

Cuyama Valley Groundwater Basin
Groundwater Sustainability Plan
Groundwater Conditions
Draft

Prepared by:



August 2018

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Chapter 2 Chapter 2.2 Groundwater Conditions

This document includes the Groundwater Conditions Section will be included as part of a report section in the Cuyama Basin Groundwater Sustainability Plan that satisfies § 354.8 of the Sustainable Groundwater Management Act Regulations. Water budget components will be included in the upcoming Groundwater Sustainability Plan (GSP) Section titled “Water Budgets”. The amounts of water moving through the basin, consumptive uses, and inflows and outflows of the basin, comparisons of extractions to recharge, and other components, will be presented in the water budget section.

The majority of published information about groundwater in the Cuyama Valley Groundwater Basin has been focused on the central part of the basin, roughly from an area a few miles west of New Cuyama to roughly Ventucopa. The eastern uplands and western portion of the basin has been studied less, and consequentially, fewer publications have been written about those areas, and less historical information is available in those areas.

There are a small number of sub-sections that are not complete at this time, due to requiring either groundwater modeling results or field work to complete the sub-section. These subsection titles are highlighted yellow and a list of the subsections intended contents is listed.

2.1 Acronyms

Basin	Cuyama Valley Groundwater Basin
bgs	below ground surface
CUVHM	Cuyama Valley Hydrologic Model
DWR	Department of Water Resources
ft.	feet
ft/day	feet per day
GAMA	Groundwater Ambient Monitoring and Assessment
GPS	global positioning system
GSP	Groundwater Sustainability Plan
InSAR	Interferometric Synthetic-Aperture Radar
MCL	Maximum Contaminant Level
RWQCB	Regional Water Quality Control Board
SBCF	Santa Barbara Canyon Fault
SBCWA	Santa Barbara County Water Agency
SGMA	Sustainable Groundwater Management Act
TDS	Total Dissolved Solids
UNAVCO	University NAVSTAR Consortium
USGS	United States Geological Survey

2.2 Groundwater Conditions

This section describes the historical and current groundwater conditions in the Cuyama Valley Groundwater Basin (Basin). As defined by the GSP regulations promulgated by the Department of Resources (DWR), the groundwater conditions section is intended to:

- Define current groundwater conditions in the Basin
- Describe historical groundwater conditions in the Basin
- Describe the distribution, availability, and quality of groundwater
- Identify interactions between groundwater, surface water, dependent ecosystems, and subsidence
- Establish a baseline of quality and quantity conditions that will be used to monitor changes in the groundwater conditions relative to measurable objectives and minimum thresholds
- Define measurable objectives to maintain or improve specified groundwater conditions
- Support monitoring to demonstrate that the GSP is achieving sustainability goals of the Basin

The groundwater conditions described in this section are intended to convey the present and historical availability, quality, and distribution of groundwater and are used elsewhere in the GSP to define measurable objectives, identify sustainability indicators, and establish undesirable results. Groundwater conditions in the Basin vary by location. To assist in discussion of the location of specific groundwater conditions, Figure 2.2-1 shows selected landmarks in the Basin to assist discussion of the location of specific groundwater conditions. Figure 2.2-1 shows major faults in the basin in red, highways in yellow, towns as orange dots, and canyons and Bitter Creek in purple lines that show their location.

2.2.1 Useful Terminology

The groundwater conditions section includes descriptions of the amounts, quality, and movement of groundwater, among other related components. A list of technical terms and a description of the terms are listed below. The terms and their descriptions are identified here to guide readers through the section and are not a definitive definition of each term:

- **Historical high groundwater elevations** – This is the highest measurement of groundwater elevation (closest to the ground surface) in a monitoring well that was recorded. Measurements of groundwater elevation are used to indicate the elevation of groundwater levels in the area near the monitored well.
- **Historical low groundwater elevations** – This is the lowest measurement of groundwater elevation (furthest from the ground surface) in a monitoring well that was recorded. Measurements of groundwater elevation are used to indicate the elevation of groundwater levels in the area near the monitored well.
- **Depth to Groundwater** – This is the distance from the ground surface to groundwater, typically reported at a well.
- **Horizontal gradient** – The gradient is the slope of groundwater from one location to another when one location is higher, or lower than the other. The gradient is shown on maps with an arrow showing the direction of groundwater flow in a horizontal direction.
- **Vertical gradient** – A vertical gradient describes the movement of groundwater perpendicular to the ground surface. Vertical gradient is measured by comparing the elevations of groundwater in wells that are of different depths. A downward gradient is one where groundwater is moving down into the ground, and an upward gradient is one where groundwater is upwelling towards the surface.
- **Contour Map** – A contour map shows changes in groundwater elevations by interpolating groundwater elevations between monitoring sites. The elevations are shown on the map with the use of a contour line, which indicates that at all locations that line is drawn, it represents

groundwater being at the elevation indicated. There are two versions of contour maps used in this section, one which shows the elevation of groundwater above mean sea level (msl), which is useful because it can be used to identify the horizontal gradients of groundwater, and one which shows contours of depth to water, the distance from the ground surface to groundwater, which is useful because it can identify areas of shallow or deep groundwater.

- **Hydrograph** – A hydrograph is a graph that shows the changes in groundwater elevation over time for each monitoring well. Hydrographs show how groundwater elevations change over the years and indicate whether groundwater is rising or descending over time.
- **MCL** – Maximum Contaminant Levels (MCLs) are standards that are set by the State of California for drinking water quality. An MCL is the legal threshold limit on the amount of a substance that is allowed in public water systems. The MCL is different for different constituents.
- **Elastic Land Subsidence** - is the reversible and temporary fluctuation in the earth's surface in response to seasonal periods of groundwater extraction and recharge.
- **Inelastic Land Subsidence** – is the irreversible and permanent decline in the earth's surface resulting from the collapse or compaction of the pore structure within the fine-grained portions of an aquifer system

2.2.2 Groundwater Elevation Data Processing

Groundwater well information and groundwater level monitoring data were collected from eight major sources, and a small number of additional data were collected from private stakeholders. Well and groundwater elevation data were collected from:

- United States Geologic Survey (USGS)
- Department of Water Resources (DWR)
- Santa Barbara County
- San Luis Obispo County
- Private Landowners
- Santa Barbara County Water Agency (SBCWA)

Data collected included well information such as location, well construction, owner, ground surface elevation and other related components. Data collected also included groundwater elevation data including information such as date measured, depth to water, groundwater surface elevation, questionable measurement code, and comments. Groundwater elevation data was available covering the time period from 1949 to 2018. Many monitoring wells were monitored in the past, but were not monitored recently, while a small number of monitoring wells have been monitored for over 50 years. Figure 2.2-2 through Figure 2.2-5 show the locations of monitoring well data collected by each entity. The figures also show in a larger, darker symbol if the monitoring well has been measured in 2017 or 2018.

Figure 2.2-2 shows the locations of well data received from the DWR database. Roughly half of the wells from DWR's database were monitored in 2017-18, and half were not measured in 2017-18. Wells in DWR's database are concentrated in the central portion of the basin, east of Bitter Creek and north of the Santa Barbara Canyon Fault (SBCF). Data collected from DWR has been typically measured bi-annually, with one measurement in the spring, and one measurement in the fall.

Figure 2.2-3 shows the locations of well data received from the USGS database. The majority of wells from the USGS database were not monitored in 2017-18. Wells that were monitored in 2017-18 are concentrated in the western portion of the basin, west of New Cuyama, with a small number of monitoring wells in the central portion of the basin and near Ventucopa. Data collected from USGS has been typically measured bi-annually, with one measurement in the spring, and one measurement in the fall.

Figure 2.2-4 shows the locations of well data received from the Santa Barbara and San Luis Obispo Counties. The wells from both counties were monitored in 2017-18. Santa Barbara wells are concentrated in the western portion of the basin west of Bitter Creek. The two San Luis Obispo wells are located in the central portion of the basin and also appeared in the USGS database. Data collected from the counties has been typically measured bi-annually, with one measurement in the spring, and one measurement in the fall.

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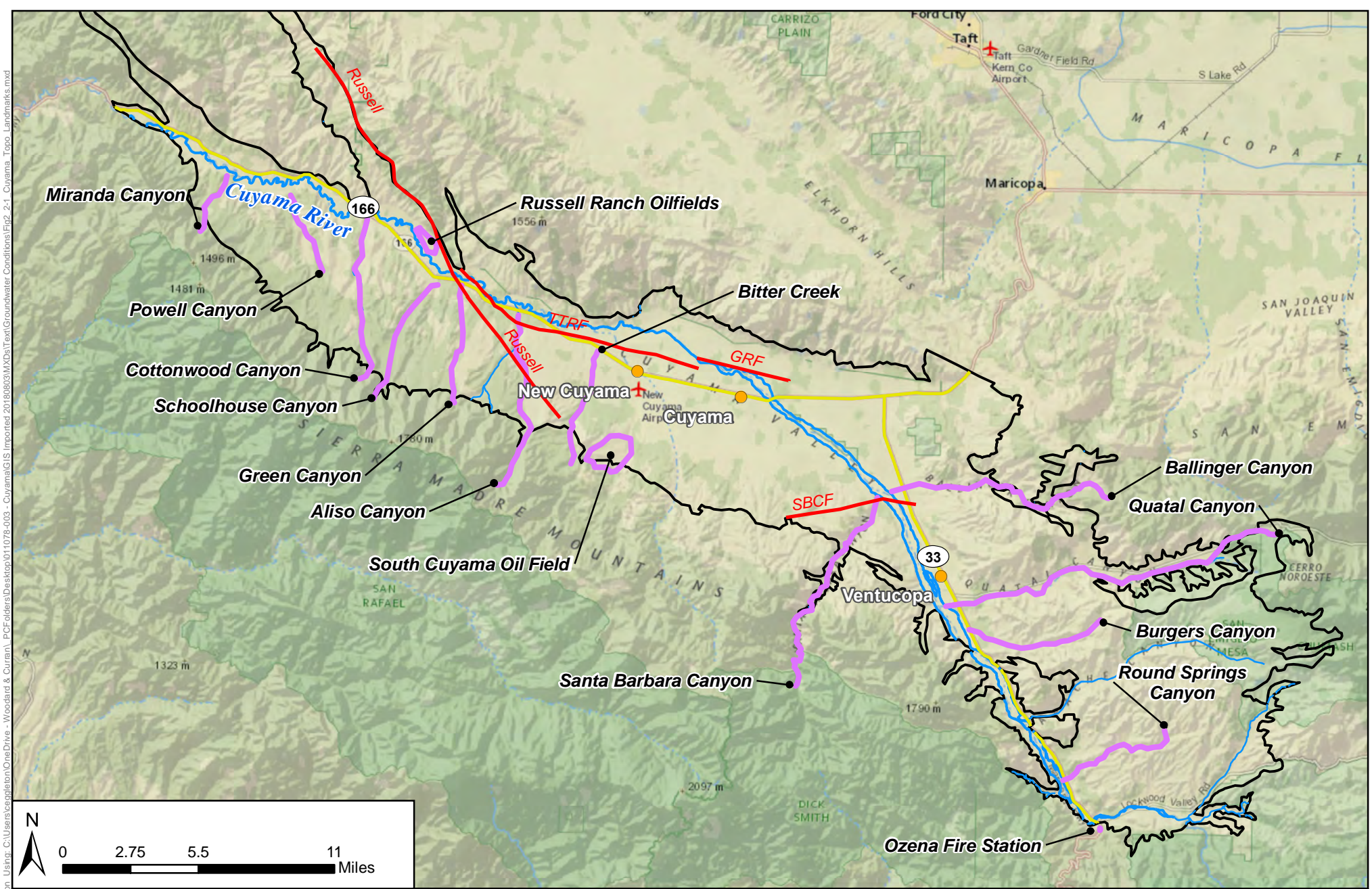


Figure 2.2-1 - Cuyama Basin Landmarks

Cuyama Basin Groundwater Sustainability Agency
 Cuyama Valley Groundwater Basin Groundwater Sustainability Plan
 August 2018

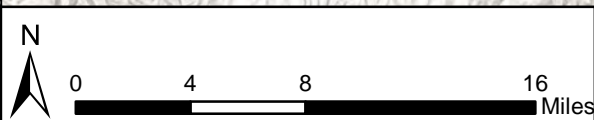
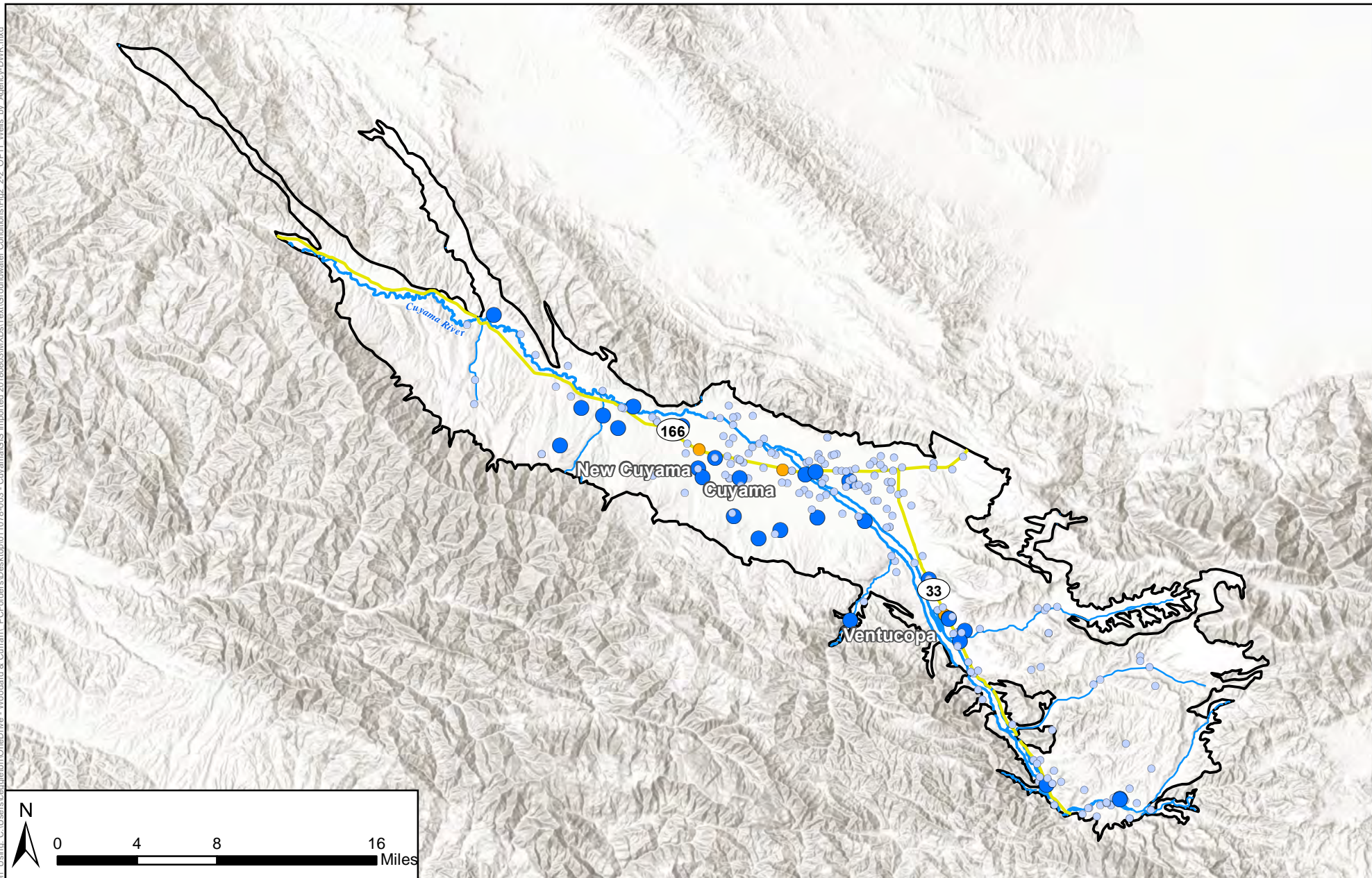


