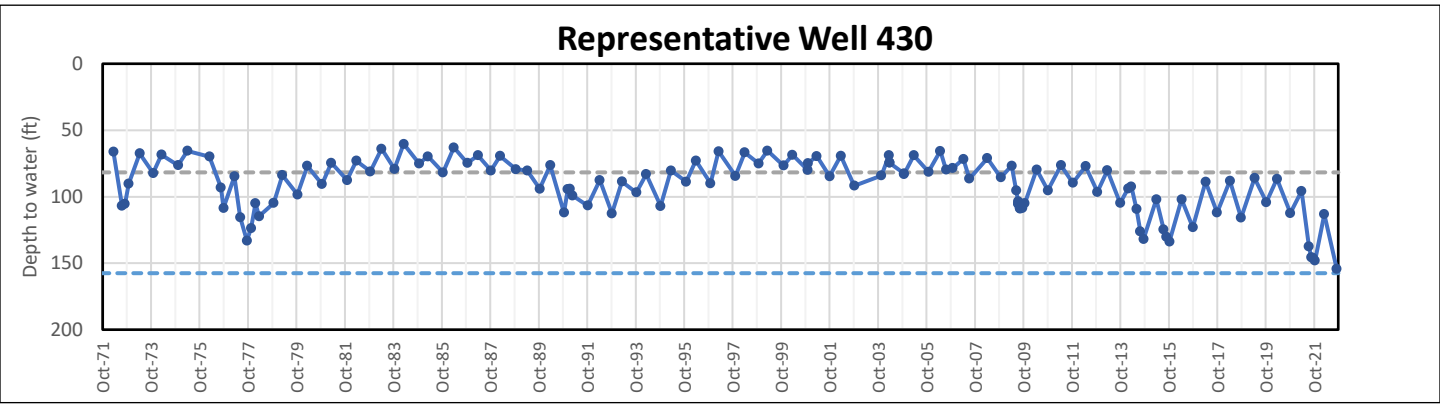


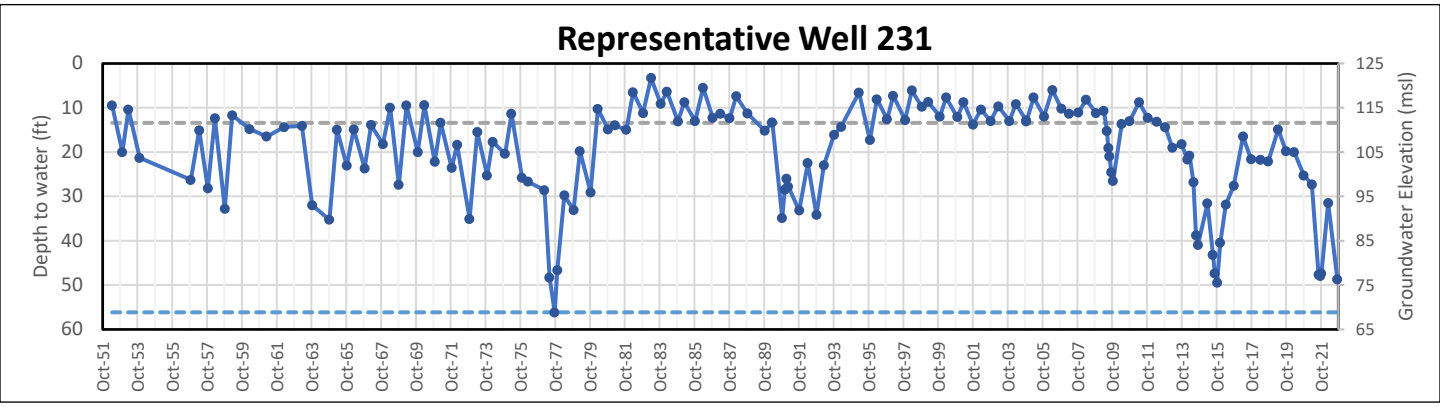


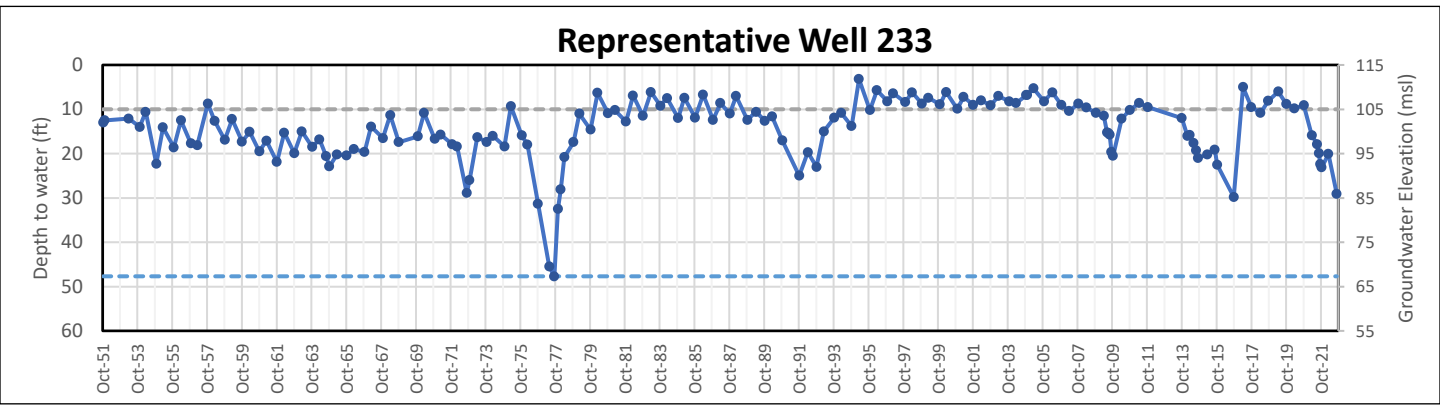


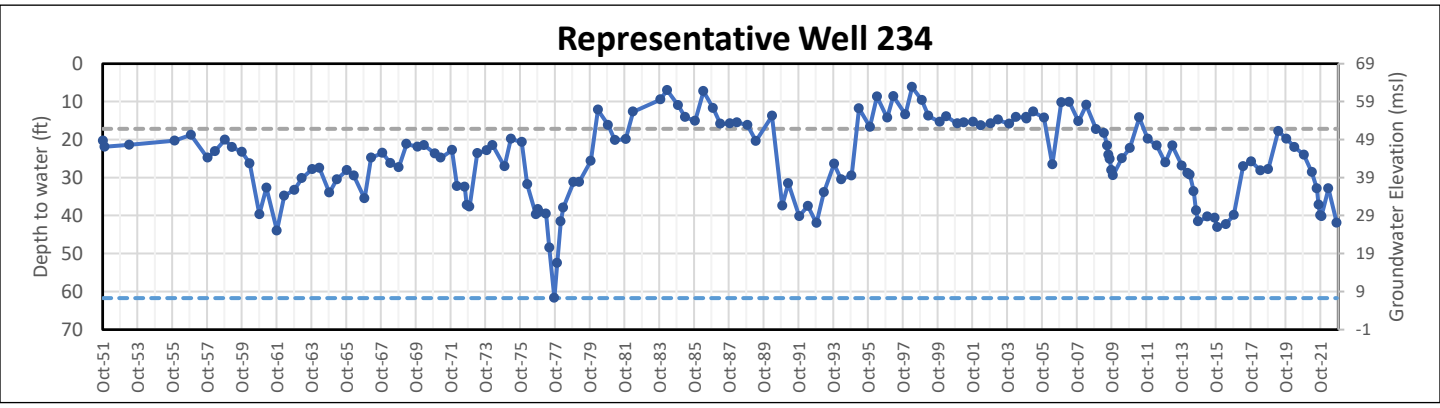
CENTRAL YOLO REPRESENTATIVE HYDROGRAPHS

Minimum Threshold | Measurable Objective | Groundwater Elevation



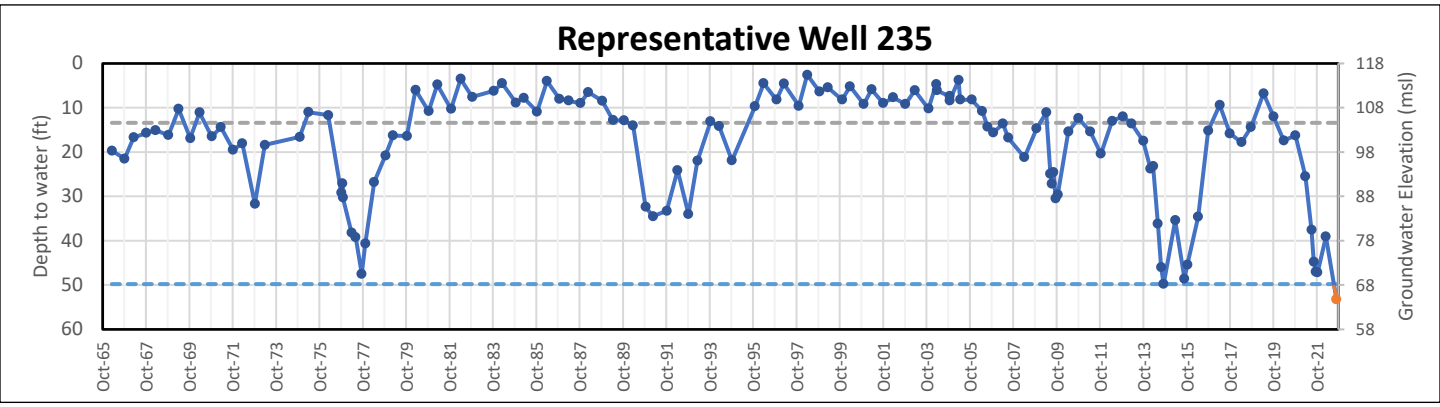


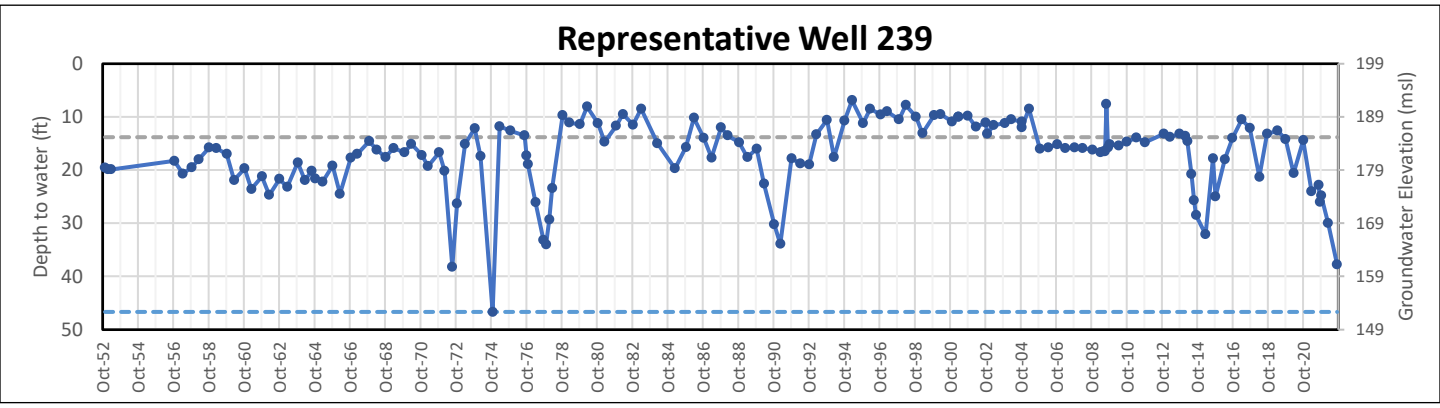


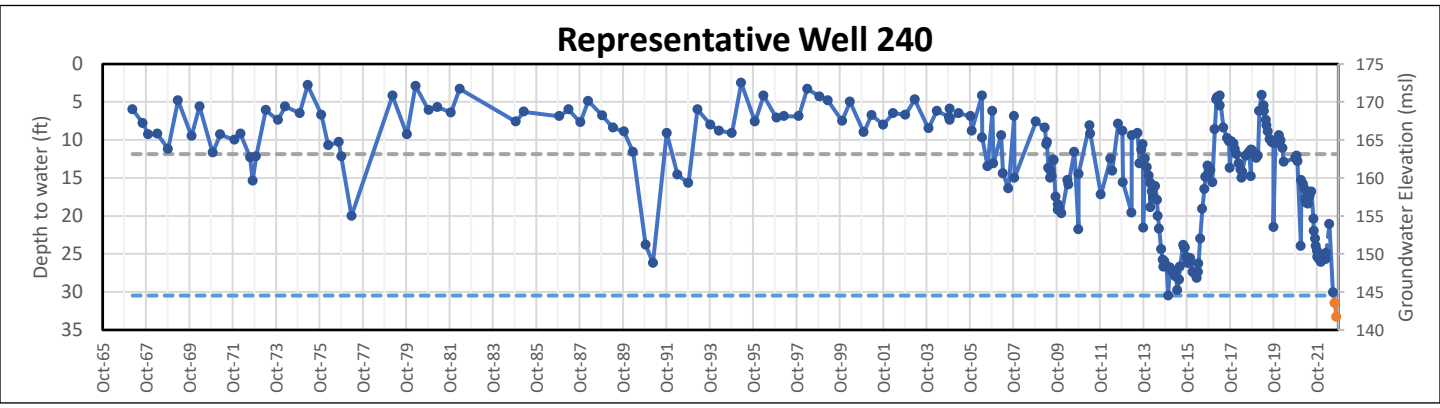


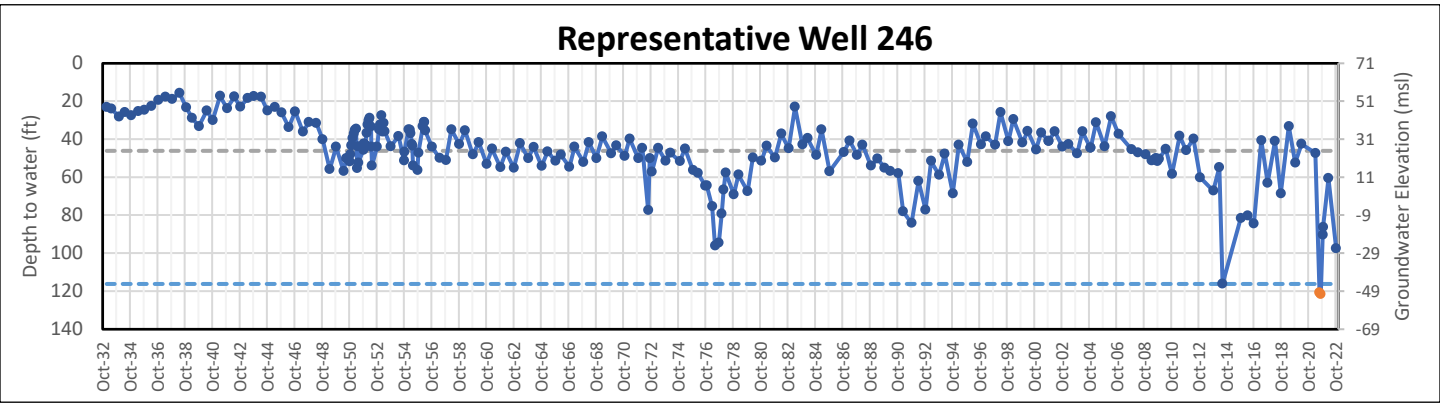