Legend

- Cuyama Basin
- Cuyama River
- Towns
- Streams
- Highways
- Landmarks
- Faults

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**Figure 2.2-2: Cuyama GW Basin
DWR Wells**

Cuyama Basin Groundwater Sustainability Agency

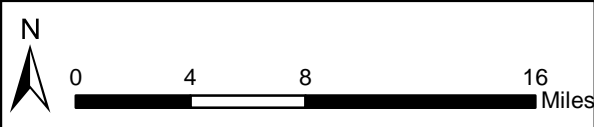
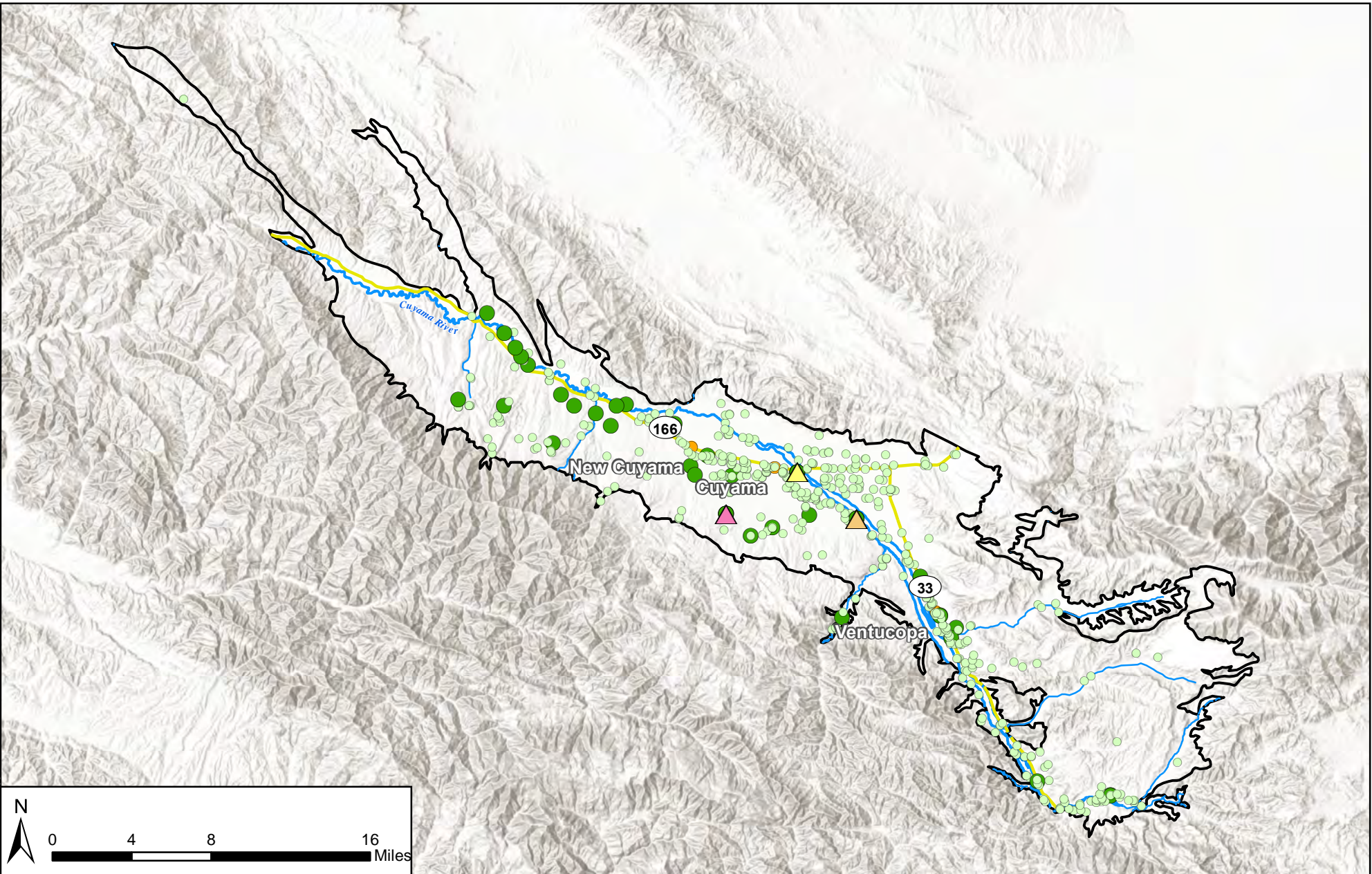
Cuyama Valley Groundwater Basin Groundwater
Sustainability Plan

August 2018



Legend

- | | |
|--------------|---|
| Cuyama Basin | DWR Database Wells Last Measured in 2017-2018 |
| Towns | DWR Database Wells Last Measured 2016 and Earlier |
| Highways | |
| Cuyama River | |
| Streams | |



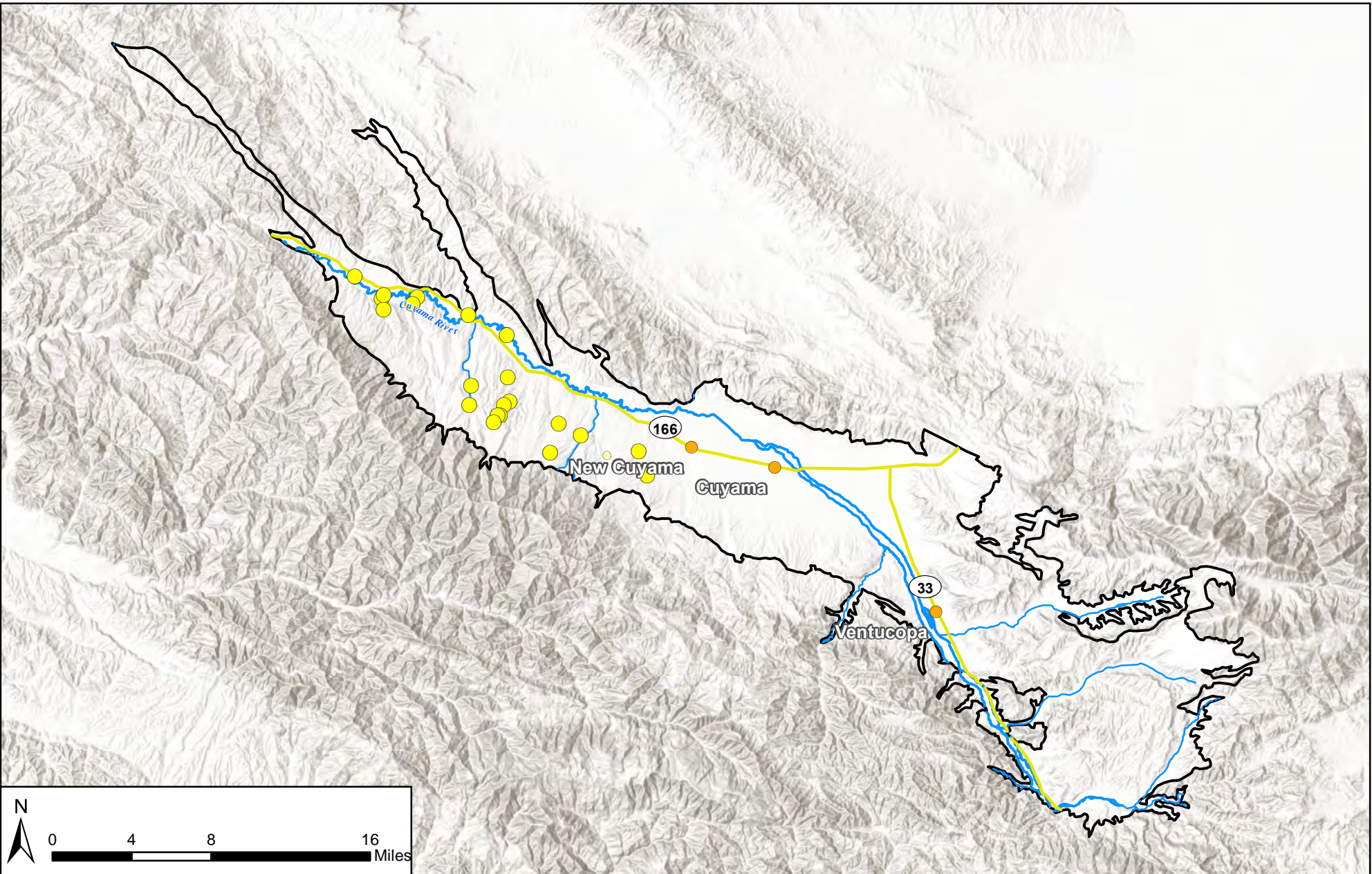
**Figure 2.2-3: Cuyama GW Basin
USGS Wells**

Cuyama Basin Groundwater Sustainability Agency
 Cuyama Valley Groundwater Basin Groundwater Sustainability Plan
 August 2018



Legend

- Cuyama Basin
- Towns
- Highways
- Cuyama River
- Streams
- USGS Database Wells Last Measured in 2017-2018
- USGS Database Wells Last Measured 2016 or Earlier
- ▲ CVBR Multi-Completion Well
- ▲ CVFR Multi-Completion Well
- ▲ CVKR Multi-Completion Well



**Figure 2.2-4: Cuyama GW Basin
County Wells**

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater
Sustainability Plan

August 2018



Legend

- Cuyama Basin
- Towns
- County Database Wells Last Measured in 2017-2018
- County Database Wells Last Measured 2016 or Earlier
- Highways
- Cuyama River
- Streams

Figure 2.2-5 shows the locations of well data received from private landowners. The majority of wells provided by private landowners are located in the central portion of the basin, between the Cuyama River and Highway 33, generally running along Highway 166. Additional wells provided by private landowners are located along the Cuyama River and Highway 166, near the Russell Ranch Oilfields. The locations of SBCWA well data are located west of Cottonwood Canyon. Associated data provided with private landowners varies by source. Some data and measurements were taken annually, while other well owners were taken biannually.

Figure 2.2-6 shows the locations of collected data by their last measured date. Wells monitored in 2017-2018 are shown in bright green triangles. Recent measurements are near the Cuyama river in the eastern uplands and near Ventucopa and are concentrated in the central portion of the basin, north of Highway 166. Recent monitoring also occurs throughout the central basin, is spread out in the western portion of the basin east of Aliso Canyon. An additional concentration of recent monitoring points is present along the Cuyama River near the Russell Ranch Oilfields.

Figure 2.2-7 shows a comparison of data collected from private landowners and data collected from DWR and the USGS in the central portion of the Basin. The figure shows the location of compared wells, and the measurements on those wells by source. The measurements of groundwater elevation among the measured wells indicate that the monitoring by the private landowners and agencies match in tracking historical trends and are accurate measurements.

Figure 2.2-8 shows a comparison of data collected from other private landowners, and data collected from Santa Barbara County. The figure shows the location of compared wells, and the measurements on those wells by source. A long-term comparison is not possible due to the shorter measurement period of the Santa Barbara County wells, but the measurements of groundwater elevation among the measured wells indicate that the monitoring by private landowners in the western portion of the Basin and the county are similar in elevation, with the county's data showing slightly higher elevations.

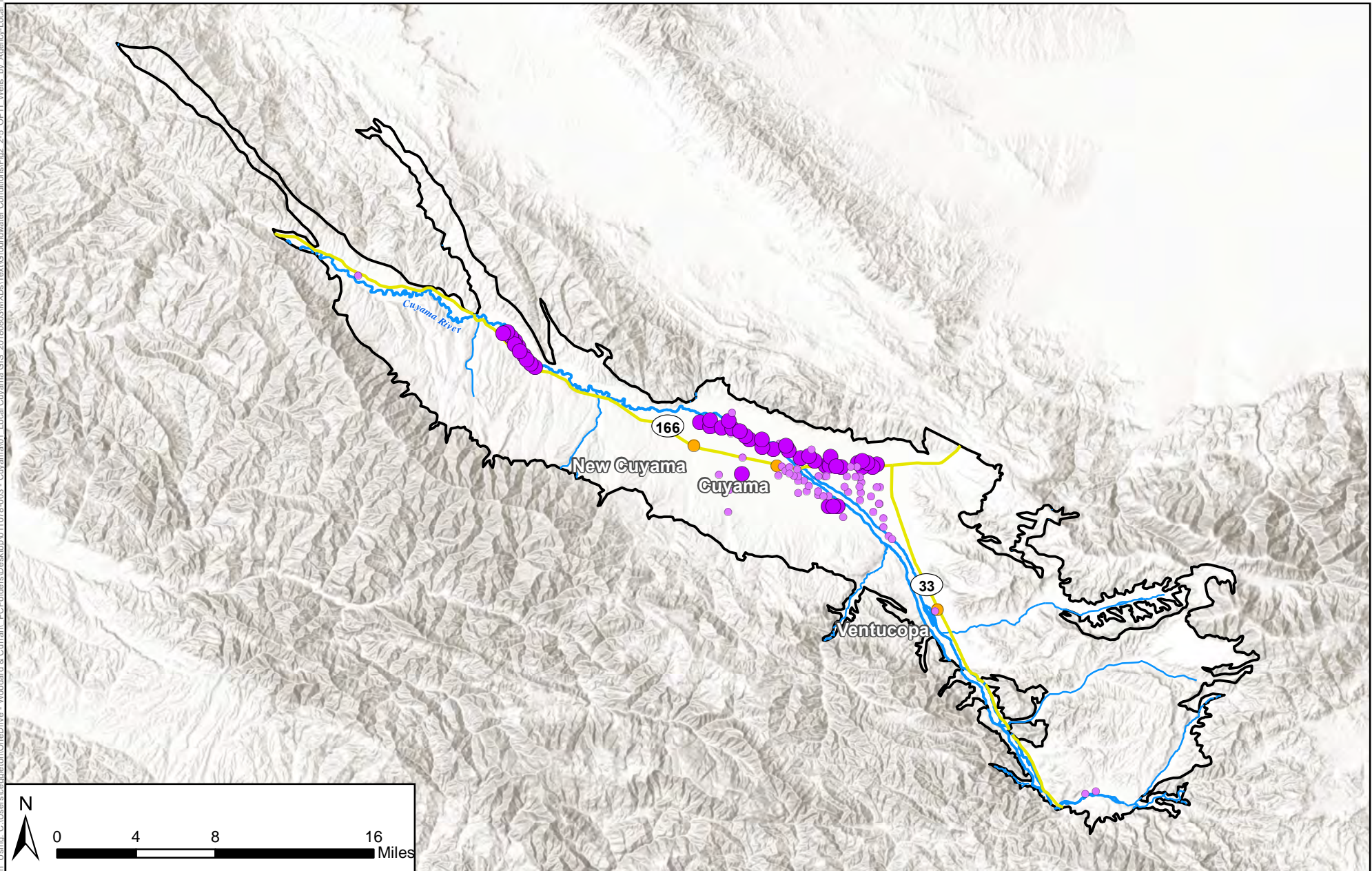


Figure 2.2-5: Cuyama GW Basin Private Landowners Wells

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

August 2018



Legend

- Cuyama Basin
- Towns
- Highways
- Cuyama River
- Streams
- Private Landowners Reported Wells Last Measured in 2017-2018
- Private Landowners Reported Wells Last Measured 2016 and Earlier