CENTRAL YOLO REPRESENTATIVE HYDROGRAPHS

Minimum Threshold | Measurable Objective | Groundwater Elevation



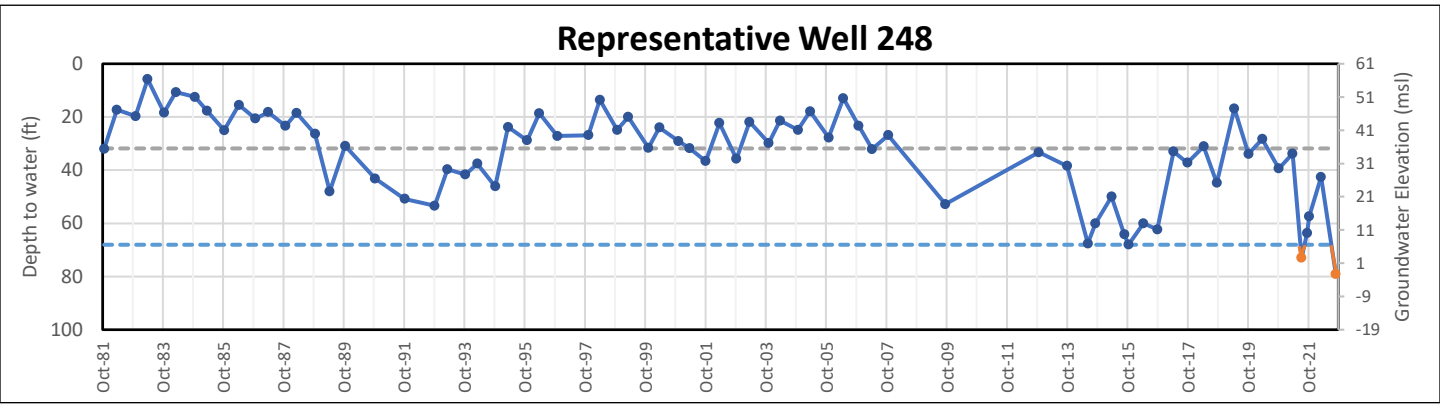


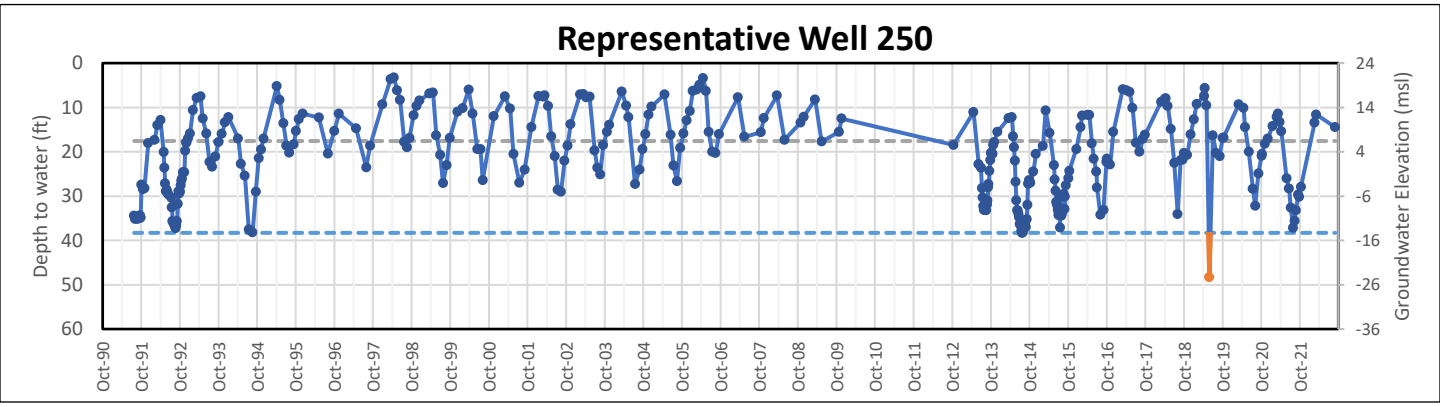


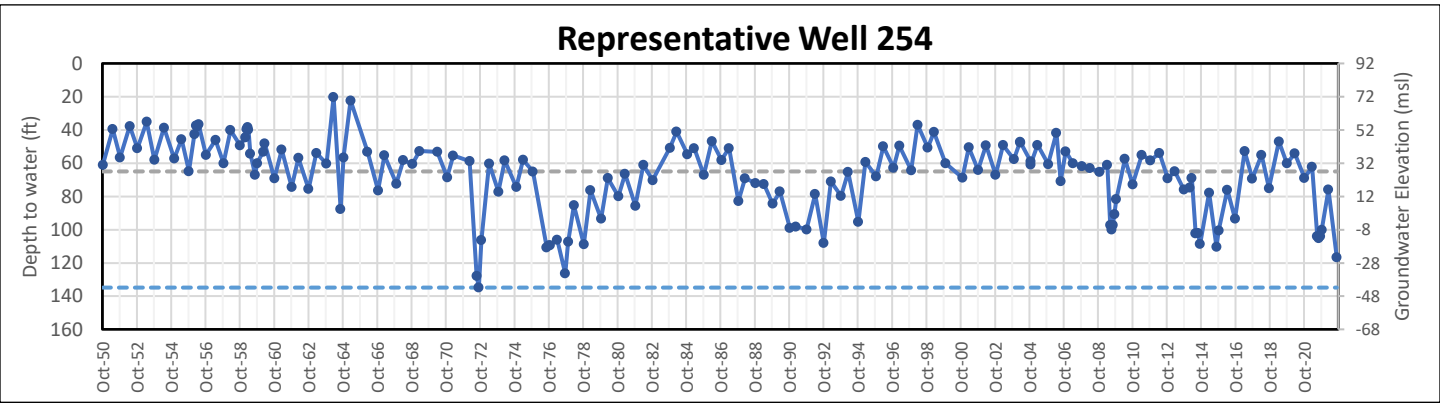


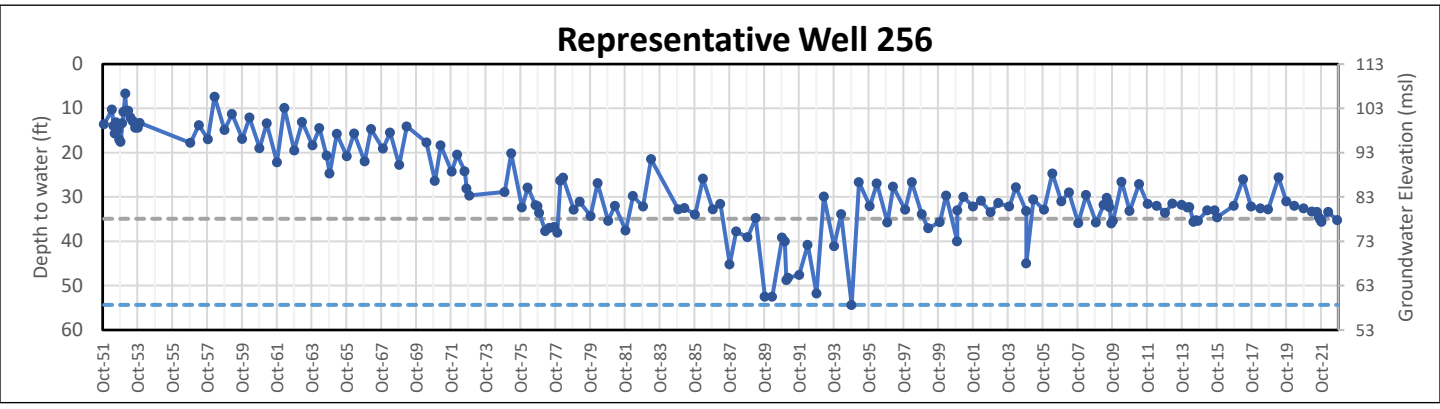
CENTRAL YOLO REPRESENTATIVE HYDROGRAPHS

Minimum Threshold | Measurable Objective | Groundwater Elevation



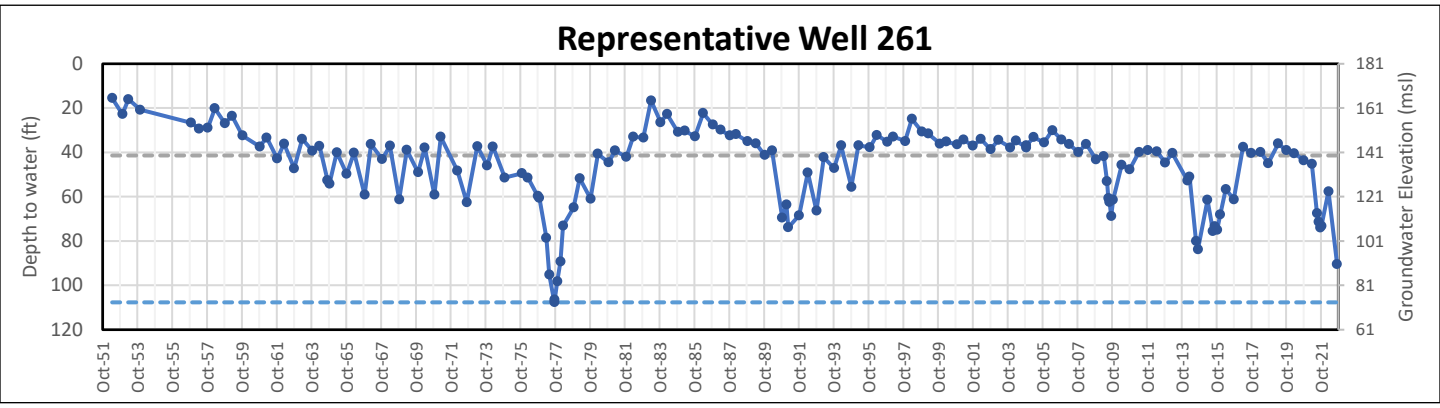


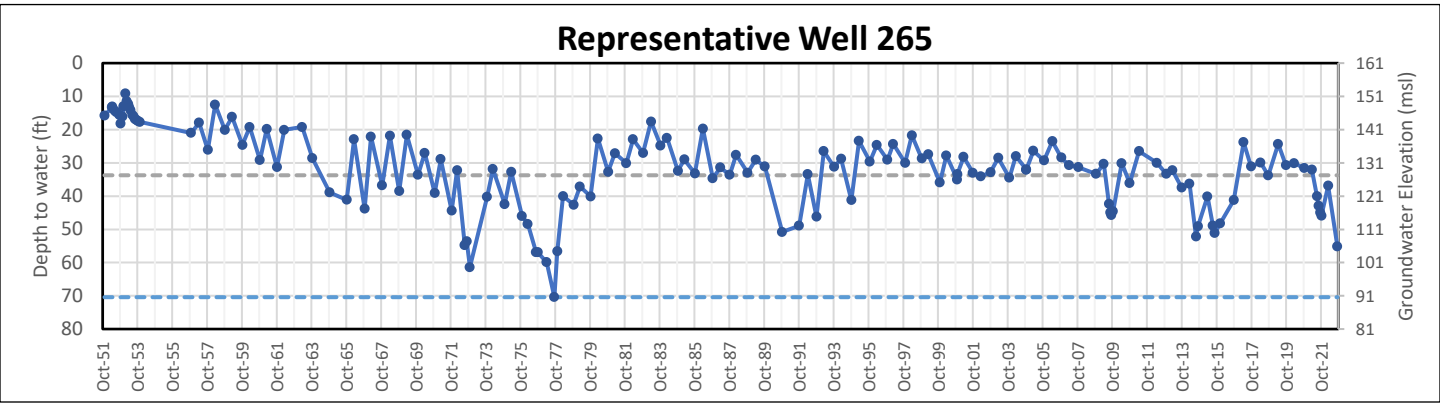


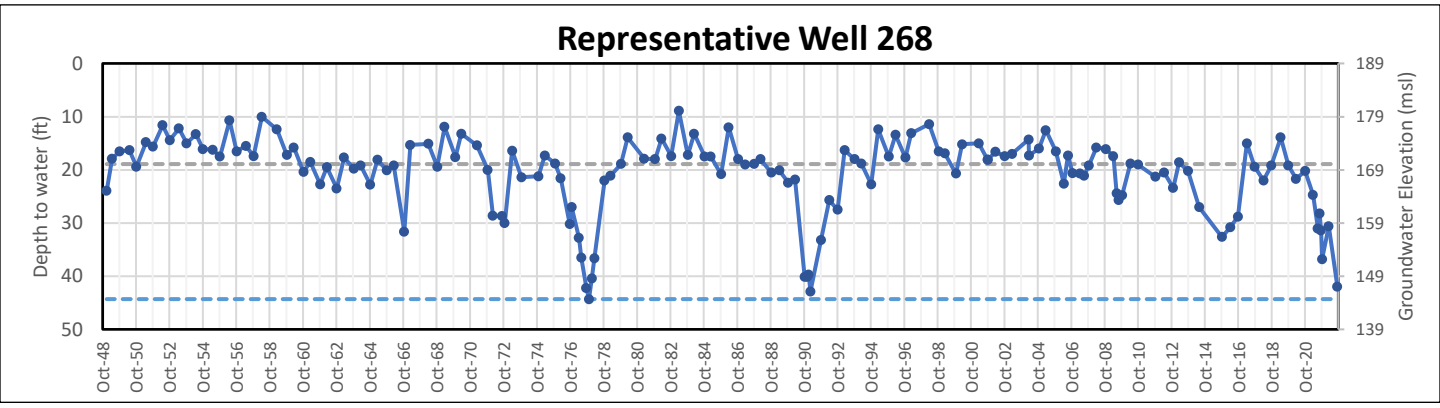


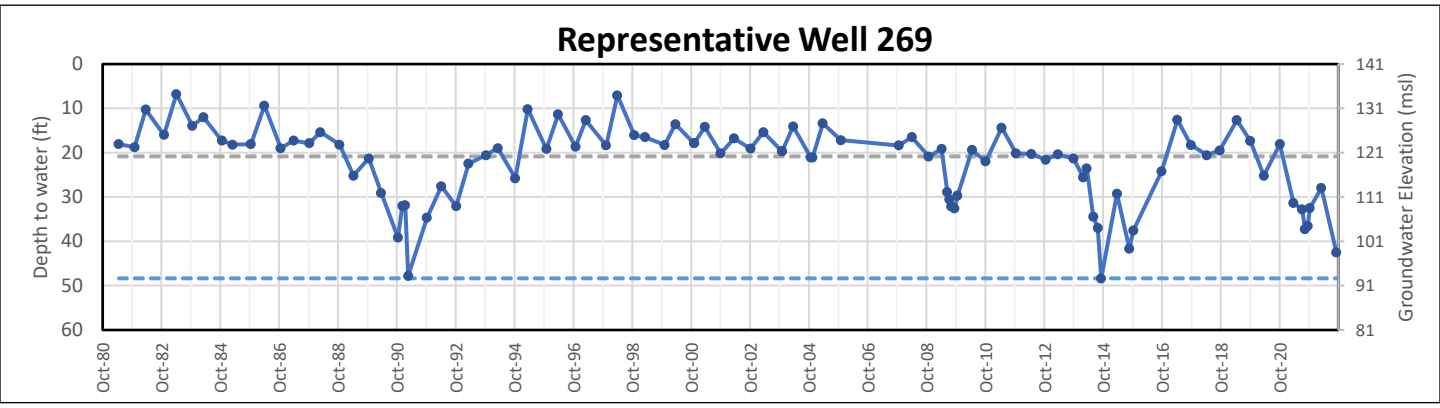
CENTRAL YOLO REPRESENTATIVE HYDROGRAPHS

Minimum Threshold | Measurable Objective | Groundwater Elevation



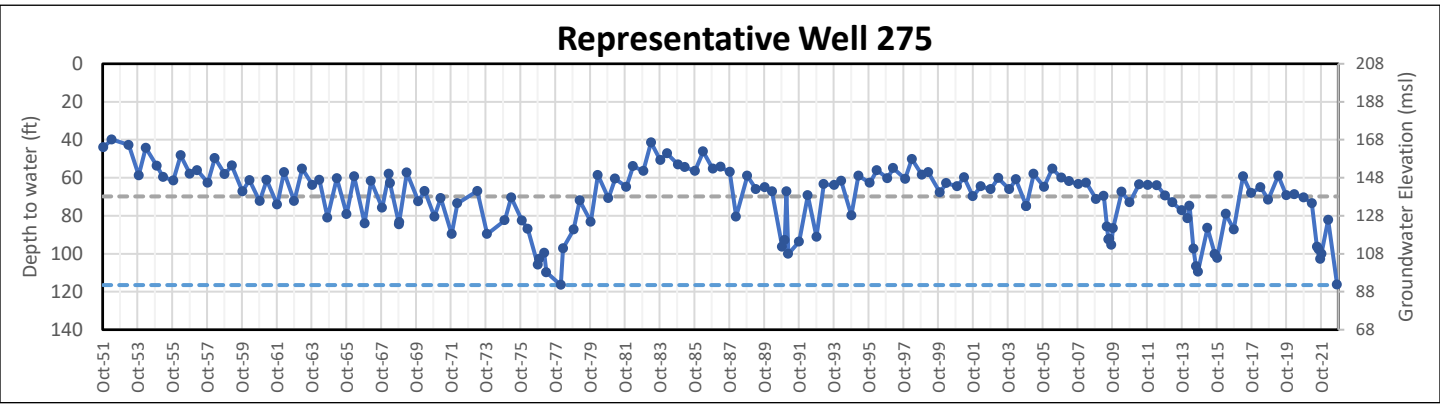


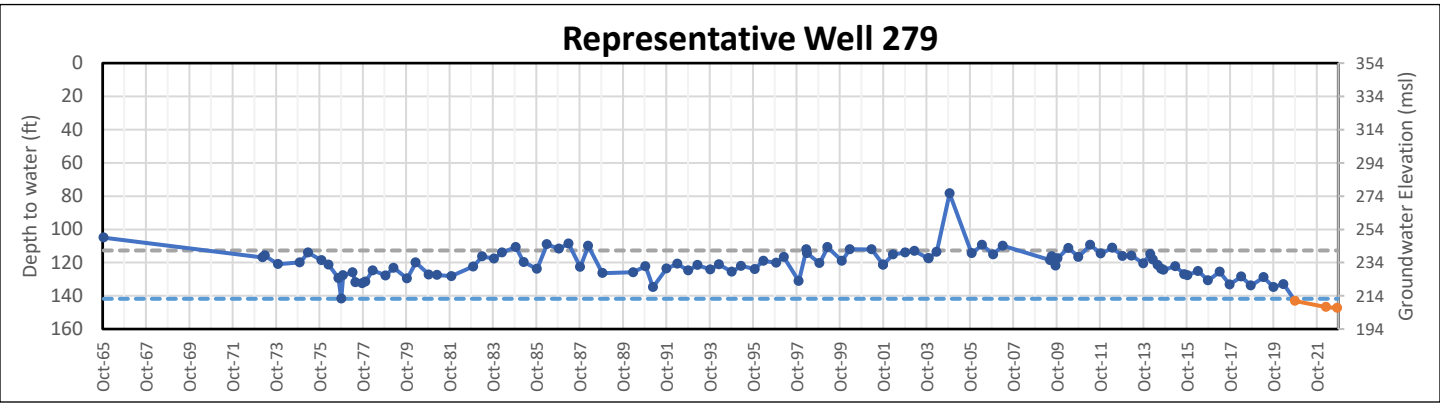


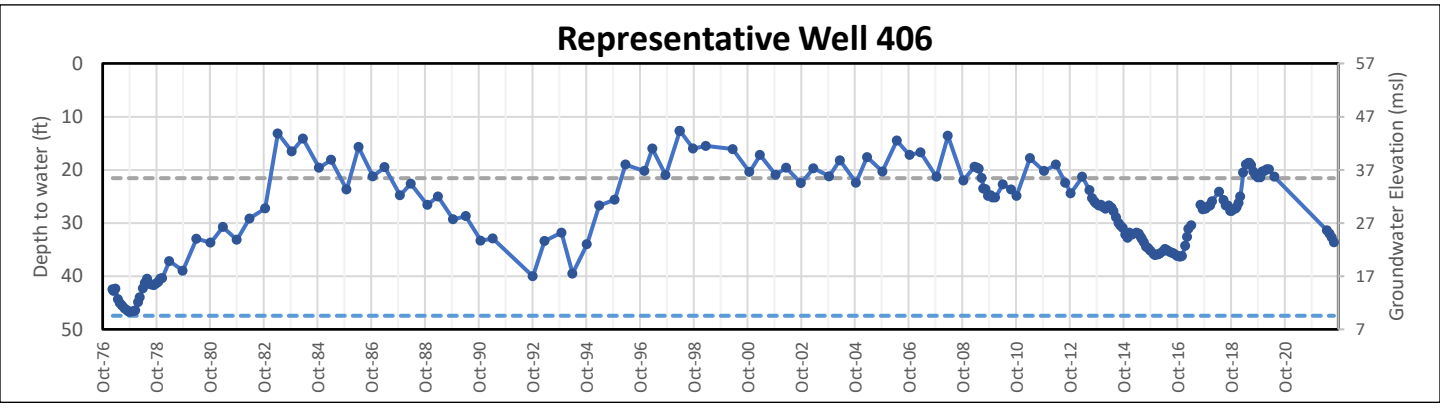


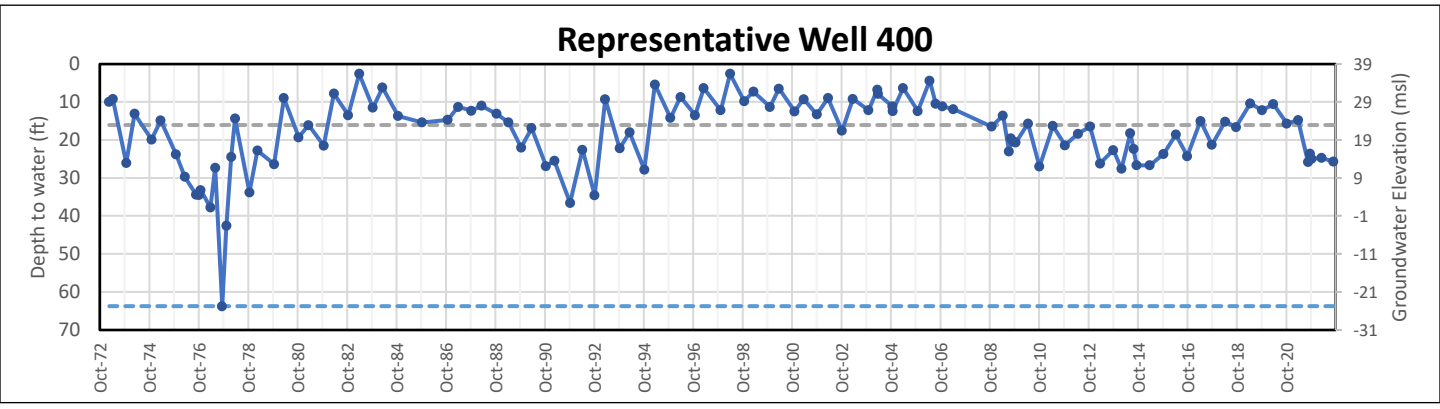
CENTRAL YOLO REPRESENTATIVE HYDROGRAPHS

Minimum Threshold | Measurable Objective | Groundwater Elevation