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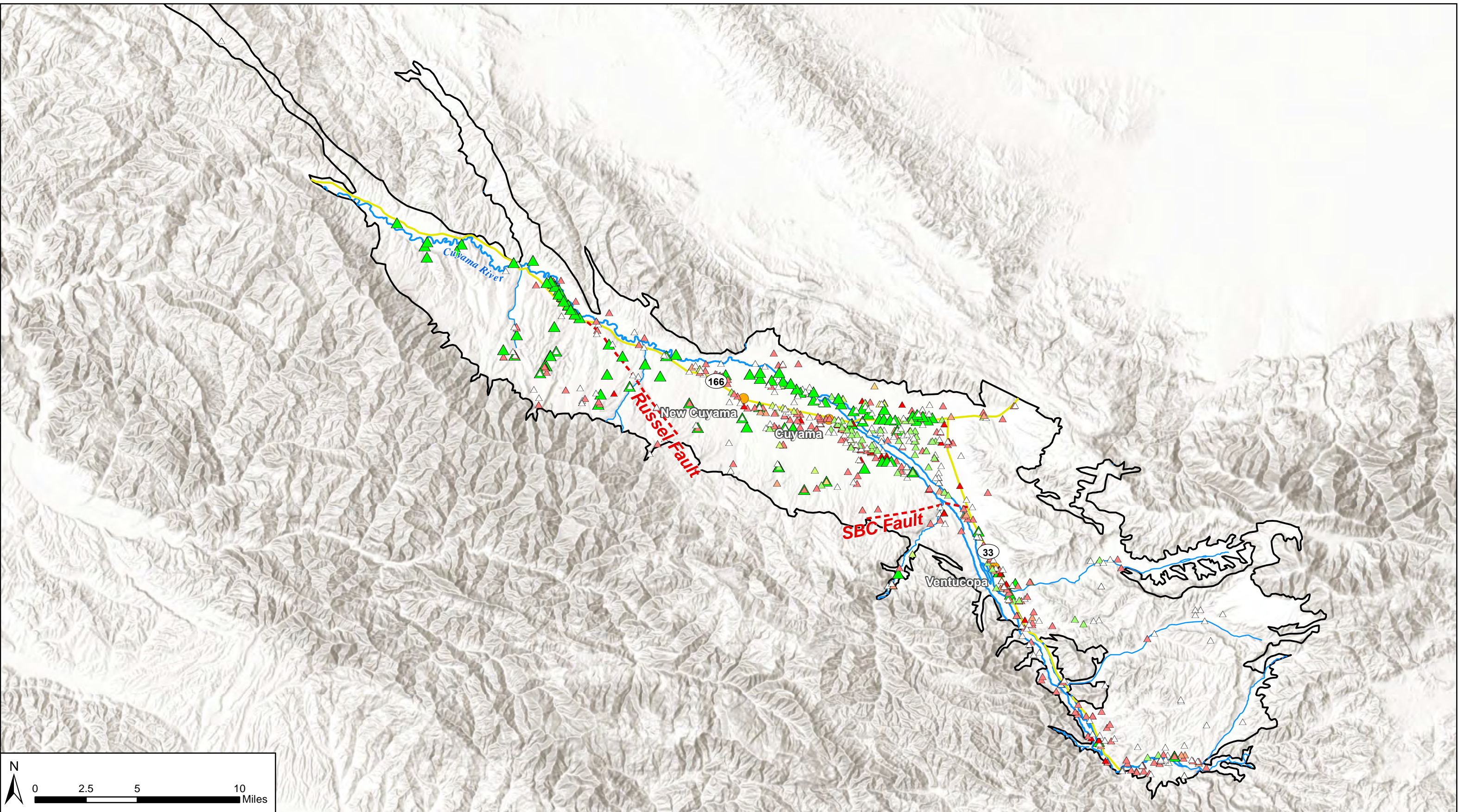


Figure 2.2-6: Cuyama GW Basin Wells by Last Measurement Date

Cuyama Basin Groundwater Sustainability Agency
 Cuyama Valley Groundwater Basin Groundwater Sustainability Plan
 August 2018



Legend

- | | | | | |
|--------------|--------------|-------------|-------------|---------------------|
| Cuyama Basin | Cuyama River | 2017 - 2018 | 1980 - 1989 | Pre-1950 |
| Towns | Streams | 2010 - 2016 | 1970 - 1979 | No Measurement Data |
| Highways | Fault | 2000 - 2009 | 1960 - 1969 | |
| | | 1990 - 1999 | 1950 - 1959 | |

Most Recent Year with Measurements

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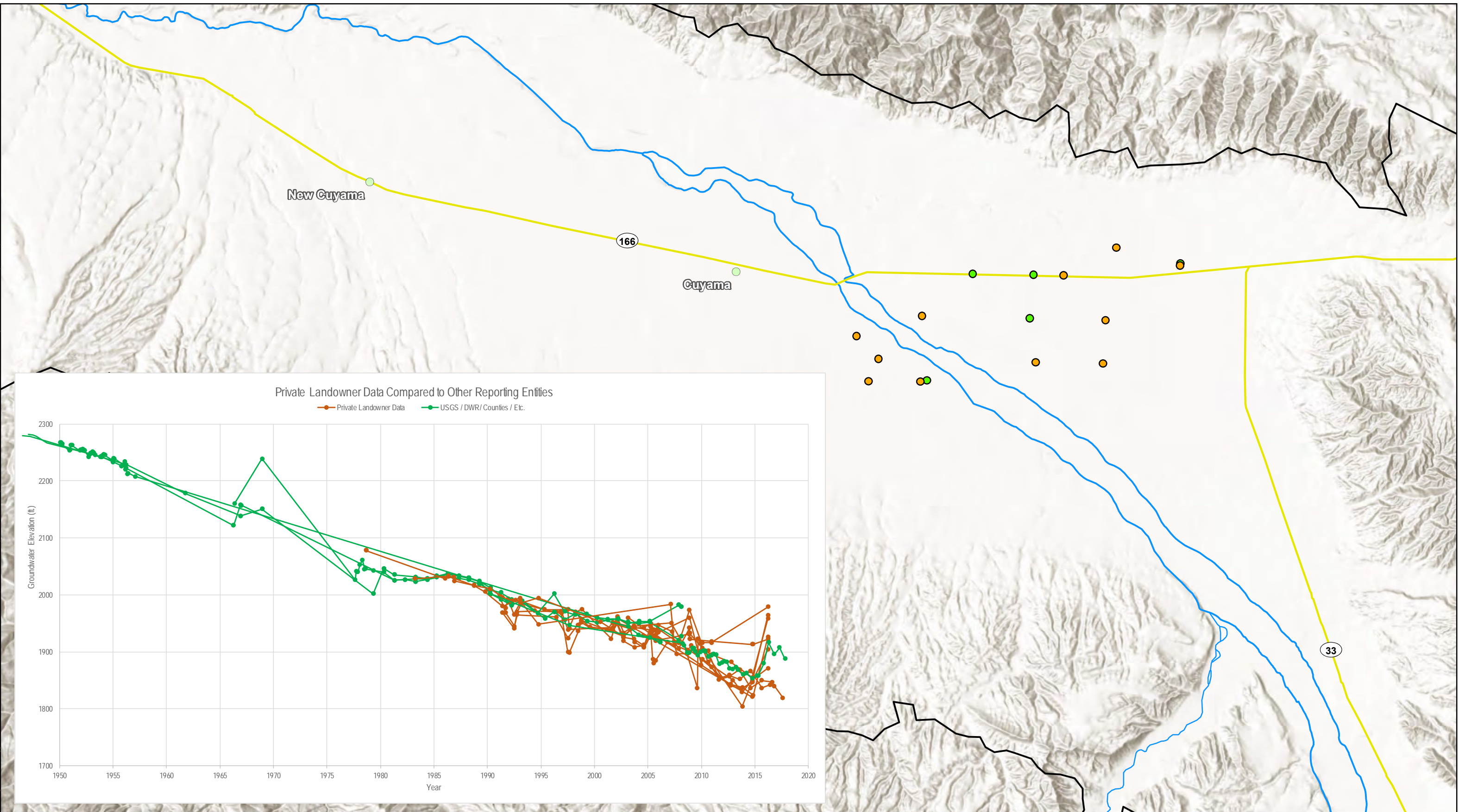


Figure 2.2-7: Central Cuyama GW Basin Wells and Hydrographs by Data Source

Cuyama Basin Groundwater Sustainability Agency
 Cuyama Valley Groundwater Basin Groundwater Sustainability Plan
 August 2018



Legend

- Cuyama Basin
- Towns
- Highways
- Cuyama River
- Streams
- USGS, DWR, County, Etc., Wells
- Private Landowner Wells

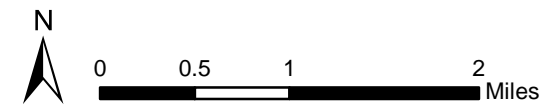


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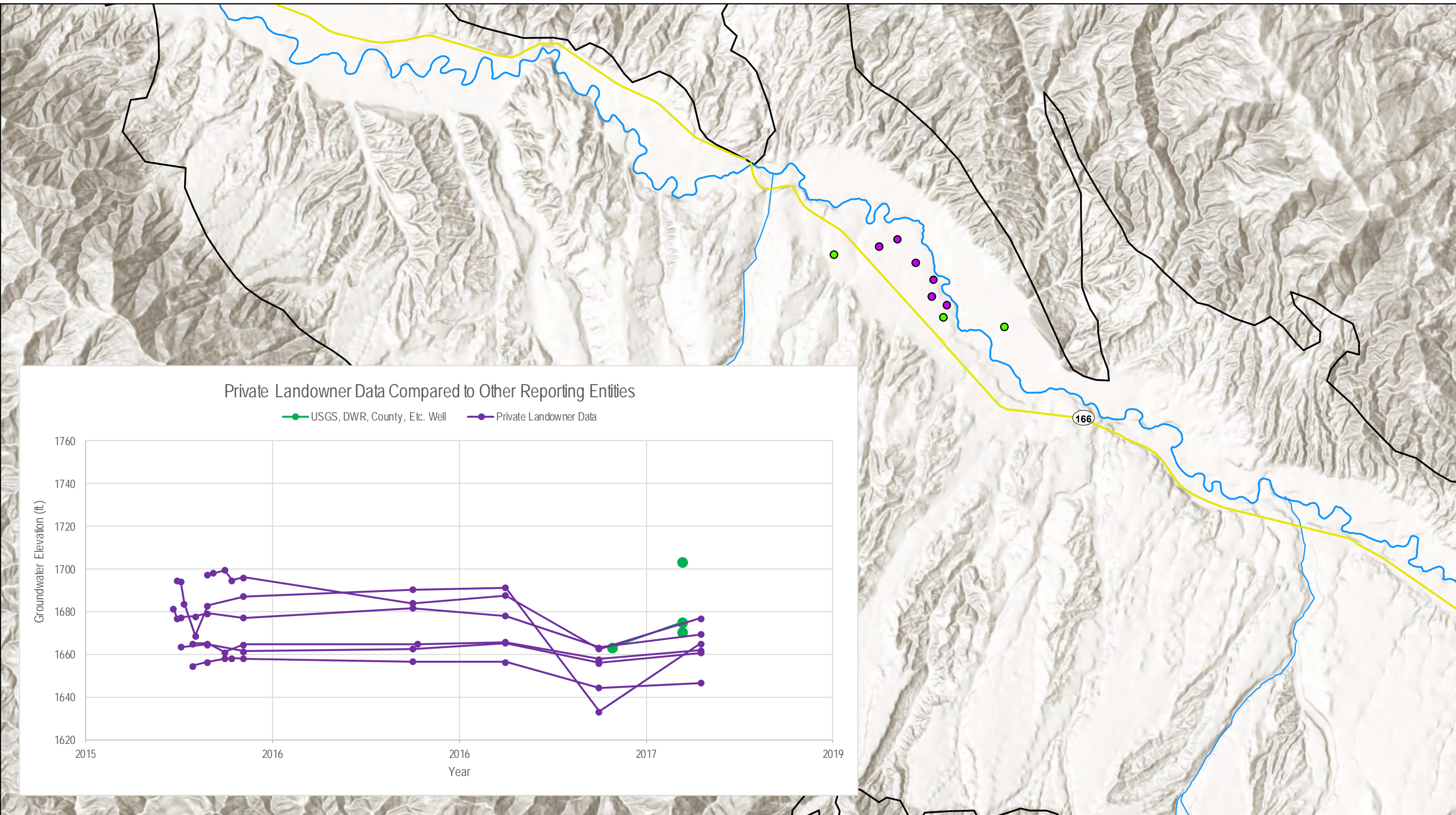
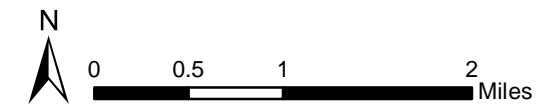


Figure 2.2-8: Western Cuyama GW Basin Wells and Hydrographs by Data Source
 Cuyama Basin Groundwater Sustainability Agency
 Cuyama Valley Groundwater Basin Groundwater Sustainability Plan
 August 2018



Legend

- Cuyama Basin
- Highways
- Cuyama River
- Streams
- USGS, DWR, County, Etc. Wells
- Private Landowner Wells



2.2.3 Groundwater Trends

This section describes groundwater trends in the basin generally from the oldest available studies and data to the most recent. Groundwater conditions vary widely across the Basin. Groundwater conditions were evaluated and summarized for this section based on historical reports and groundwater level monitoring.

1947 to 1966 Groundwater Trends

Information about groundwater conditions in the basin are limited to reports that discuss the central portion of the basin and scattered groundwater elevation measurements in monitoring wells. This section discusses published reports about conditions from 1947 to 1966.

The report *Water Levels in Observation Wells in Santa Barbara County, California* (USGS 1956) discussed groundwater elevation monitoring in the Cuyama Valley Groundwater Basin. The report states that prior to 1946, there was no electric power in the valley, which restricted intensive irrigation, and that groundwater levels in the central portion of the basin remained fairly static until 1946. The report states that:

“Declines in groundwater began after 1946” (USGS 1956). Groundwater declined “as much as 8.8 feet from the spring of 1955 to 1956; the average decline was 5.2 feet. The decline of water levels at the lower and upper ends of the valley during this period was not so great as in the middle portion and averaged 1.7 and 2.2 feet respectively. Since 1946, water levels in observation wells have decline on the average about 27 feet.”

The report *Hydrologic Models and Analysis of Water Availability in the Cuyama Valley, California* (USGS 2015) presents two maps generated by the Cuyama Valley Hydrologic Model (CUVHM) simulated data. Figure 2.2-9 shows the estimated drawdown in the central portion of the basin from 1947 to 1966. Figure 2.2-9 shows that estimated drawdown ranged from zero at the edges of the central basin to over 160 feet in the southeastern portion of the central basin. Figure 2.2-10 shows the estimated contours of groundwater elevation for September 1966. These contours show a low area in the central portion of the central basin, and a steep groundwater gradient in the southeast near Ventucopa and in the highlands. A gentle groundwater gradient occurs in the southwestern portion of the central basin, generally matching topography.