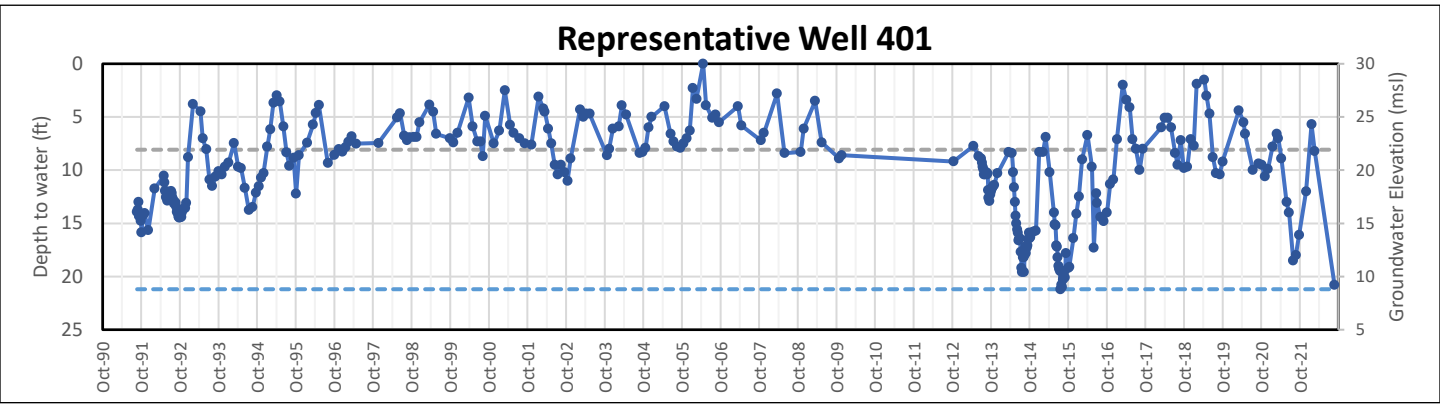


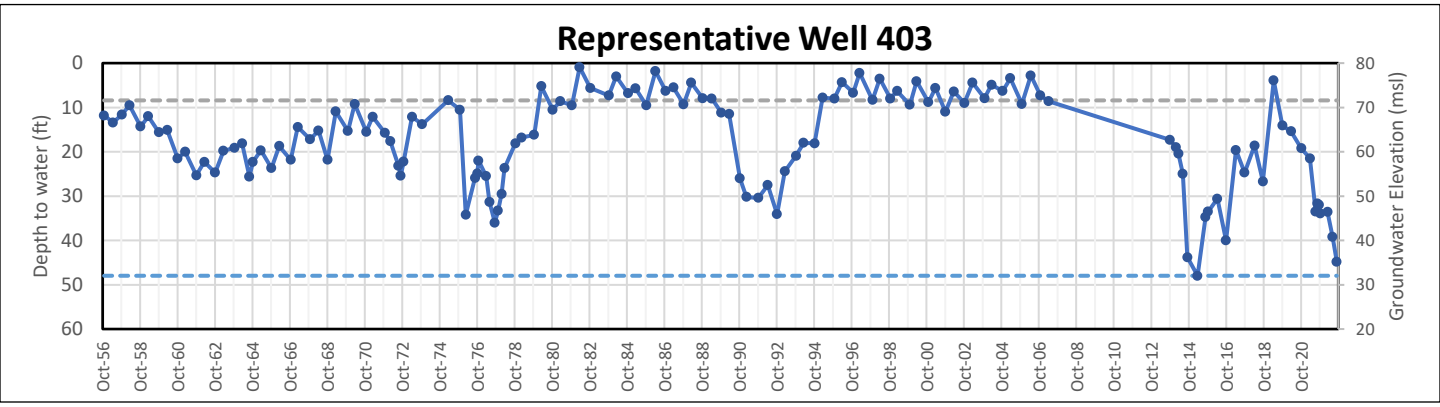


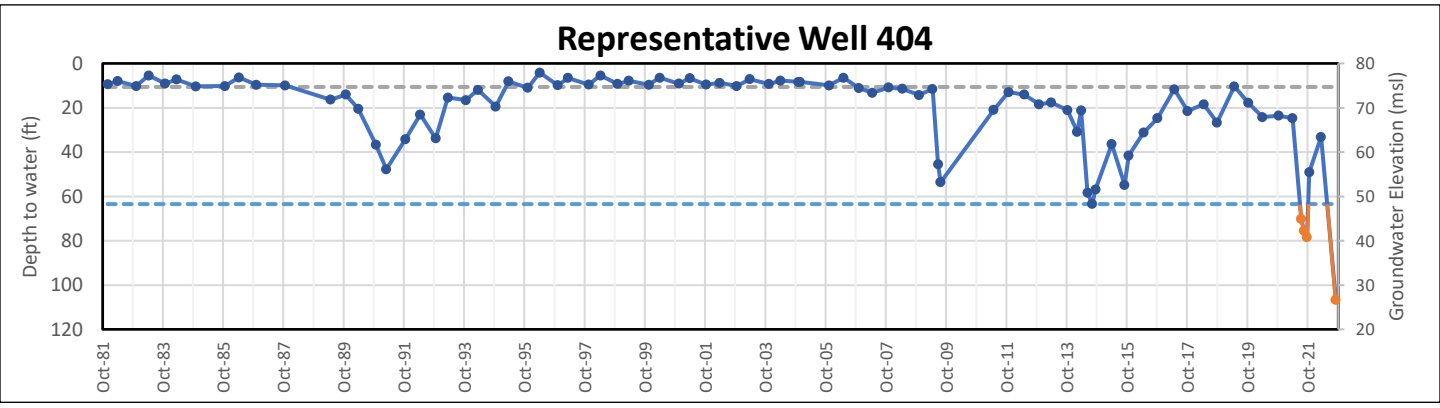


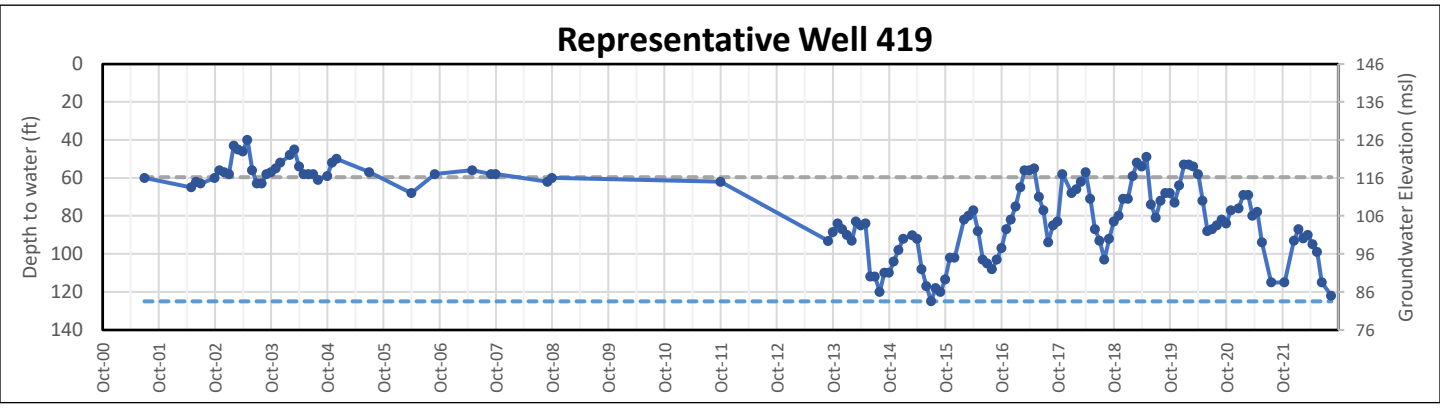
CENTRAL YOLO REPRESENTATIVE HYDROGRAPHS

Minimum Threshold | Measurable Objective | Groundwater Elevation



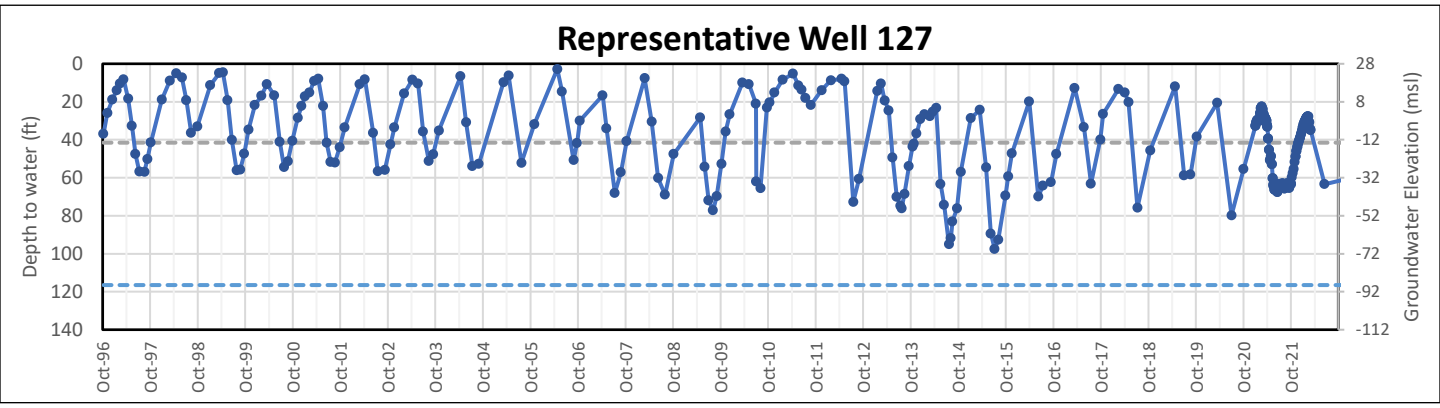


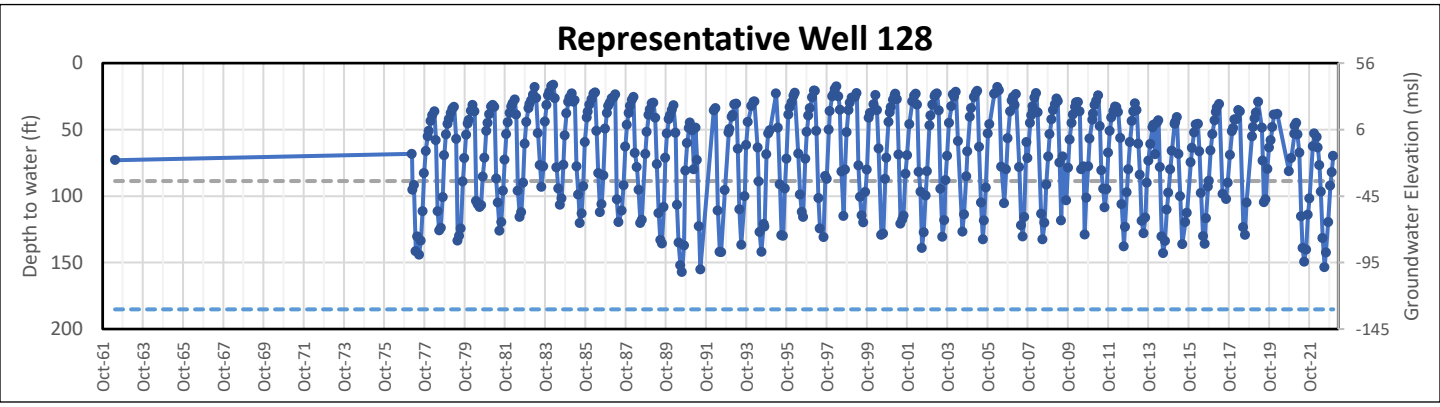


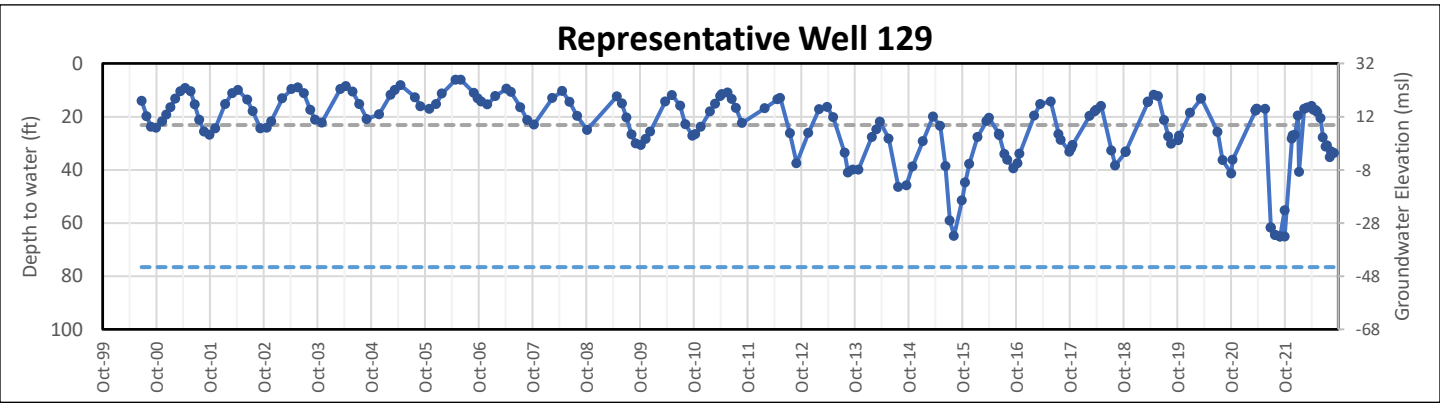


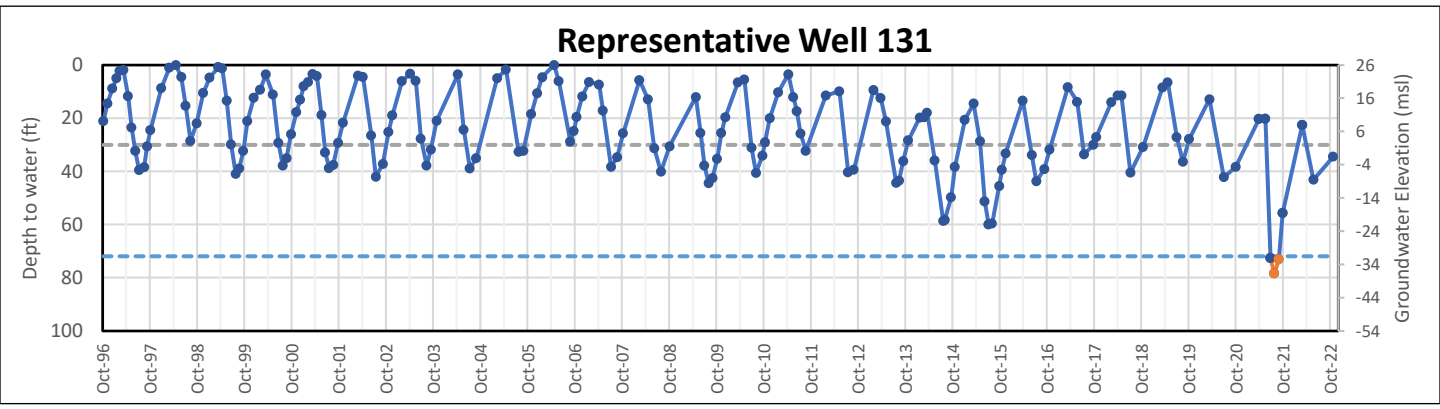
NORTH YOLO REPRESENTATIVE HYDROGRAPHS

Minimum Threshold | Measurable Objective | Groundwater Elevation



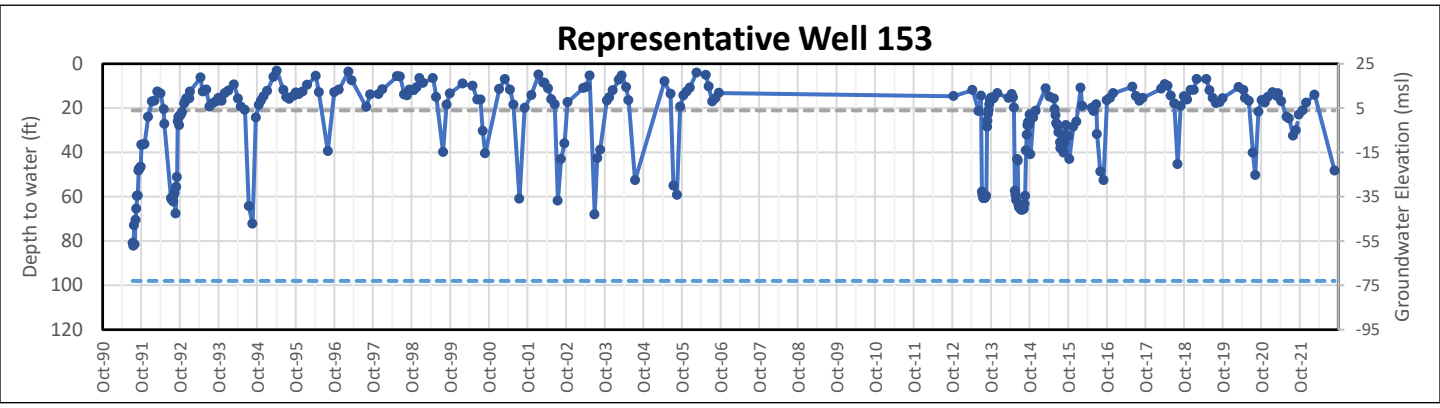


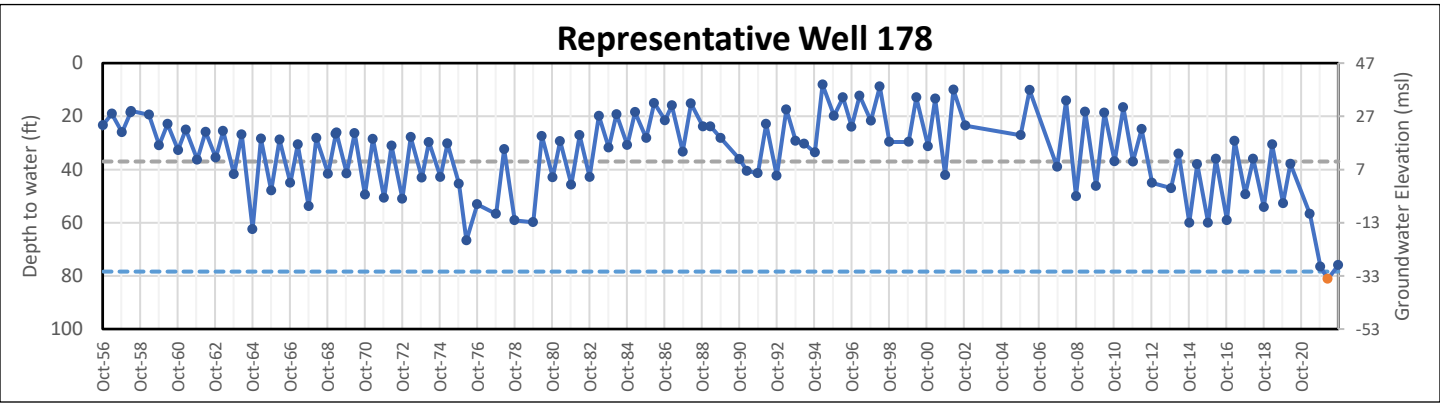


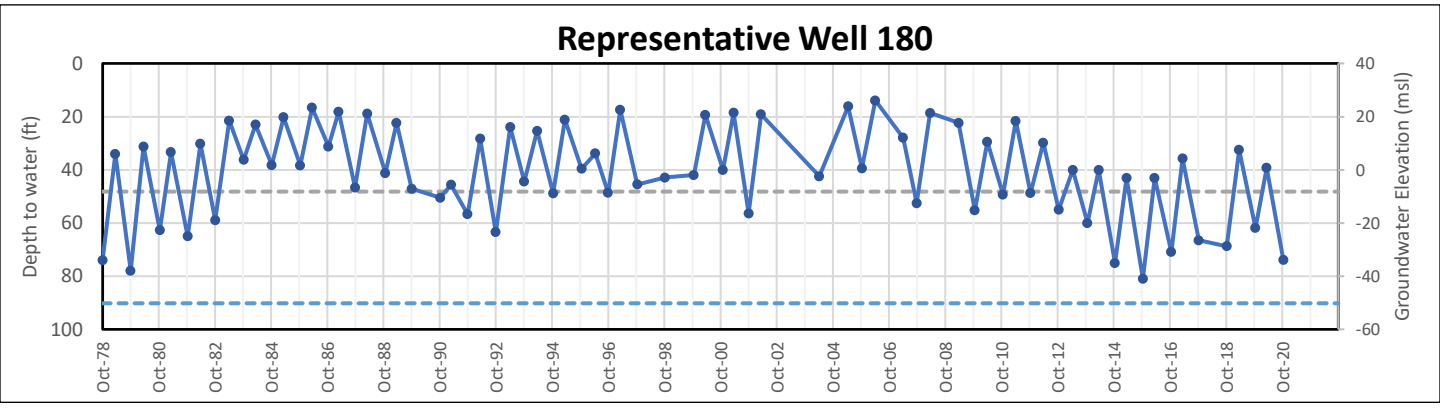


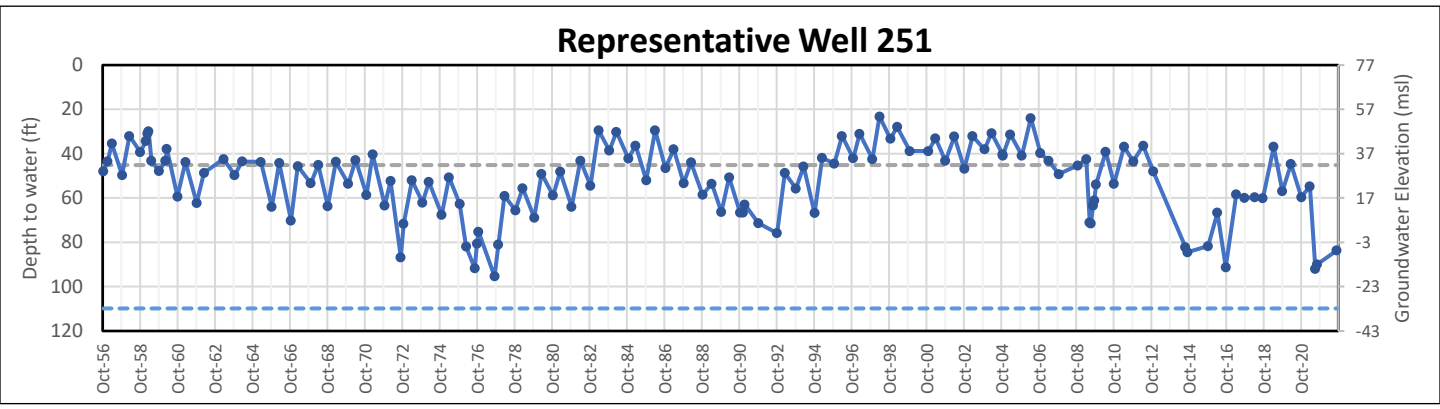
NORTH YOLO REPRESENTATIVE HYDROGRAPHS

Minimum Threshold | Measurable Objective | Groundwater Elevation



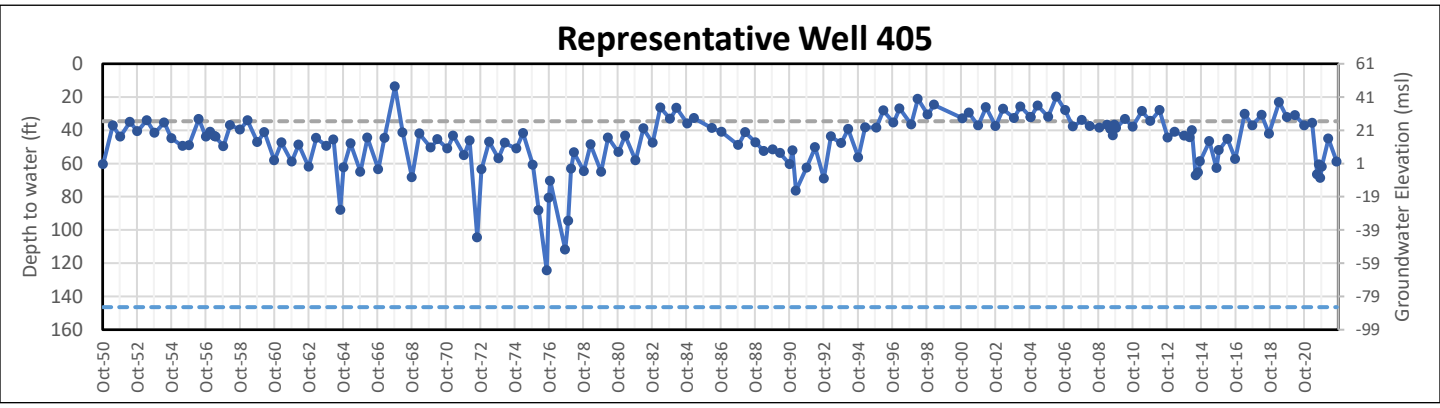