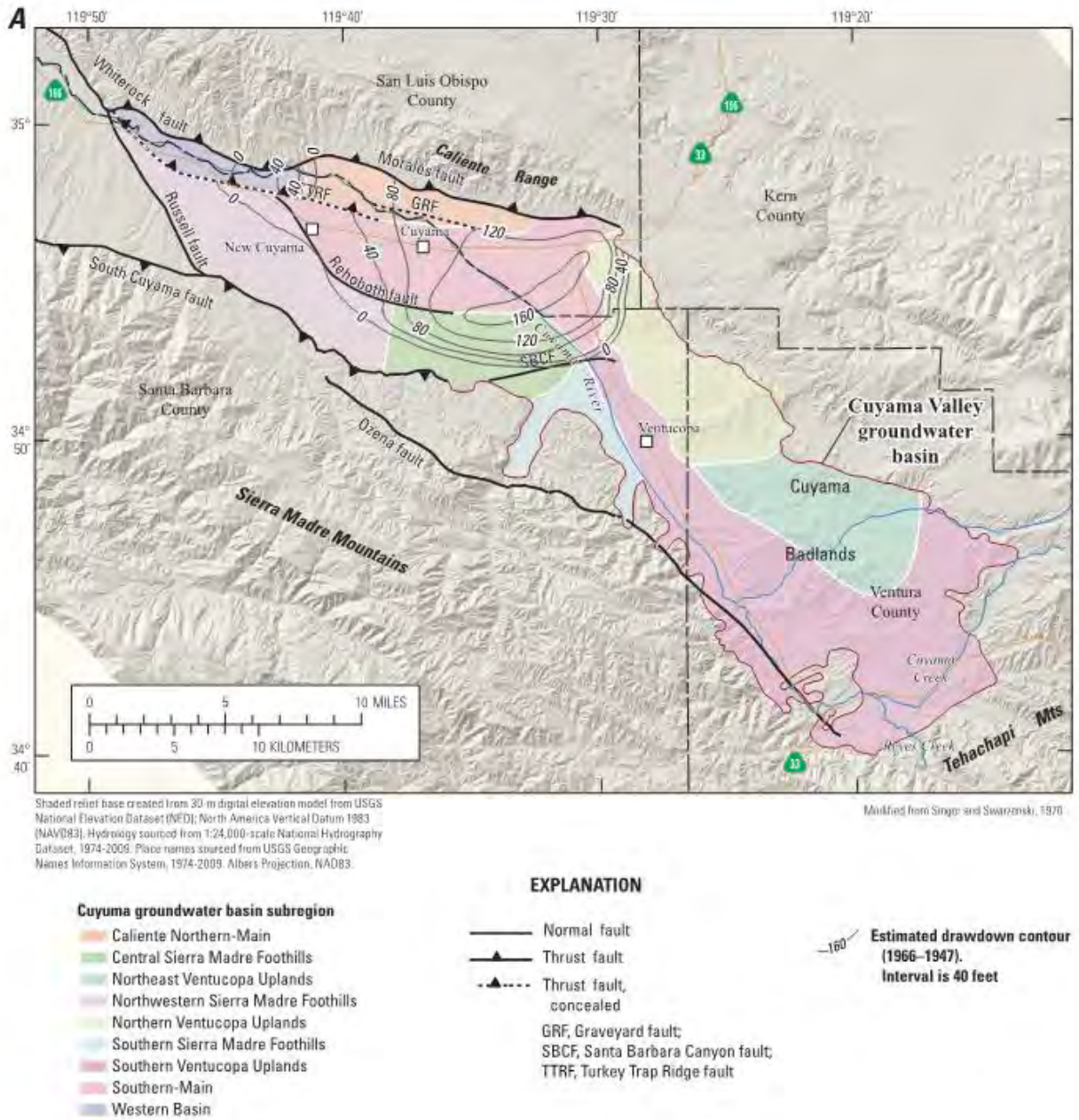


Figure 2.2-9: USGS 2015 – Water Level Drawdown Contours 1966 - 1947

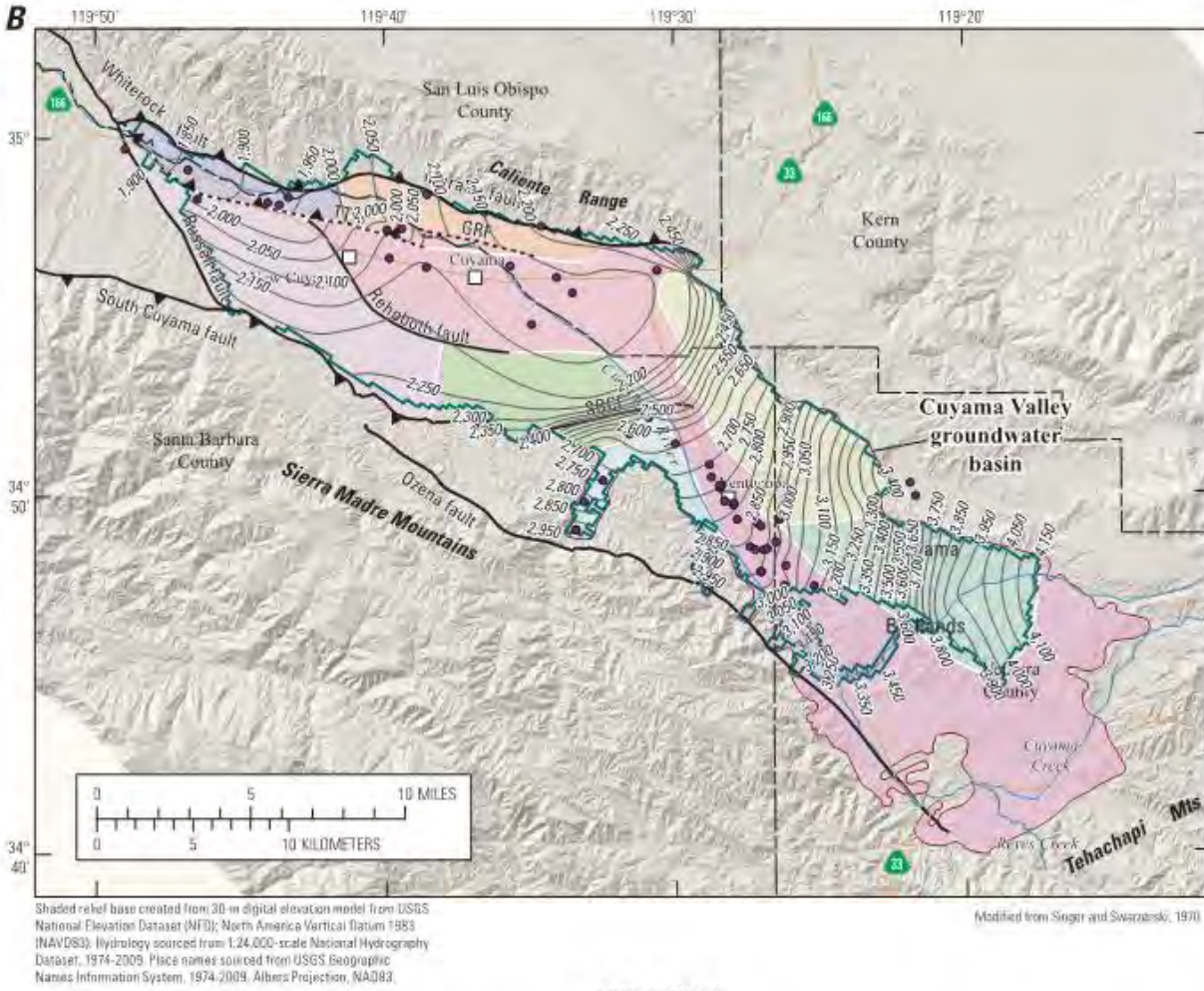


Figure 2.2-10: USGS 2015 – Water Level Contours 1966

Groundwater Hydrographs

Groundwater hydrographs were developed to provide indicators of groundwater trends throughout the Basin. Measurements from each monitoring well were compiled into one hydrograph for each well. Hydrographs for all monitoring wells with elevation data that were collected are presented in **Appendix X**.

Groundwater conditions in the Basin generally vary by general area in the basin. Figure 2.2-11 shows Hydrographs in different portions of the basin. Generally speaking:

- In the area southeast of Round Springs Canyon, near Ozena Fire Station - Groundwater levels have stayed relatively stable with a small decline in the 2012-2015 drought and quick recovery.
- In the vicinity of Ventucopa - Groundwater levels followed climactic patterns and have generally been declining since 1995.
- Just south of the SBCF – Groundwater levels have been fairly stable and are closer to the surface than levels in Ventucopa.
- North of the SBCF and east of Bitter Creek in the central portion of the basin - Groundwater levels have been declining consistently since 1947.
- In the western area west of Bitter Creek are near the surface near the Cuyama river, and deeper below ground to the south, uphill from the river, and have been generally stable since 1966.

Figure 2.2-12 shows selected hydrographs in the areas near Ventucopa. In the area southeast of Round Springs Canyon, near Ozena Fire Station, the hydrograph for Well 89 is representative of monitoring wells in this area, and groundwater levels have stayed relatively stable with a small decline in the 2012-2015 drought and quick recovery. Near Ventucopa, hydrographs for Wells 85 and 62 show the same patterns and conditions from 1995 to the present and show that groundwater levels in this area respond to climactic patterns, but also have been in decline since 1995 and are currently at historic low elevations. Prior to 1995, the hydrograph for Well 85 shows that groundwater levels responded to drought conditions but recovered during wetter years. The hydrograph for Well 40 is located just south of the SBCF and indicates that groundwater levels in this location have remained stable from 1951 to 2013, when monitoring ceased. Hydrographs for wells 91, 316, and 620 are north of the SBCF and show more recent conditions, where depth to water has declined consistently and is below 580 below ground surface (bgs).

Figure 2.2-13 shows hydrographs of discontinued monitoring wells in the central portion of the basin, north of the SBCF and east of Bitter Creek. The hydrographs in this area show consistent declines of groundwater levels and little to no responses to either droughts or wetter periods. The hydrograph for Well 35 shows a consistent decline from 1955 to 2008, from 30 feet bgs to approximately 150 feet bgs. Well 472 shows a decline from approximately 5 feet bgs in 1949 to approximately 85 feet bgs in 1978.

Figure 2.2-14 shows hydrographs of recently monitored wells in the central portion of the basin, north of the SBCF and east of Bitter Creek. In general, hydrographs in this area show that groundwater levels are decreasing, with the lowest levels in the southeast portion of the area just northwest of the SBCF, as shown in the Well 610 hydrograph, where groundwater levels were below 600 feet bgs. Levels remain lowered along the Cuyama River, as shown in the hydrographs for Wells 604 and 640, which are currently approximately 500 feet bgs. Groundwater levels are higher to the west (Well 72) and towards the southern end of the area (Well 96), however all monitoring wells in this area show consistent declines in elevation.

Figure 2.2-15 shows hydrographs of monitoring wells in the western portion of the basin, west of Bitter Creek. Hydrographs in this area show that generally, groundwater levels are near the surface near the Cuyama River, and further from the surface to the south, which is uphill from the river. The hydrograph for Well 119 shows a few measurements from 1953-1969, as well as three recent measurements, all measurements on this well show a depth to water of 60 feet bgs. The hydrograph for Well 846 shows that in 2015 depth to water was slightly above 40 feet and is slightly below 40 feet in 2018. The hydrograph for Well 840 shows a groundwater level near ground surface in 2015, and a decline to 40 feet bgs in 2018. Hydrographs for wells uphill from the river (Wells 573 and 121) show that groundwater is roughly 70 feet bgs in this area. Hydrographs for wells 571 and 108, at the edge of the basin only have recent measurements, show groundwater levels that range from 120 to 140 feet bgs.

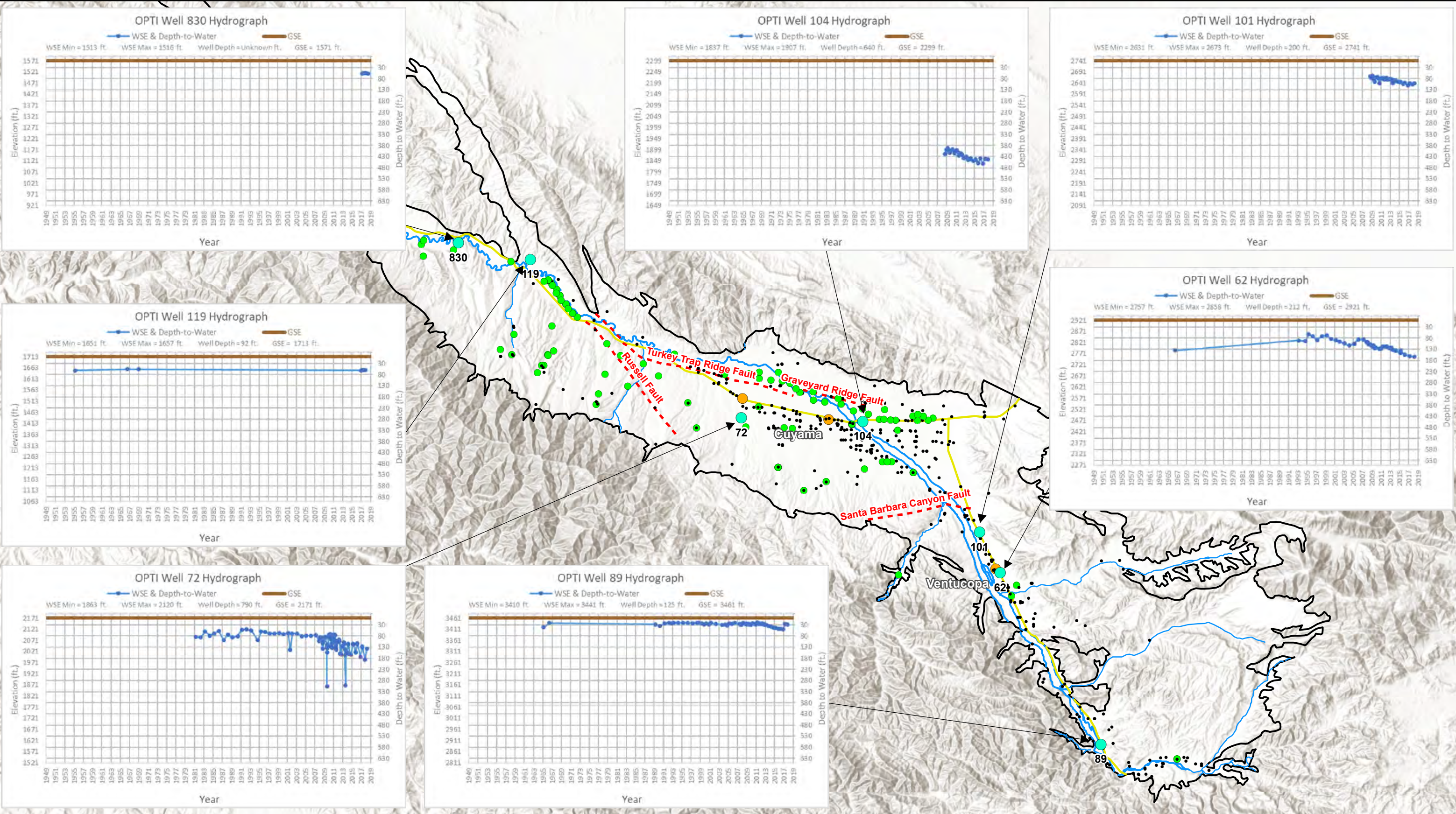


Figure 2.2-11: Cuyama GW Basin Hydrographs

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

August 2018



Legend

- Cuyama Basin
- - - Faults
- Towns
- Hydrographed Wells
- Currently Monitored Wells
- Not Currently Monitored
- Highways
- Cuyama River
- Streams

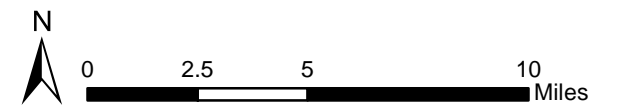


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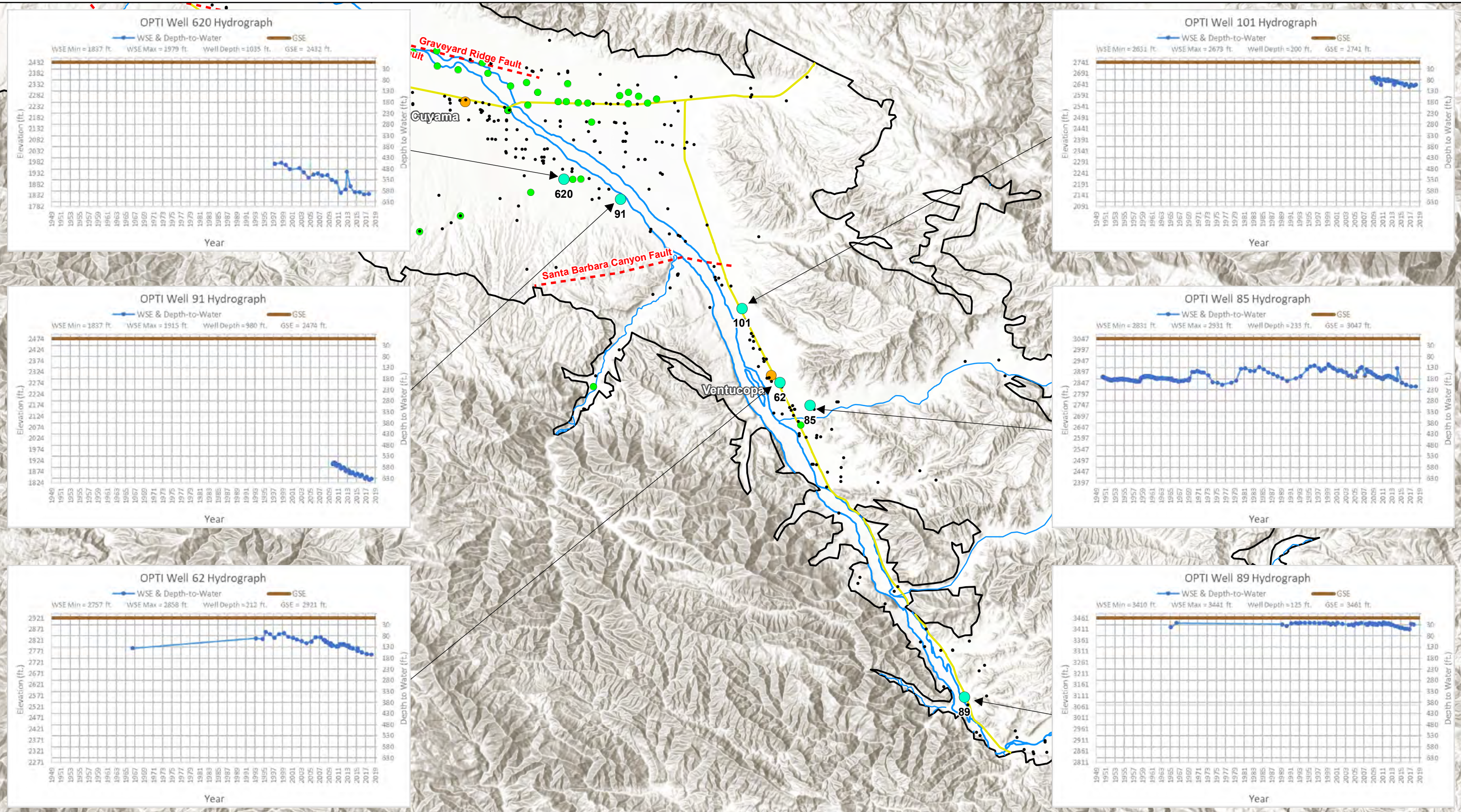


Figure 2.2-12: Cuyama GW Basin Hydrographs for the Ventucopa Area of the Basin
 Cuyama Basin Groundwater Sustainability Agency
 Cuyama Valley Groundwater Basin Groundwater Sustainability Plan
 August 2018



- Legend**
- Cuyama Basin
 - - - Faults
 - Towns
 - Hydrographed Wells
 - Highways
 - Currently Monitored Wells
 - Cuyama River
 - Not Currently Monitored
 - Streams



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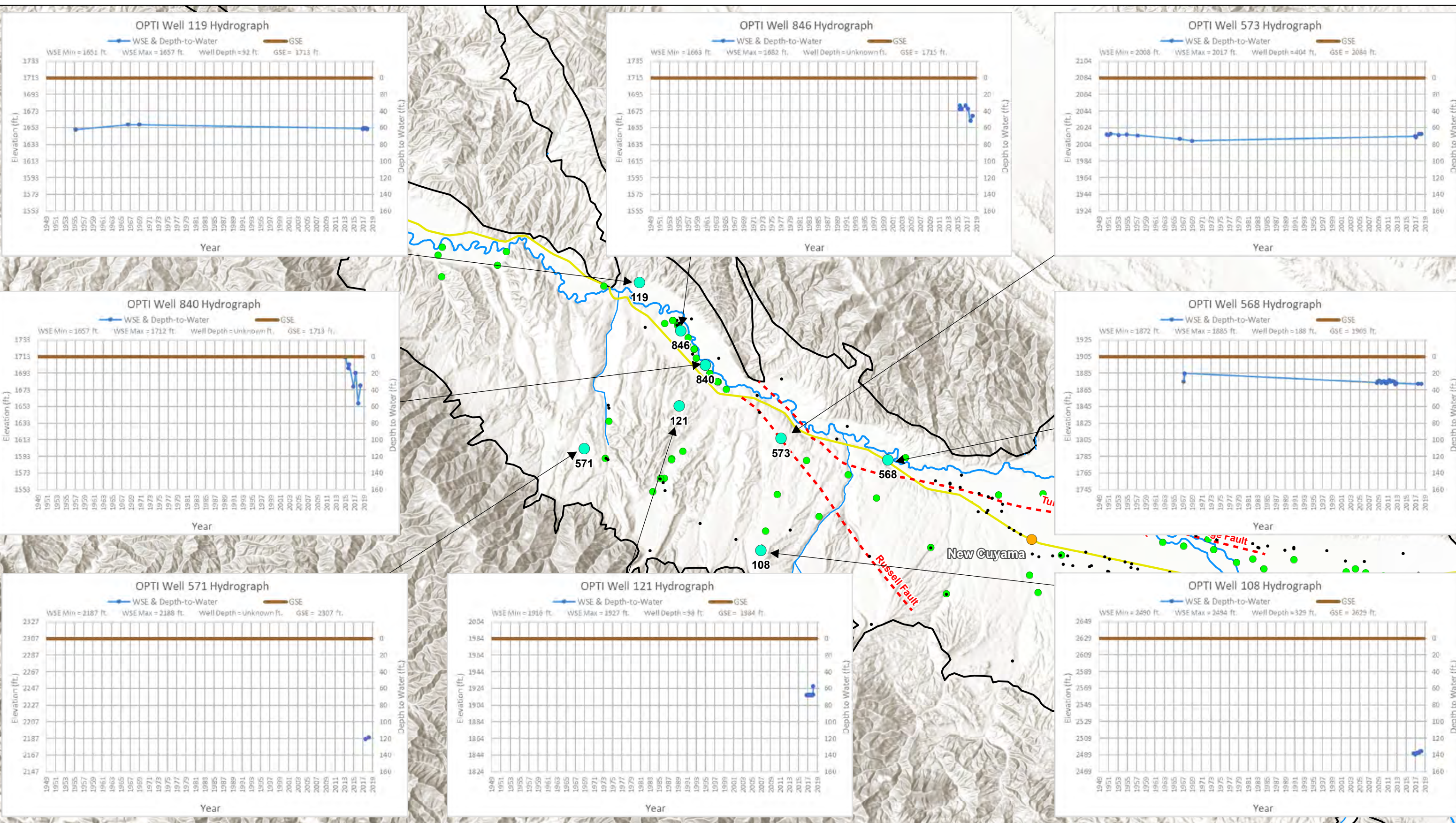


Figure 2.2-15: Cuyama GW Basin Hydrographs for the Westside Area of the Basin
 Cuyama Basin Groundwater Sustainability Agency
 Cuyama Valley Groundwater Basin Groundwater Sustainability Plan
 August 2018



Legend

- Cuyama Basin
- - - Faults
- Towns
- Hydrographed Wells
- Currently Monitored Wells
- Cuyama River
- Not Currently Monitored
- Highways
- Streams

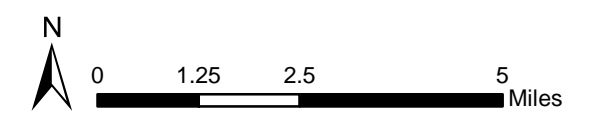


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Vertical Gradients

A vertical gradient describes the movement of groundwater perpendicular to the ground surface. Vertical gradient is typically measured by comparing the elevations of groundwater in a well with multiple completions that are of different depths. If groundwater elevations in the shallower completions are higher than in the deeper completions, the gradient is identified as a downward gradient. A downward gradient is one where groundwater is moving down into the ground. If groundwater elevations in the shallower completions are lower than in the deeper completions, the gradient is identified as an upward gradient. An upward gradient is one where groundwater is upwelling towards the surface. If groundwater elevations are similar throughout the completions, there is no vertical gradient to identify. Knowledge about vertical gradients is required by regulation and is useful for understanding how groundwater moves in the Basin.

There are three multiple completion wells in the Basin. The locations of the multiple completion wells are shown in Figure 2.2-3 Monitoring Well Data Received From USGS. The three multiple completion wells are located in the central portion of the basin, north of the SBCF and east of Bitter Creek.

Figure 2.2-16 shows the combined hydrograph the multiple completion well CVFR, which was installed by the USGS. CVFR is comprised of four completions, each at different depths:

- CVFR-1 is the deepest completion with a screened interval from 960 to 980 feet bgs
- CVFR-2 is the second deepest completion with a screened interval from 810 to 830 feet bgs
- CVFR-3 is the third deepest completion with a screened interval from 680 to 700 feet bgs
- CVFR-4 is the shallowest completion with a screened interval from 590 to 610 feet bgs

The hydrograph of the four completions shows that they are at the same elevation at each completion, and therefore there is no vertical gradient at this location.

Figure 2.2-17 shows the combined hydrograph the multiple completion well CVBR, which was installed by the USGS. CVBR is comprised of four completions, each at different depths:

- CVBR-1 is the deepest completion with a screened interval from 830 to 850 feet bgs
- CVBR-2 is the second deepest completion with a screened interval from 730 to 750 feet bgs
- CVBR-3 is the third deepest completion with a screened interval from 540 to 560 feet bgs
- CVBR-4 is the shallowest completion with a screened interval from 360 to 380 feet bgs

The hydrograph of the four completions shows that at the deeper completions are slightly lower than the shallower completions in the spring at each completion, and deeper completions are generally lower in the summer and fall. This likely indicates that during the irrigation season, the deeper portions of the aquifer are where pumping occurs, which removes water from the deeper portion of the aquifer, creating a vertical gradient during the summer and fall. By the spring, enough water has moved down to replace removed water, and the vertical gradient is significantly smaller at this location in the spring measurements.

Figure 2.2-18 shows the combined hydrograph the multiple completion well CVKR, which was installed by the USGS. CVKR is comprised of four completions, each at different depths:

- CVKR-1 is the deepest completion with a screened interval from 960 to 980 feet bgs
- CVKR-2 is the second deepest completion with a screened interval from 760 to 780 feet bgs
- CVKR-3 is the third deepest completion with a screened interval from 600 to 620 feet bgs
- CVKR-4 is the shallowest completion with a screened interval from 440 to 460 feet bgs

The hydrograph of the four completions shows that at the deeper completions are slightly lower than the shallower completions in the spring at each completion, and deeper completions are generally lower in the

summer and fall. This likely indicates that during the irrigation season, the deeper portions of the aquifer are where pumping occurs, which removes water from the deeper portion of the aquifer, creating a vertical gradient during the summer and fall. By the spring, enough water has moved down to replace removed water, and the vertical gradient is significantly smaller at this location in the spring measurements.