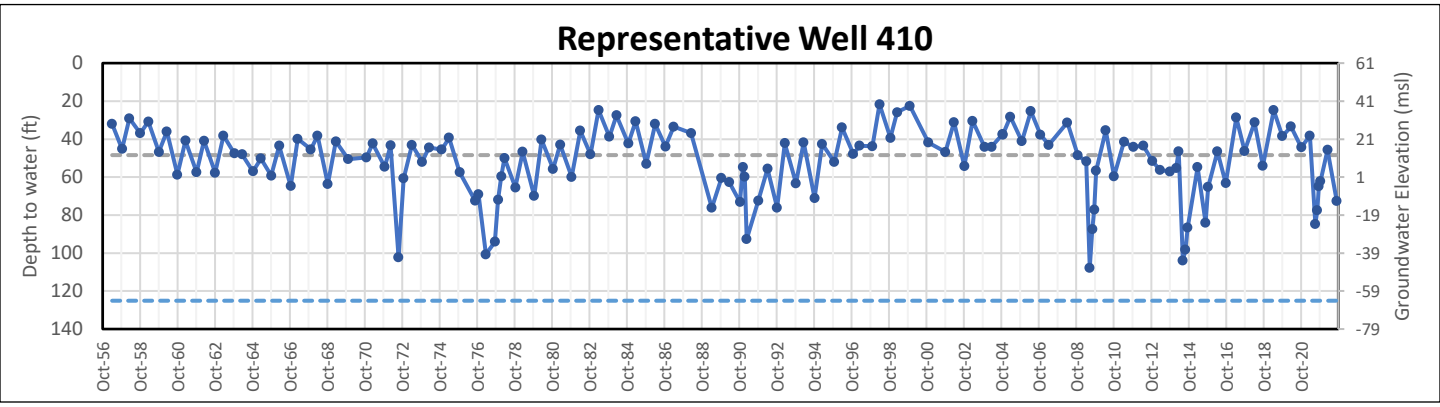


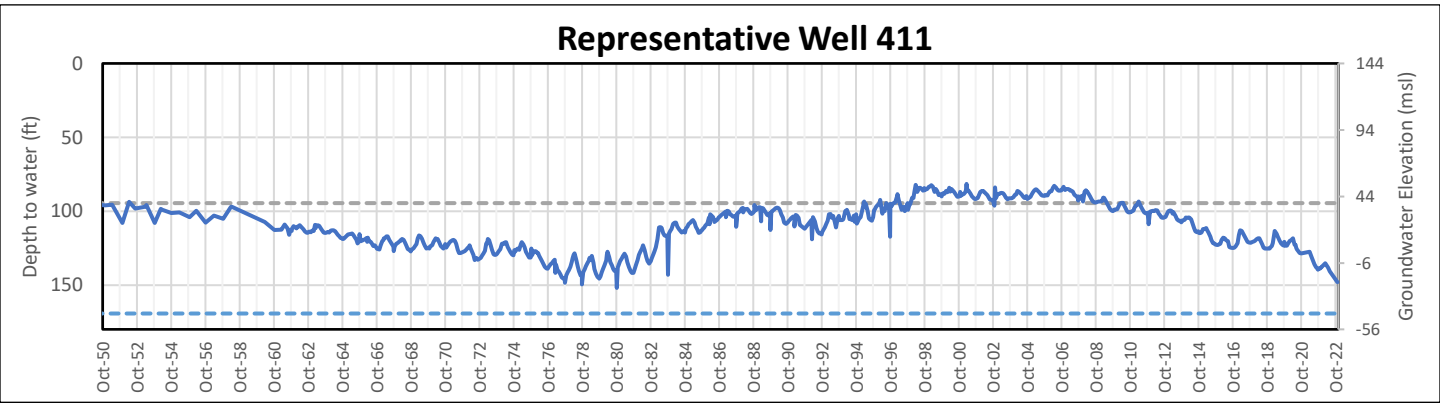


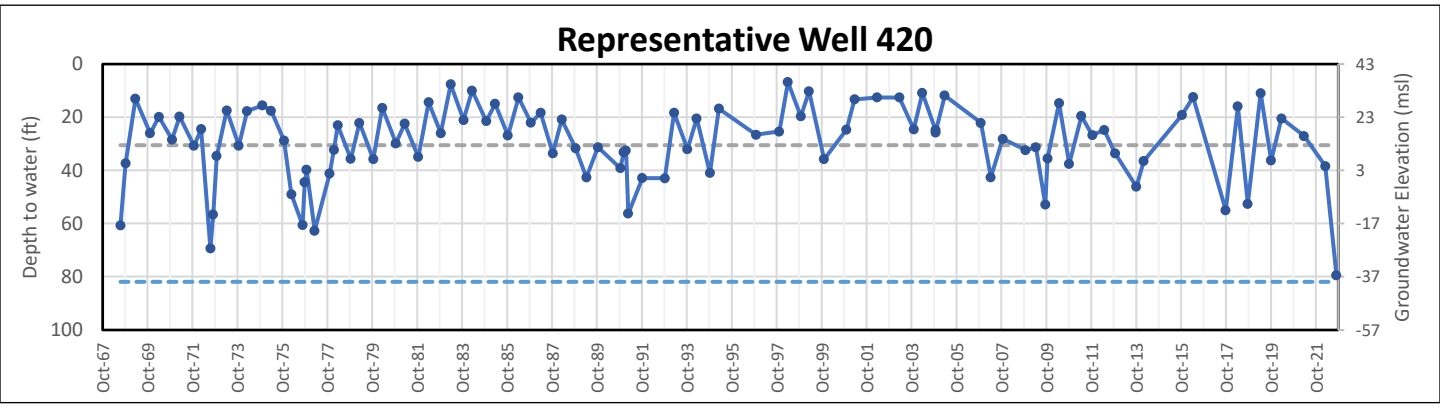
NORTH YOLO REPRESENTATIVE HYDROGRAPHS

Minimum Threshold | Measurable Objective | Groundwater Elevation

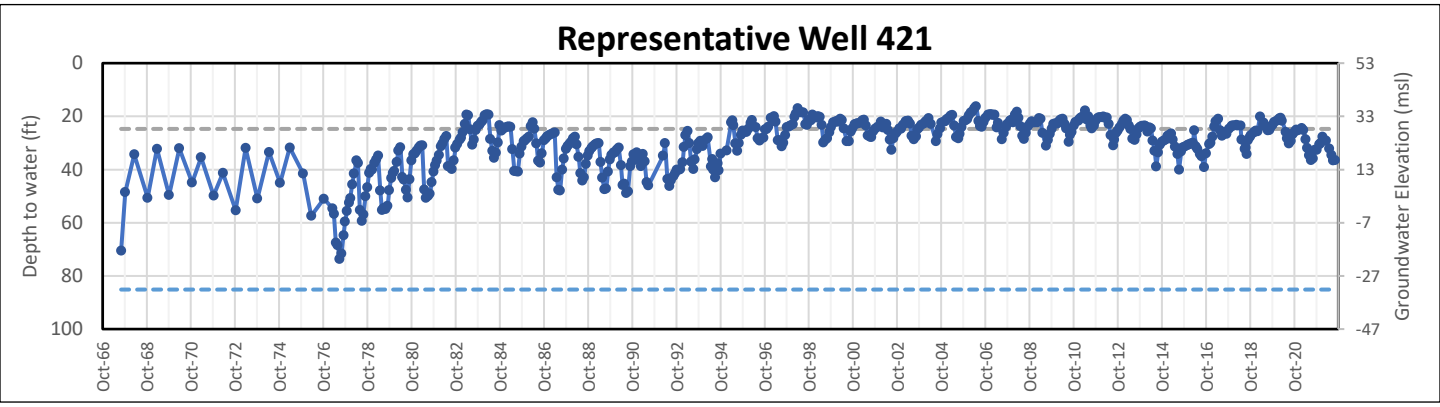








NORTH YOLO REPRESENTATIVE HYDROGRAPHS

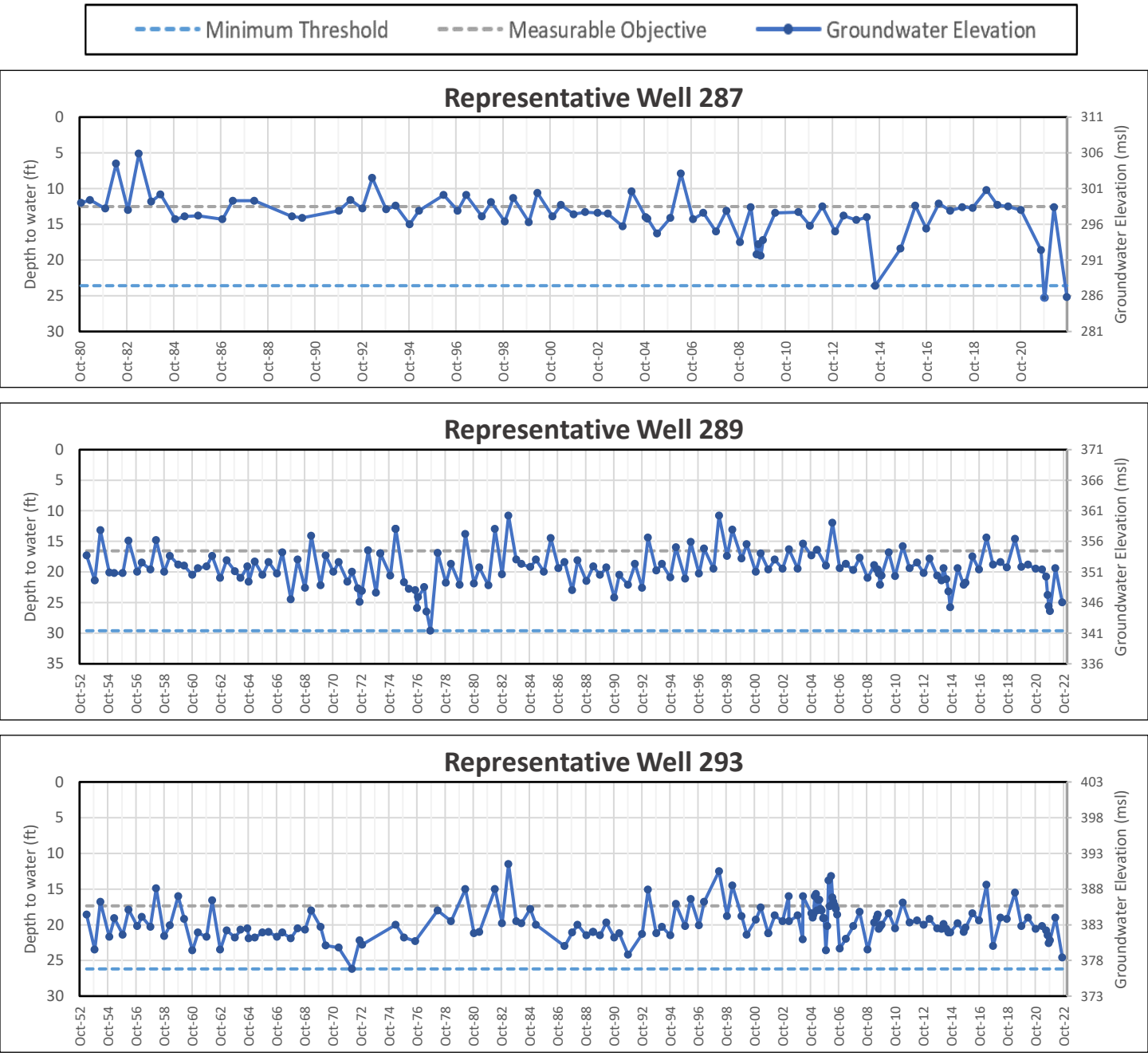


YOLO SUBBASIN GSP ANNUAL REPORT 2023

ATTACHMENT B

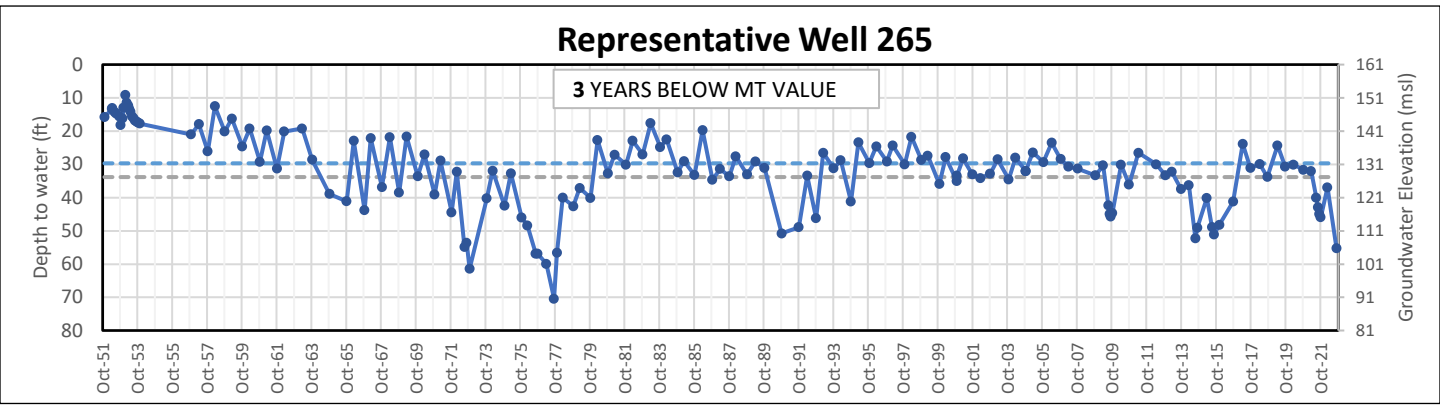