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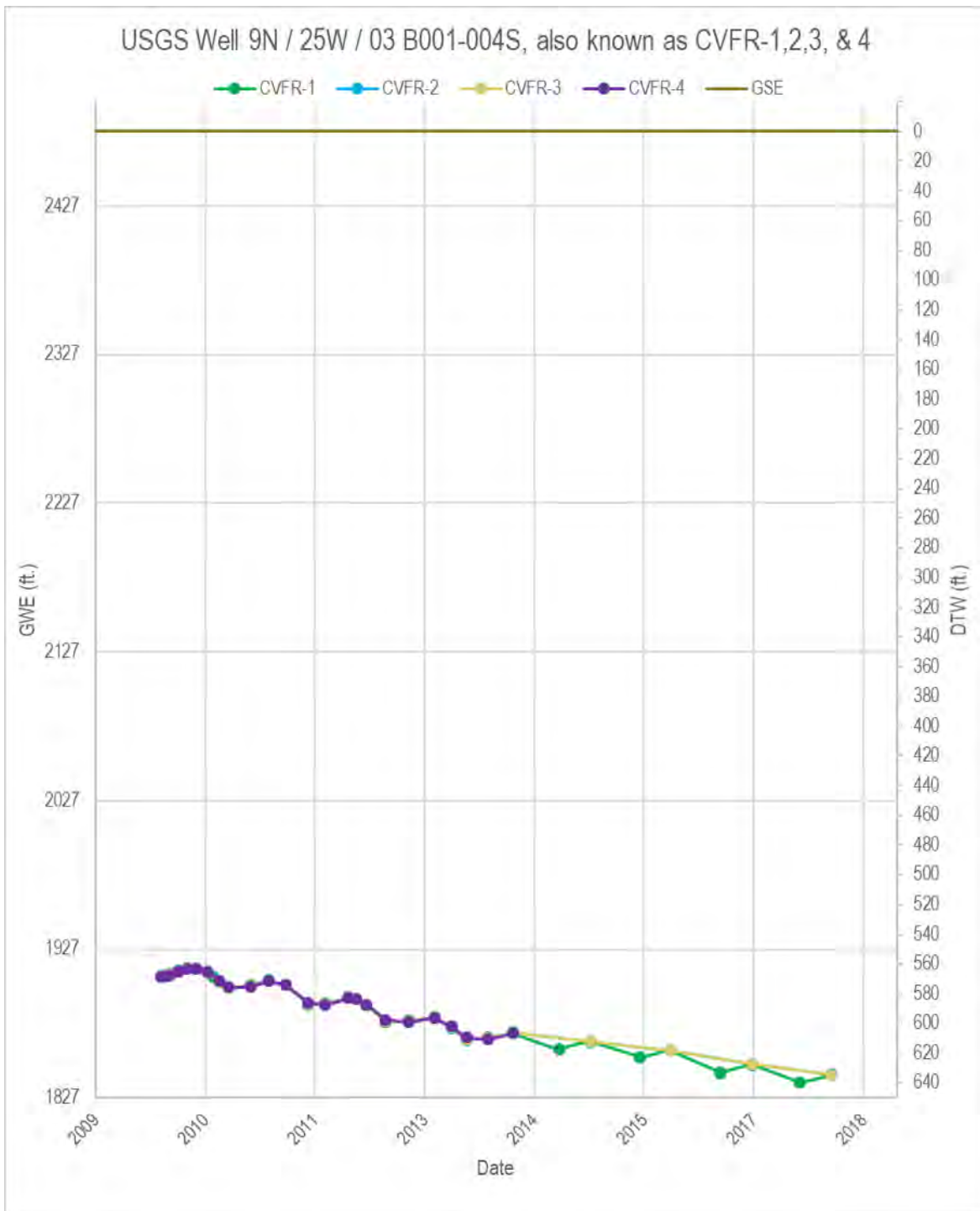


Figure 2.2-16: Hydrographs of CVFR1-4

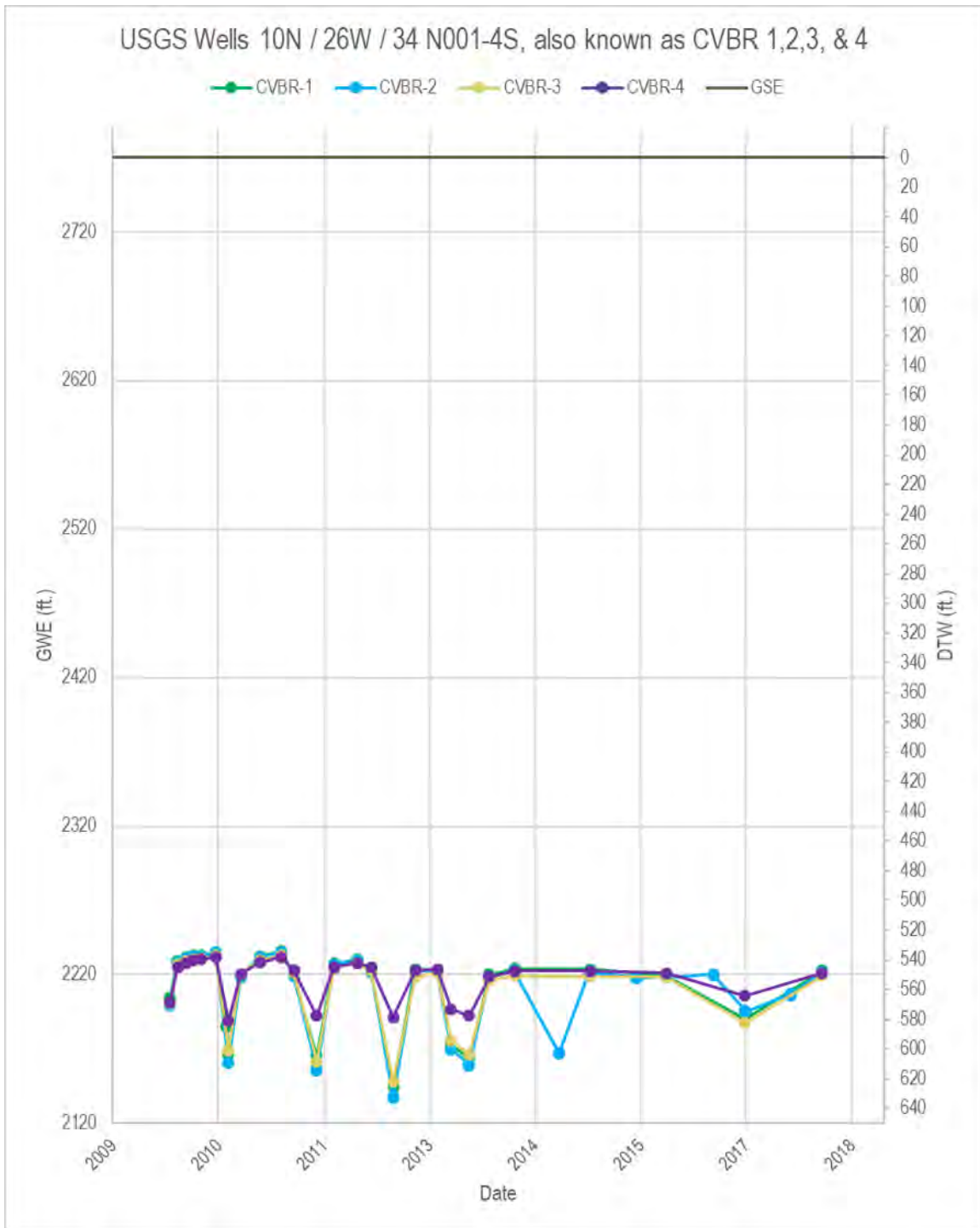


Figure 2.2-17: Hydrographs of CVBR-1-4

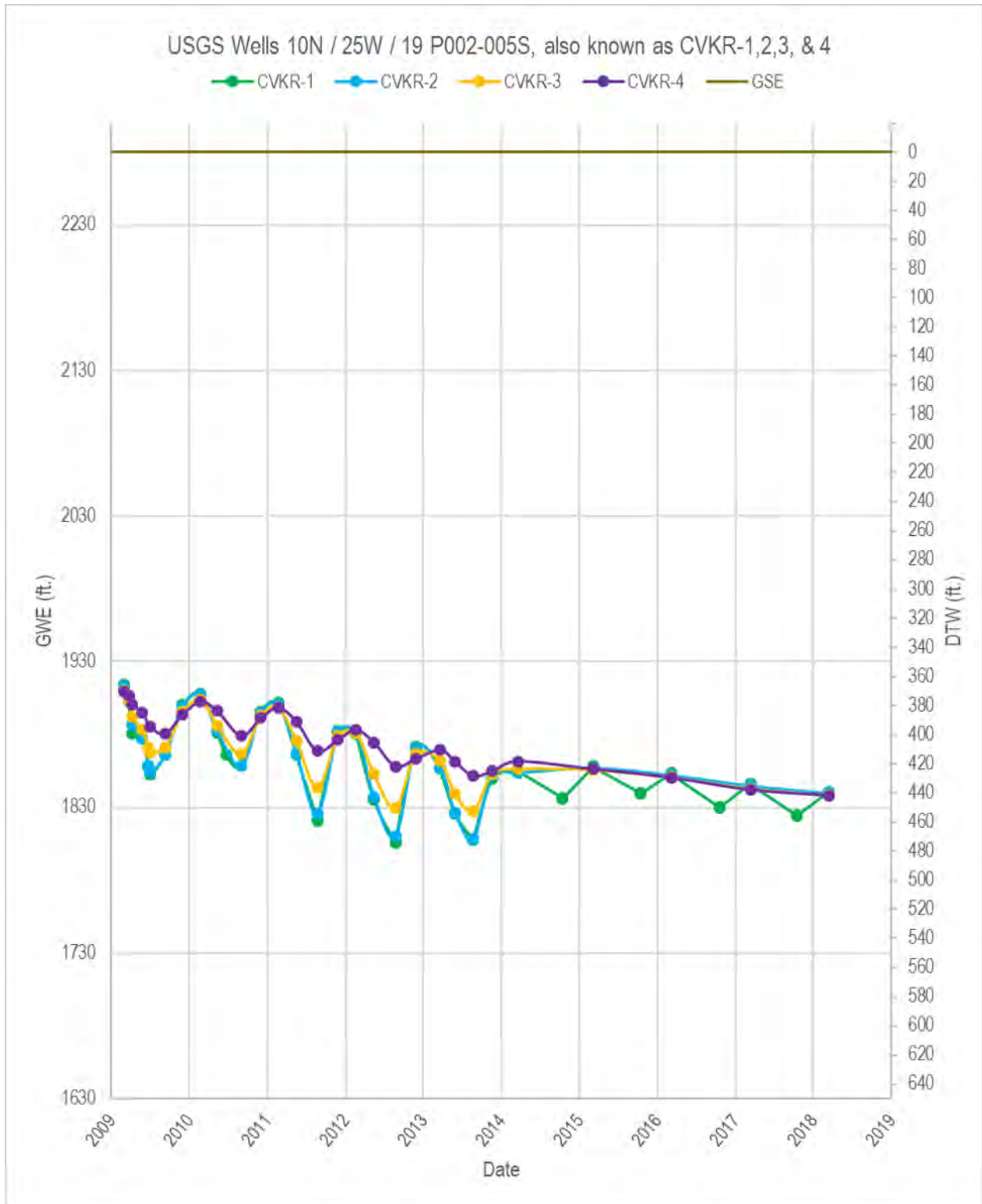


Figure 2.2-18: Hydrographs of CVKR1-4

Groundwater Contours

Groundwater contour maps were prepared to improve understanding of recent groundwater trends in the basin. Data collected in Section 2.2.2 was used to develop the contour maps. A contour map shows changes in groundwater elevations by interpolating groundwater elevations between monitoring sites. The elevations are shown on the map with the use of a contour line, which indicates that at all locations that line is drawn, it represents groundwater being at the elevation indicated. There are two versions of contour maps used in this section, one which shows the elevation of groundwater above msl, which is useful because it can be used to identify the horizontal gradients of groundwater, and one which shows contours of depth to water, the distance from the ground surface to groundwater, which is useful because it can identify areas of shallow or deep groundwater.

Groundwater contour maps were prepared for both groundwater elevation and depth to water for the following periods and are described below: Spring 2018, Fall 2017, Spring 2017, Spring 2015, and Fall 2014. These years were selected for contours to provide analysis of current conditions, and to identify conditions near January 1, 2015, which is a key date in Sustainable Groundwater Management Act (SGMA) legislation.

Each contour map follows the same general format. Each contour map is contoured at a 50 foot contour interval, with contour elevations indicated in white numeric labels, and measurements at individual monitoring points indicated in black numeric labels. Areas where the contours are dashed and not colored in are inferred contours that extend elevations beyond data availability and are included for reference only. The groundwater contours prepared for this section were based on several assumptions in order to accumulate enough data points to generate useful contour maps:

- Measurements from wells of different depths are representative of conditions at that location and there are no vertical gradients. Due to the limited spatial amount of monitoring points, data from wells of a wide variety of depths were used to generate the contours.
- Measurements from dates that may be as far apart temporally as three months are representative of conditions during the spring or fall season, and conditions have not changed substantially from the time of the earliest measurement used to the latest. Due to the limited temporal amount of measurements in the basin, data from a wide variety of measurement dates were used to generate the contours.

These assumptions make the contours useful at the planning level to understand groundwater levels across the basin, and to identify general horizontal gradients and regional groundwater level trends. The contour maps are not indicative of exact values across the basin because groundwater contour maps approximate conditions between measurement points, and do not account for topography. Therefore, a well on a ridge may be farther from groundwater than one in a canyon, and the contour map will not reflect that level of detail.

Expansion and improvement of the monitoring network in order to generate more accurate understandings of groundwater trends in the basin is discussed in [Section Z: Monitoring Networks](#)

Figure 2.2-19 shows groundwater elevation contours for spring of 2018. In the southeastern portion of the basin near Ventucopa, groundwater has a horizontal gradient to the northwest. The gradient increases in the vicinity of the SBCF and flows to an area of lowered groundwater elevation southeast of the town of Cuyama. From the town of New Cuyama to the west, groundwater has a horizontal gradient that generally flows to the northeast, from areas with higher elevation topography towards areas with lower elevation topography where the Cuyama River is located.

Figure 2.2-20 shows depth to groundwater contours for spring of 2018. In the southeastern portion of the basin near Ventucopa, groundwater is mostly between 100 and 150 feet bgs. Just south the SBCF,

groundwater is near 100 feet bgs. North of the SBCF, depth to groundwater declines rapidly and is over 600 feet bgs. Depth to groundwater reduces to the west towards New Cuyama, where groundwater is around 150 feet bgs. West of Bitter Creek, groundwater is shallower than 100 feet bgs in most locations, and is shallower than 50 feet bgs in the far west and along the Cuyama River.

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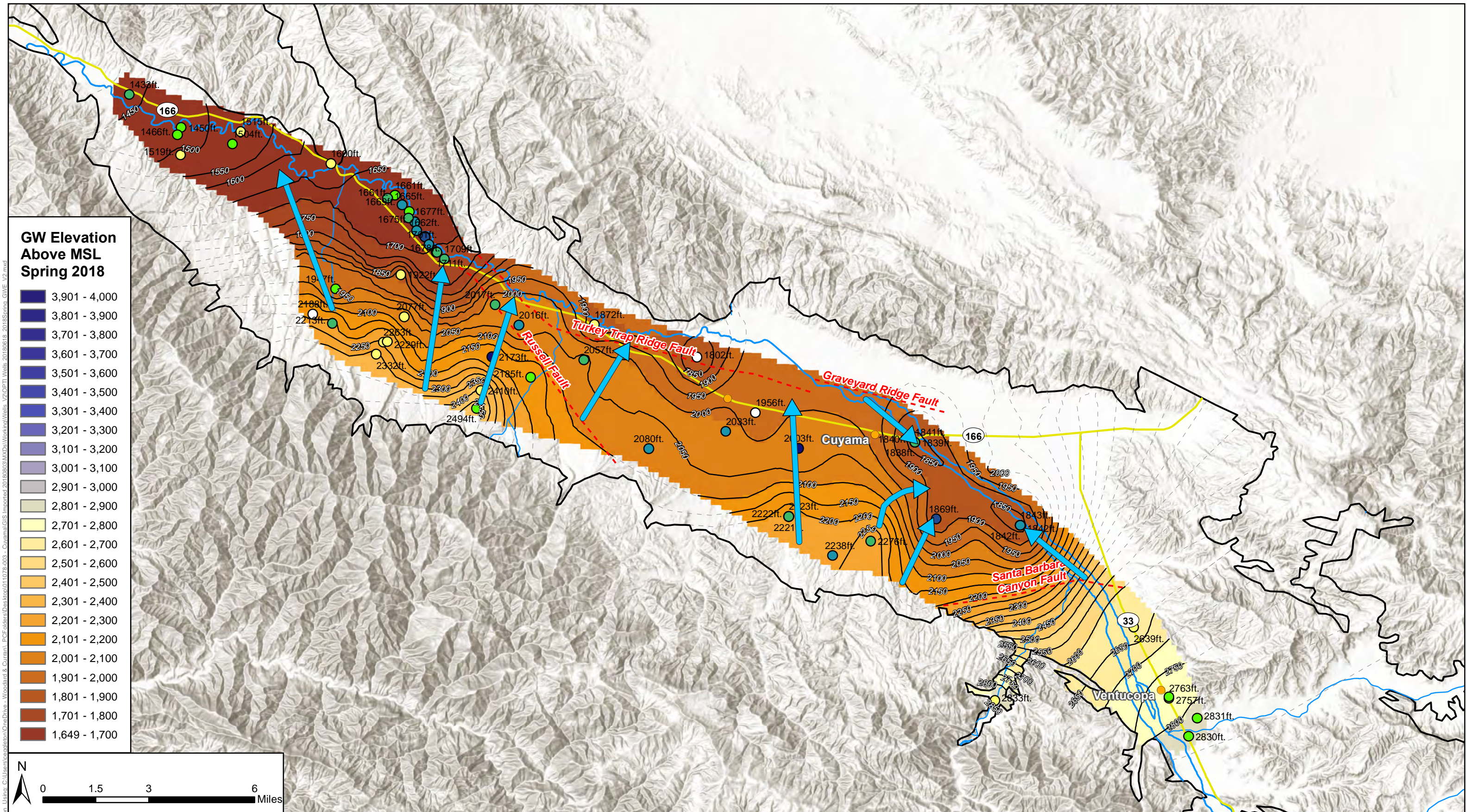