INTERCONNECTED SURFACE WATERS REPRESENTATIVE WELL HYDROGRAPHS

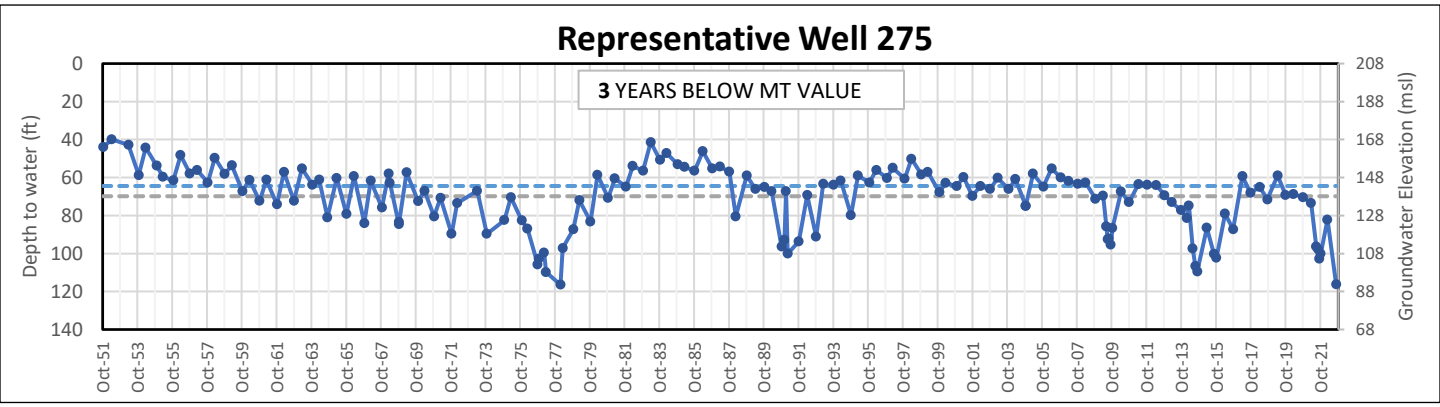
UPPER CACHE CREEK REPRESENTATIVE HYDROGRAPHS

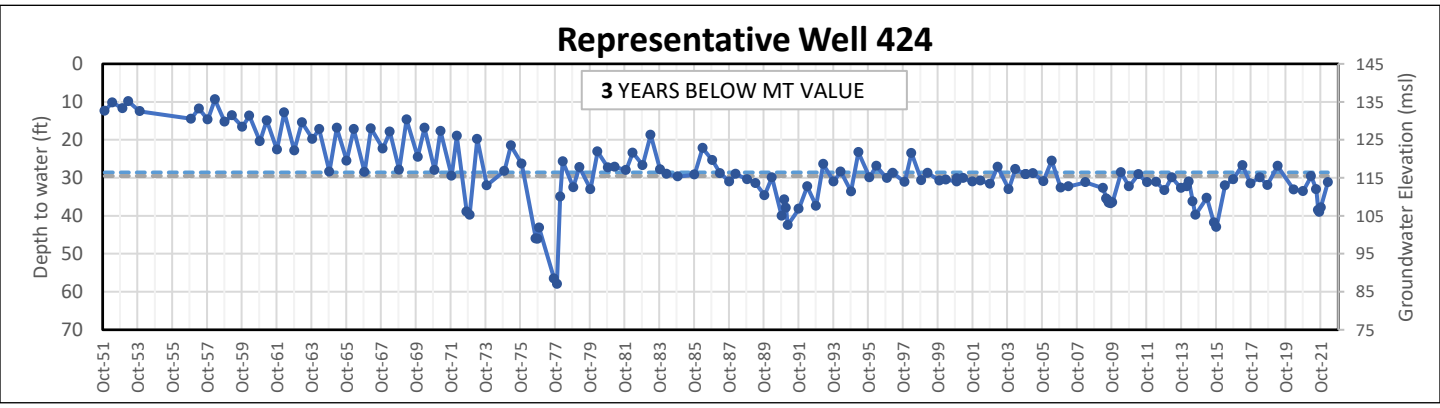


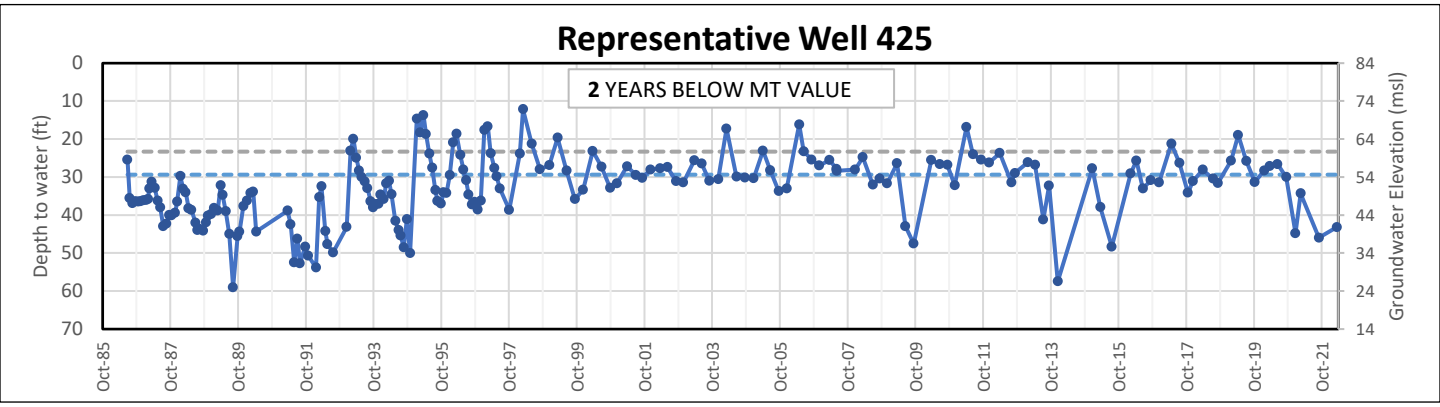
LOWER CACHE CREEK REPRESENTATIVE HYDROGRAPHS

Minimum Threshold | Measurable Objective | Groundwater Elevation

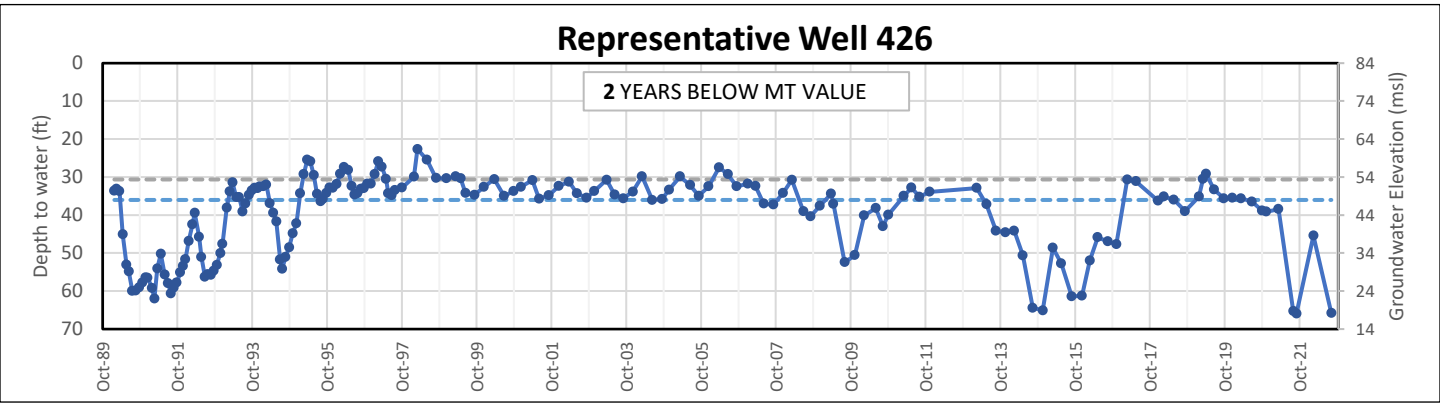




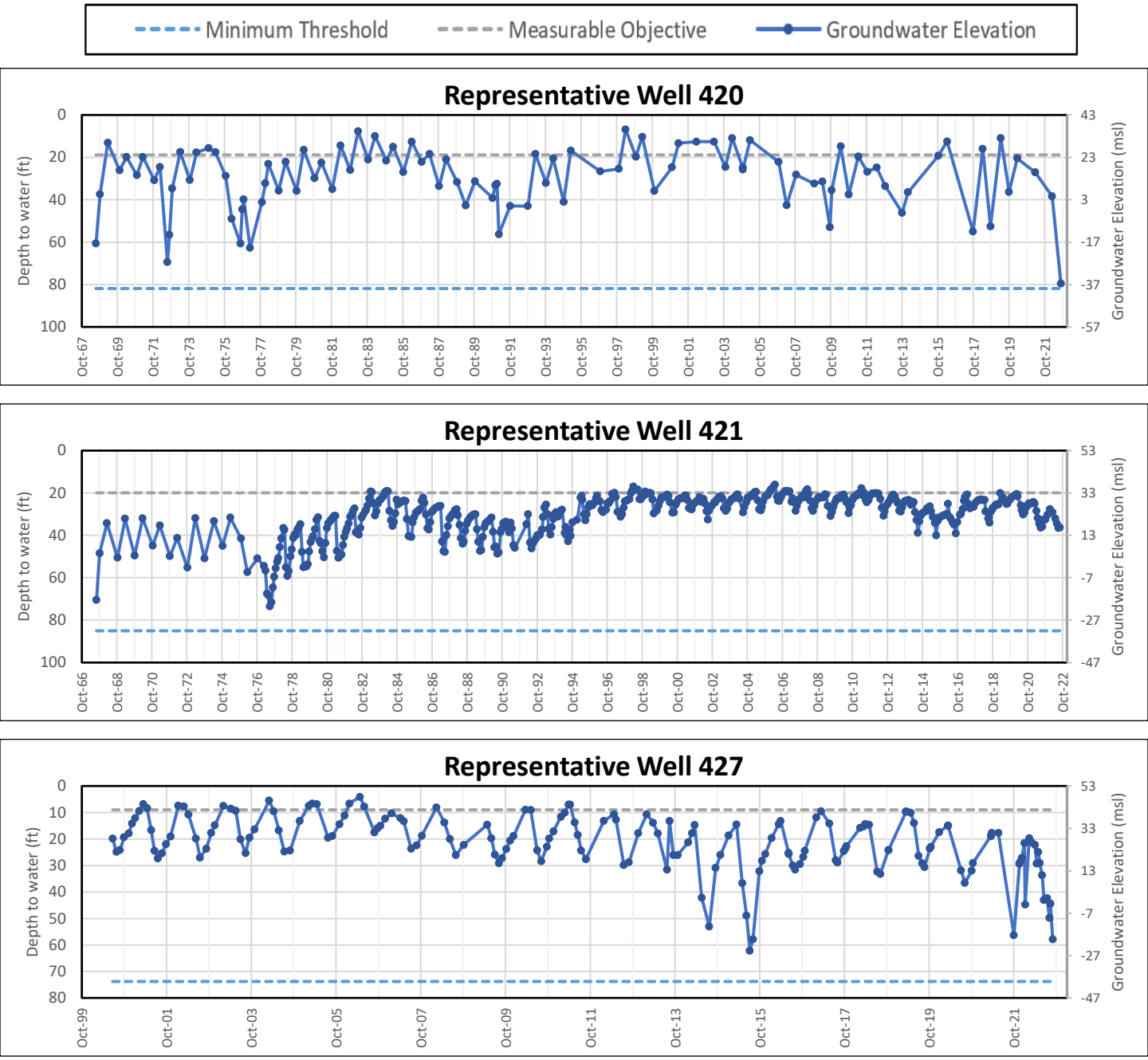




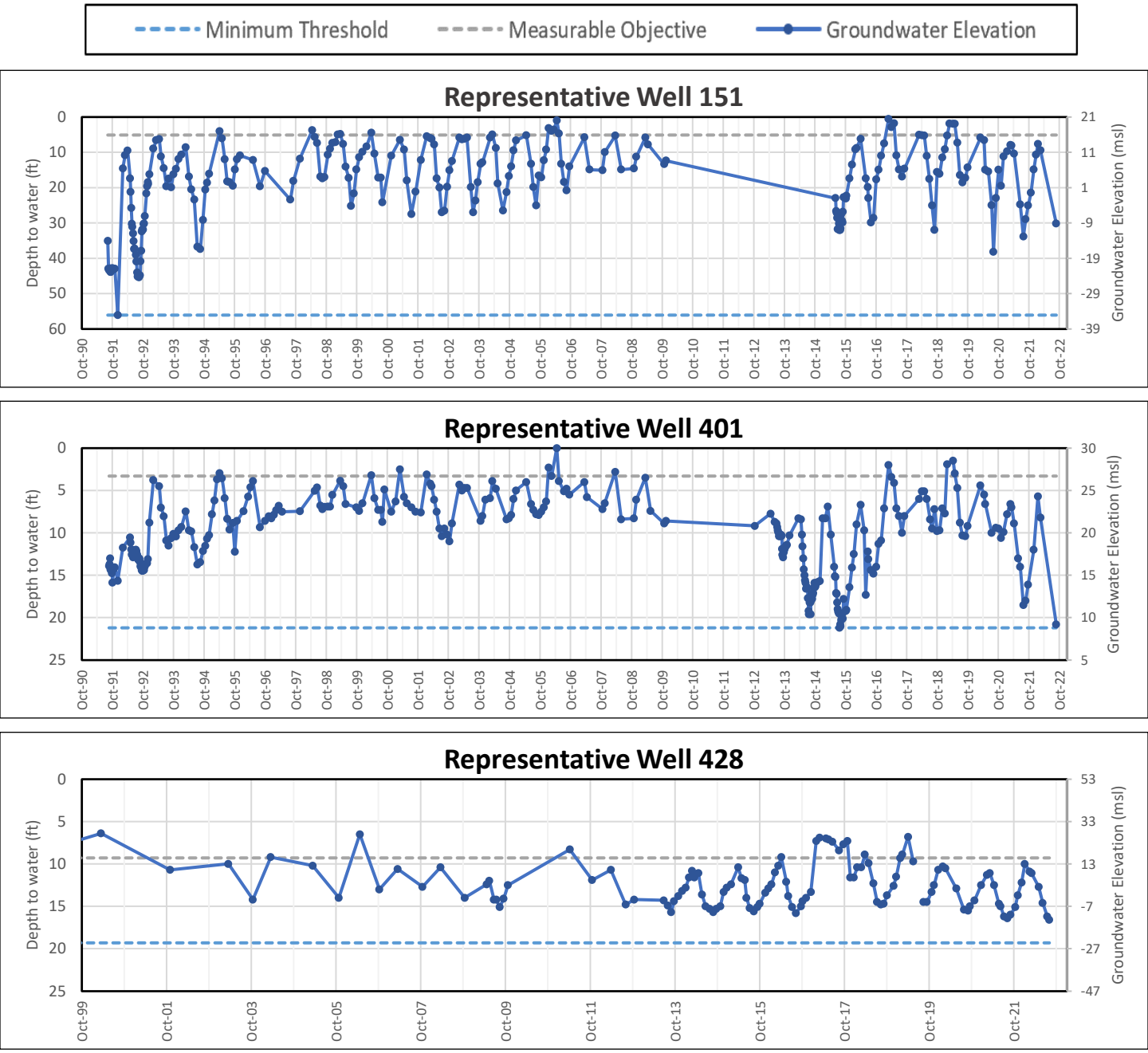
LOWER CACHE CREEK REPRESENTATIVE HYDROGRAPHS



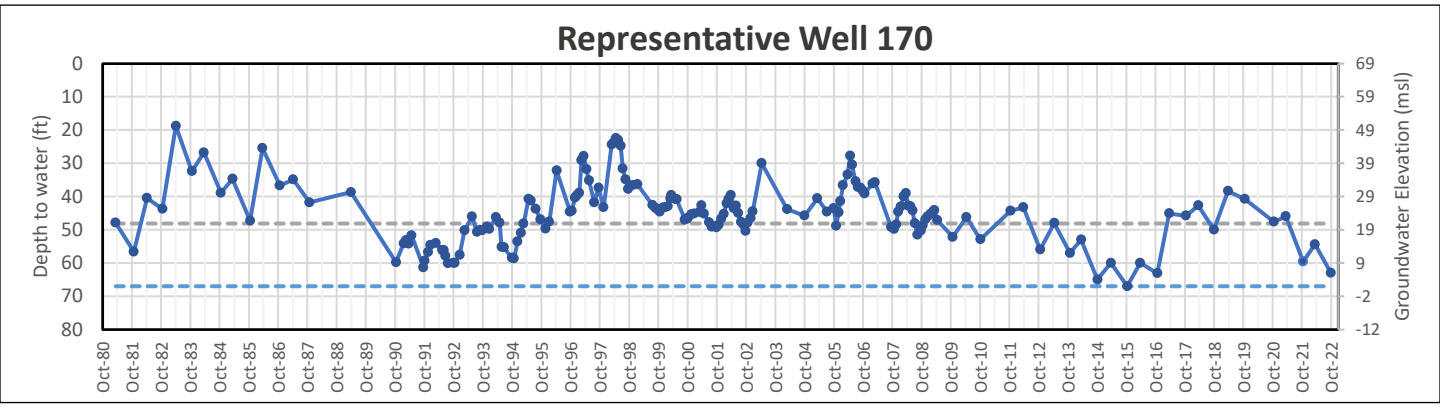
UPPER SACRAMENTO RIVER REPRESENTATIVE HYDROGRAPHS

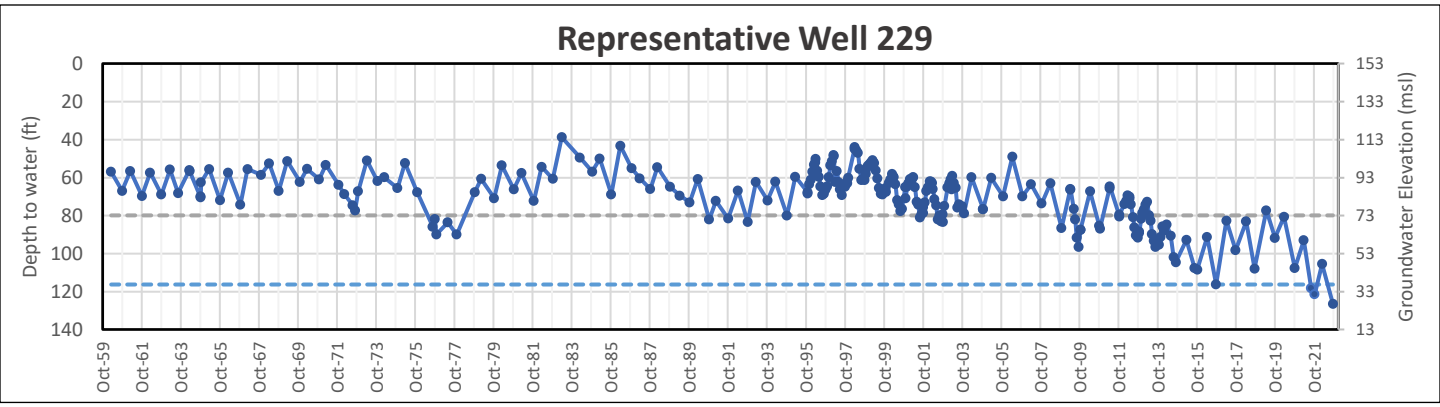


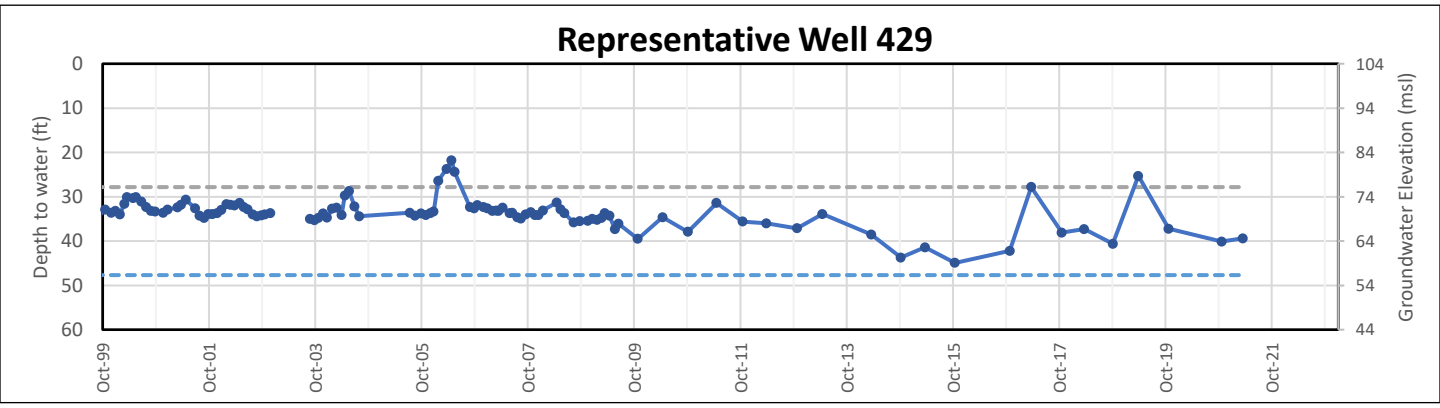
LOWER SACRAMENTO RIVER REPRESENTATIVE HYDROGRAPHS



PUTAH CREEK REPRESENTATIVE HYDROGRAPHS







YSGA
Yolo Subbasin Groundwater Agency
YOLOGROUNDWATER.ORG

530-662-3211
www.yologroundwater.org
34274 State Hwy 16, Woodland CA