Figure 2.2-19: Cuyama GW Basin Wells by Groundwater Surface Elevation
 Cuyama Basin Groundwater Sustainability Agency
 Cuyama Valley Groundwater Basin Groundwater Sustainability Plan
 August 2018



Legend

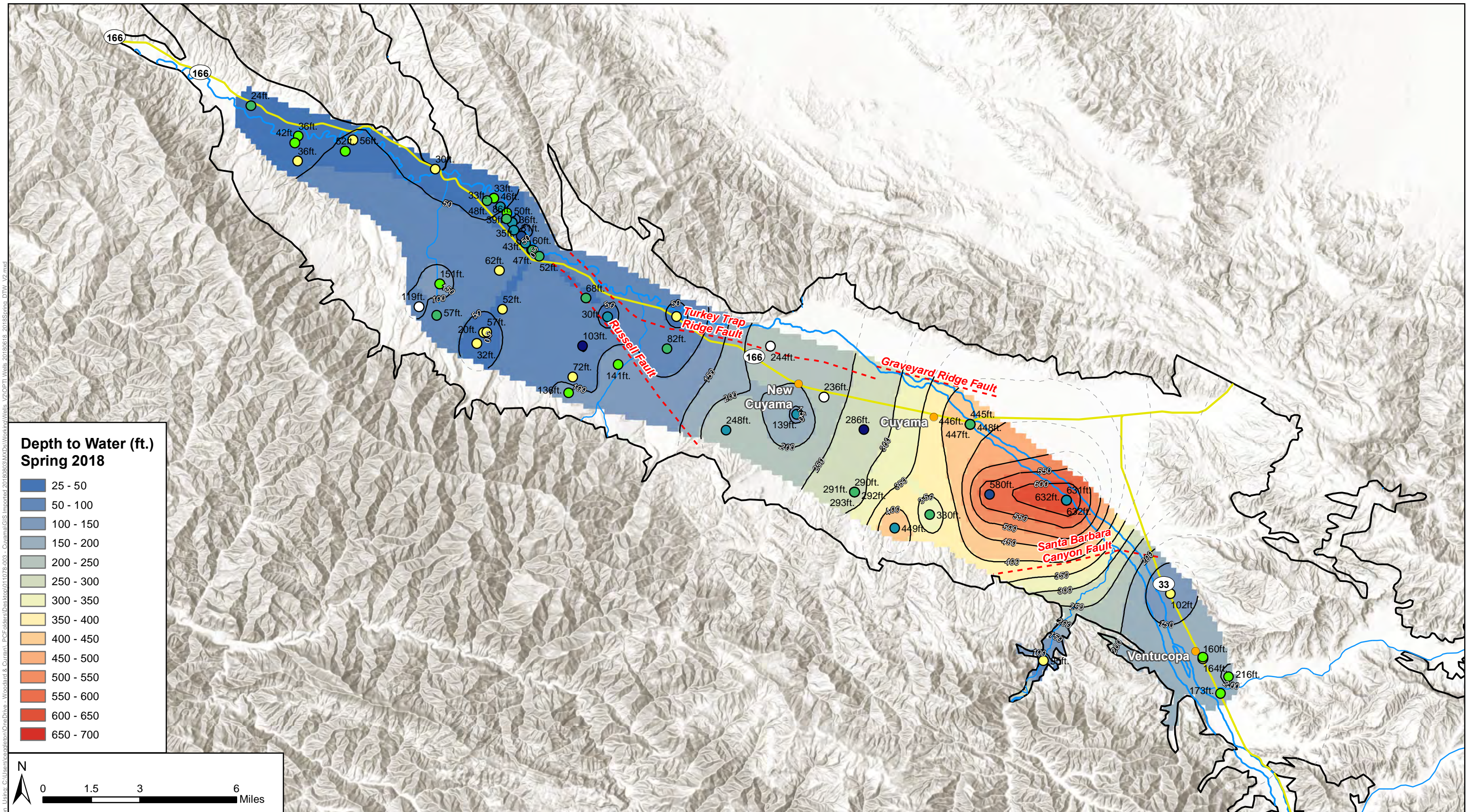
- Cuyama Basin
- Cuyama River
- - - Faults
- Groundwater Elevation Above MSL
- Inferred Groundwater Elevation Above MSL
- ➔ Groundwater Flow Direction

Well Depth Below GSE

- Unknown
- 0 - 200 ft
- 200 - 400 ft
- 400 - 600 ft
- 600 - 800 ft
- 800 - 1,000 ft
- 1,000 - 1,200 ft

Contours were interpolated using data measured from 2/1/2018 - 4/30/2018 due to limited data availability.
 Contours Interval: 50 ft.

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**Depth to Water (ft.)
Spring 2018**

- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250
- 250 - 300
- 300 - 350
- 350 - 400
- 400 - 450
- 450 - 500
- 500 - 550
- 550 - 600
- 600 - 650
- 650 - 700



Figure 2.2-20: Cuyama GW Basin Wells by Groundwater Surface Elevation
 Cuyama Basin Groundwater Sustainability Agency
 Cuyama Valley Groundwater Basin Groundwater Sustainability Plan
 August 2018



Legend

- Cuyama Basin
- Cuyama River
- Faults
- Groundwater Depth-to-Water Contours below Groundsurface
- Inferred Groundwater Depth-to-Water Contours below Groundsurface

- Well Depth Below GSE**
- Unknown
 - 600 - 800 ft
 - 0 - 200 ft
 - 800 - 1,000 ft
 - 200 - 400 ft
 - 1,000 - 1,200 ft
 - 400 - 600 ft

Contours were interpolated using data measured from 2/1/2018 - 4/30/2018 due to limited data availability.
 Contours Interval: 50 ft.

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Contour maps for spring 2017, fall 2017, spring 2015, and fall 2014 are included in [Appendix Y](#). Each contour map is described in this section.

Figure Y-1 shows groundwater elevation contours for fall of 2017. Because more data was available in this time frame, the contour map has increased detail in some areas. In the southeastern portion of the basin near the Ozena fire station, groundwater gradients appear to indicate flows that follow the Cuyama River. The contour map shows a steep gradient north of the SBCF and flows to an area of lowered groundwater elevation northeast of the town of Cuyama. From the town of New Cuyama to the west, groundwater has a horizontal gradient that generally flows to the northeast, from areas with higher elevation topography towards areas with lower elevation topography where the Cuyama River is located.

Figure Y-2 shows depth to water contours for fall of 2017. Because more data was available in this time frame, the contour map has increased detail in some areas. In the southeastern portion of the basin near the Ozena fire station, depth to water is under 50 feet bgs. There is a steep gradient near the SBCF, and groundwater is below 600 feet bgs immediately northwest of the SBCF. The central portion of the basin generally has a depth to water between 400 and 500 feet bgs, with groundwater levels rising to the west of New Cuyama. West of Bitter Creek, groundwater is generally shallower than 100 feet below bgs, and is shallower than 50 feet bgs along the Cuyama River in most cases.

Figure Y-3 shows groundwater elevation contours for spring of 2017. Because more data was available in this time frame, the contour map has increased detail in some areas. In the southeastern portion of the basin near the Ozena fire station, groundwater gradients appear to indicate flows that follow the Cuyama River. The contour map shows a steep gradient north of the SBCF and flows to an area of lowered groundwater elevation northeast of the town of Cuyama. From the town of New Cuyama to the west, groundwater has a horizontal gradient that generally flows to the northeast, from areas with higher elevation topography towards areas with lower elevation topography where the Cuyama River is located.

Figure Y-4 shows depth to water contours for spring of 2017. In the southeastern portion of the basin near the Ozena fire station, depth to water is under 50 feet bgs. Depth to groundwater near Ventucopa is between 150 and 200 feet bgs. There is a steep gradient near the SBCF, and groundwater is below 600 feet bgs immediately northwest of the SBCF. The central portion of the basin generally has a depth to water between 350 and 500 feet bgs, with groundwater levels rising to the west of New Cuyama. West of Bitter Creek, groundwater is generally shallower than 100 feet below bgs, and is shallower than 50 feet bgs along the Cuyama River in most cases.

Figure Y-5 shows groundwater elevation contours for spring of 2015. In the southeastern portion of the basin near the Ozena fire station, groundwater gradients appear to indicate flows that follow the Cuyama River. The contour map shows a steep gradient north of the SBCF and flows to an area of lowered groundwater elevation northeast of the town of Cuyama. From the town of New Cuyama to the west, the limited number of data points restrict strong interpretation of the gradient, which is to the northwest.

Figure Y-6 shows depth to water contours for spring of 2015. In the southeastern portion of the basin near the Ozena fire station, depth to water is under 50 feet bgs. Depth to groundwater near Ventucopa is between 150 and 200 feet bgs. There is a steep gradient near the SBCF, and groundwater is below 600 feet bgs immediately northwest of the SBCF. The central portion of the basin generally has a depth to water between 350 and 450 feet bgs, with groundwater levels rising to the west of New Cuyama. Interpretation from New Cuyama to monitoring points in the northwest is hampered by a limited set of data points.

Figure Y-7 shows groundwater elevation contours for fall of 2014. In the southeastern portion of the basin near the Ozena fire station, groundwater gradients appear to indicate flows that follow the Cuyama River. The contour map shows a steep gradient north of the SBCF and flows to an area of lowered groundwater elevation northeast of the town of Cuyama.

Figure Y-8 shows depth to water contours for fall of 2014. In the southeastern portion of the basin near the Ozena fire station, depth to water is under 50 feet bgs. There is a steep gradient near the SBCF, and groundwater is below 600 feet bgs immediately northwest of the SBCF. The central portion of the basin generally has a depth to water between 350 and 500 feet bgs, with groundwater levels rising to the west of New Cuyama. Interpretation from New Cuyama to monitoring points in the northwest is hampered by a limited set of data points.

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2.2.4 Change in Groundwater Storage

This section is under development and will feature outputs from model development. This section will include the following:

- Change in groundwater storage for the last 10 years
- How change in storage was calculated
- Estimates of annual use
- Water year types and their relationship to changes in storage
- Cover conditions at Jan 1 2015, or as close as possible

2.2.5 Seawater Intrusion

Seawater intrusion is not an applicable sustainability indicator, because seawater intrusion is not present in the Basin and is not likely to occur due to the distance between the Basin and the Pacific Ocean, bays, deltas, or inlets.

2.2.6 Land subsidence

The USGS measured land subsidence as part of its technical analysis of the Cuyama Valley in 2015. The USGS used two continuous global positioning systems (GPS) sites and five reference point interferometric synthetic-aperture radar (InSAR) sites, shown in Figure 2.2-21 (USGS, 2015). There are 308 monthly observations from 2000 to 2010, and total subsidence over the 2000 to 2010 period ranged from 0.0 to 0.2 feet. The CUVHM's simulated subsidence estimates inelastic subsidence was initiated in the late 1970s (USGS, 2015).

Subsidence data was collected from the University NAVSTAR Consortium (UNAVCO) database. UNAVCO maintains data on five GPS monitoring stations in the area in and around the basin. Figure 2.2-22: Subsidence Monitoring Locations shows the monitoring stations and their measurements since 1999. Three stations (P521, OZST, and BCWR) are located just outside the basin. The three stations' measurements show ground surface level as either staying constant or slightly increasing. The increase is potentially due to tectonic activity in the region. Two stations (VCST and CUHS) are located within the basin. Station VCST is located near Ventucopa and indicates that subsidence is not occurring in that area. Station CUHS indicates that 300 millimeters (approximately 12 inches) of subsidence have occurred in the vicinity of New Cuyama over the 19 years that were monitored. The subsidence at this station increases in magnitude following 2010, and generally follows a seasonal pattern. The seasonal pattern is possibly related to water level drawdowns during the summer, and elastic rebound occurring during winter periods.

A white paper that provides information about subsidence and subsidence monitoring techniques is included in Appendix Z.

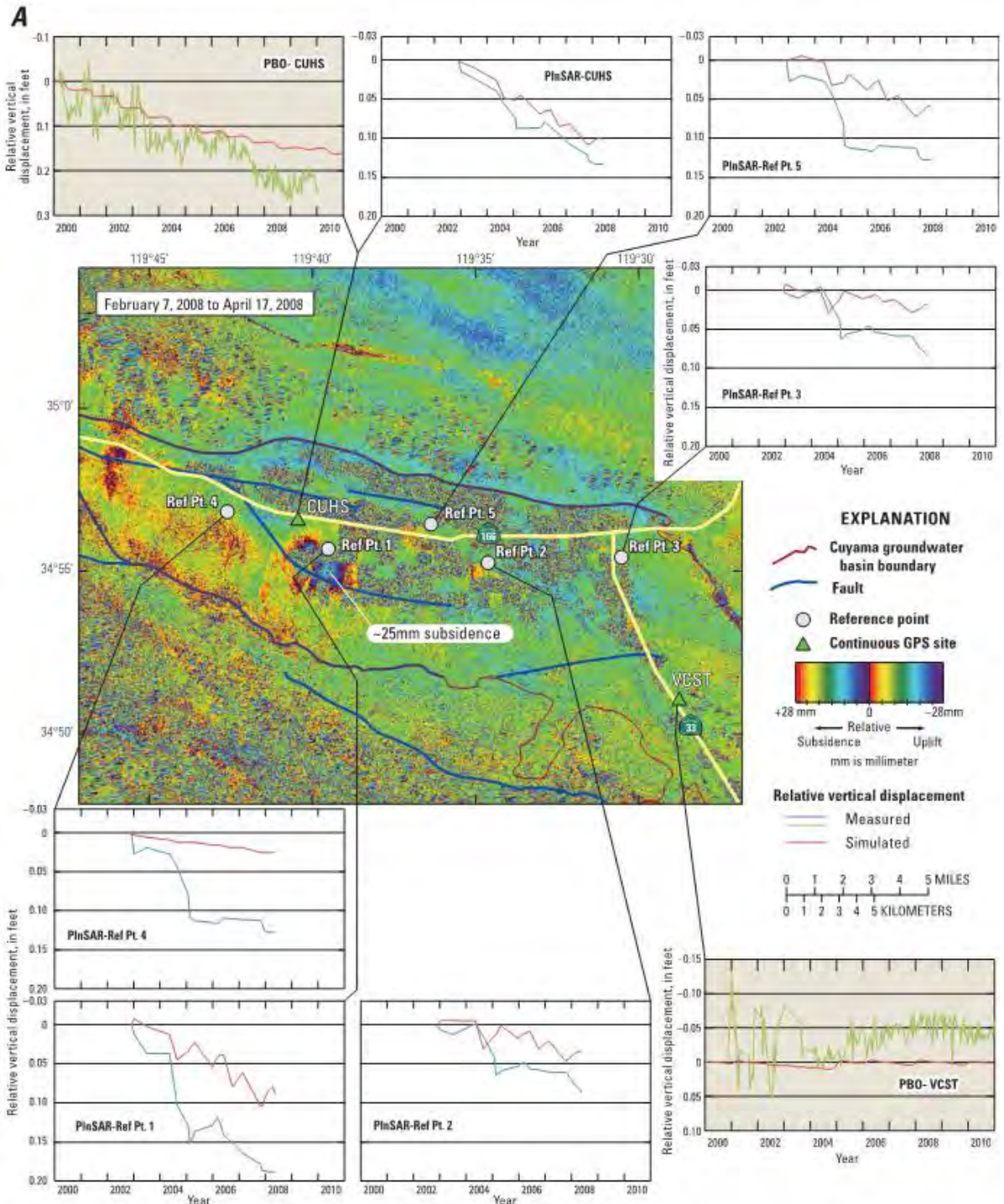


Figure 29. Historical subsidence as *A*, map of seasonal InSAR with graphs of simulated and measured time series for selected locations of relative land-surface deformation from Plate-Boundary Observation (PBO) sites and Point InSAR targets, and *B*, simulated total subsidence 1950–2010 for the calibrated hydrologic flow model, Cuyama Valley, California.

Source: USGS, 2015

Figure 2.2-21: Locations of Continuous GPS and Reference InSAR Sites in the Cuyama Valley

Page 2.2-38

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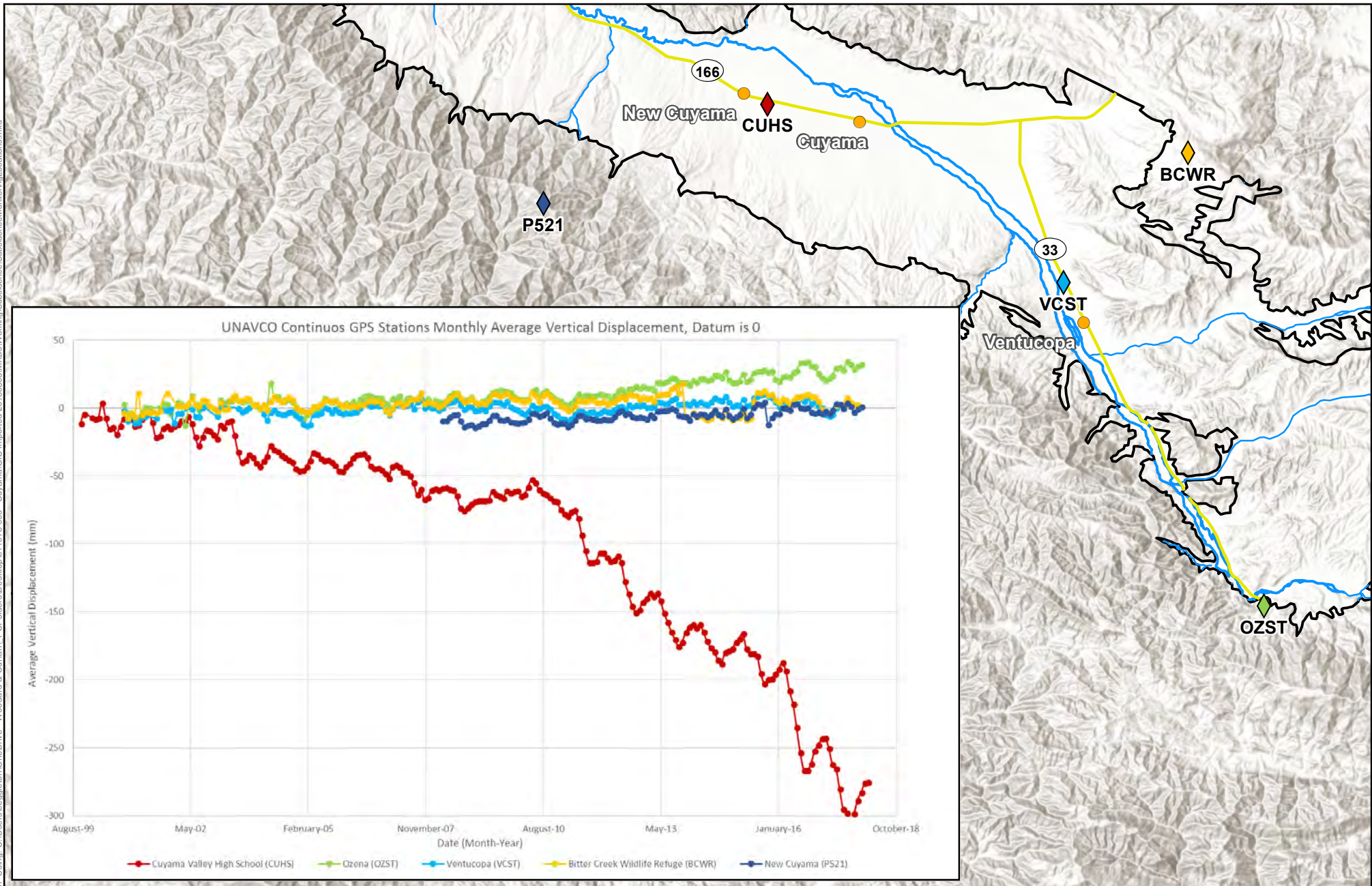


Figure 2.2-22: Subsidence Monitoring Locations

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

August 2018



Legend

- Cuyama Basin
- Cuyama River
- Towns
- Streams
- Highways



2.2.7 Groundwater Quality

This section presents groundwater quality information in the basin.

Reference and Data Collection

References and data related to groundwater quality were collected from a variety of sources. Data was collected from:

- National Water Quality Monitoring Council (USGS)- Downloaded 6/1/2018 from <https://www.waterqualitydata.us/portal/>
- GeoTracker GAMA (DWR)- Downloaded 6/5/2018, for each county, from <http://geotracker.waterboards.ca.gov/gama/datadownload>
- California Natural Resources Agency (DWR) downloaded 6/14/2018 from <http://geotracker.waterboards.ca.gov/gama/datadownload>
- County of Ventura
- Grapevine Capitol Partners

Data was compiled into a database for analysis.

References containing groundwater quality information were also collected. Data used in reference studies was not generally available for incorporation into the database. Therefore, references cite conditions that are not represented in collected data but are used to enhance understanding of groundwater quality conditions beyond available data. References used in this section include:

- Singer and Swarzensky, 1970 – *Pumpage and Ground-Water Storage Depletion in Cuyama Valley, 1947-1966*. This report focused on groundwater depletion, but also included information about groundwater quality.
- USGS, 2008 - Groundwater-Quality Data in the South Coast Interior Basins Study Unit, 2008: Results from the California Groundwater Ambient Monitoring and Assessment (GAMA) Program. This study performed water quality testing on 12 wells in the Cuyama Valley and tested for a variety of constituents.
- SBCWA 2011 – *Santa Barbara County 2011 Groundwater Report*. This report provided groundwater conditions throughout the County, and provided water quality information for the Cuyama Valley.
- USGS 2013c – *Geology, Water-Quality, Hydrology, and Geomechanics of the Cuyama Valley Groundwater Basin, California, 2008-12*. This report investigated a wide variety of groundwater components including water quality.

Data Analysis

Collected data was analyzed for Total Dissolved Solids (TDS), nitrate, and arsenic.

Figure 2.2-23 shows TDS of groundwater measured in wells in 1966. In 1966, TDS was above the MCL of 1,500 micrograms per liter (mg/L) in over 50% of measurements. TDS was over 2,000 mg/L near the Cuyama River in the southeast portion of the basin near the Ozena Fire Station, Santa Barbara Canyon, and upper Quatal Canyon, indicating that high TDS water was entering the basin from the watershed above these measurement points. TDS measurements were over the Maximum Contaminant Level (MCL) throughout the central portion of the basin where irrigated agriculture was operating, and near the towns of Cuyama and New Cuyama, and along the Cuyama River to the northwest of New Cuyama. TDS was less than 500 mg/L in a number of measurements between Bitter Creek and Cottonwood Canyon, indicating that lower TDS water was entering the basin from the watersheds in this area.

Figure 2.2-24 shows TDS of groundwater measured in wells between 2011 and 2018. Multiple years of collected data were used to generate enough mapped data density for comparison to 1966 data. In the 2011-2018 period, TDS was above the MCL in over 50% of measurements. TDS was over 1,500 mg/L near the Cuyama River in the southeast portion of the basin near the Ozena Fire Station, and in Santa Barbara Canyon, indicating that high TDS water was entering the basin from the watershed above these measurement points. TDS measurements were over the MCL throughout the central portion of the basin where irrigated agriculture was operating. A number of 500-1,000 mg/L TDS measurements were measured near New Cuyama and in upper Quatal Canyon, and along the Cuyama River between Cottonwood Canyon and Schoolhouse Canyon.

Figure 2.2-25 shows measurements of TDS for selected monitoring points over time. Monitoring points were selected by the number of measurements, with higher counts of measurements selected to be plotted. The charts indicate that TDS in the vicinity of New Cuyama has been over 800 mg/L TDS throughout the period of record, and that TDS has either slightly increased or stayed stable over the period of record. TDS in the central portion of the basin. The chart for Well 85 at the intersection of Quatal Canyon and the Cuyama River I generally below 800 mg/L TDS with spikes of TDS increases. The spikes of TDS increases correspond with Cuyama River flow events, indicating a connection between rainfall and stream flow and an increase in TDS. This is the only location where this trend was detected.

Figure 2.2-26 shows measurements of nitrate in 1966. Figure 2.2-26 shows that data collected in 1966 was below the MCL of 5 mg/L throughout the basin, with some measurements above the MCL in the central portion of the basin where irrigated agriculture was operating.

Figure 2.2-27 shows measurements of nitrate of groundwater measured in wells between 2011 and 2018. Multiple years of collected data were used to generate enough mapped data density for comparison to 1966 data. Figure 2.2-27 shows that data collected over this period was generally below the MCL, with two measurements that were over 20 mg/L.

Figure 2.2-28 shows arsenic measurements from 2008-2018. Data was not available prior to this time period in significant amounts. Figure 2.2-28 shows arsenic measurements were below the MCL of 10 ug/L where data was available.

Figure 2.2-29: Known Contamination Sites shows the results of a query with the Regional Water Quality Control Board (RWQCB)'s Geotracker website. Geotracker documents contaminant concerns that the RWQCB is or has been working with site owners to clean up. Figure 2.2-29 shows that most of these sites are for fuels.

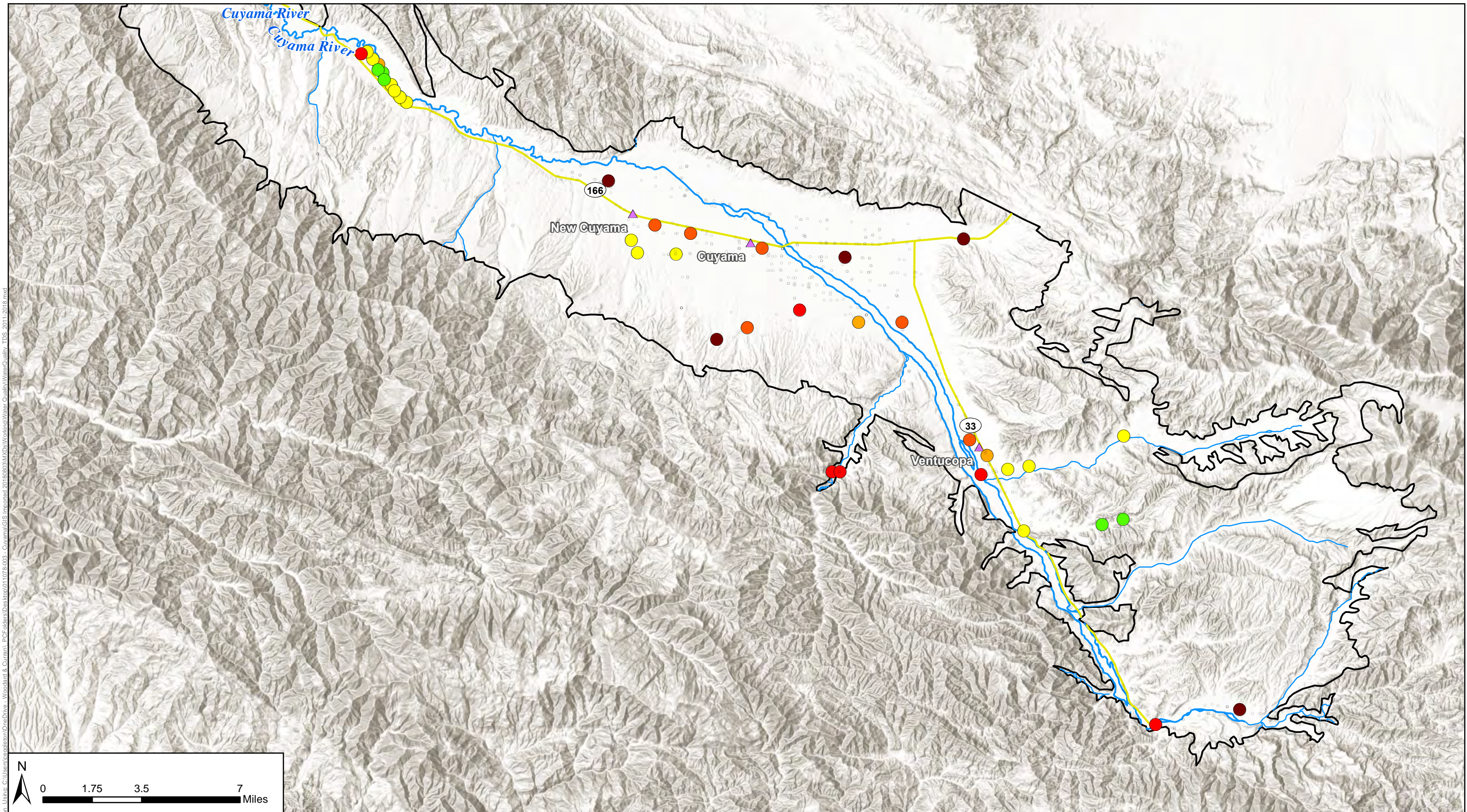


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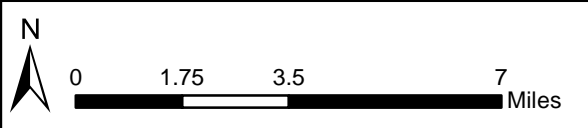


Figure 2.2-24: 2011-2018 Average Well Measurements of Total Dissolved Solids, mg/L
 Cuyama Basin Groundwater Sustainability Agency
 Cuyama Valley Groundwater Basin Groundwater Sustainability Plan
 August 2018



Legend

TDS, mg/L	
○ No Measurements	● 1,500 - 1,750 mg/L
● < 500 mg/L	● 1,750 - 2,000 mg/L
● 500 - 1,000 mg/L	● >2,000 mg/L
● 1,000 - 1,500 mg/L	

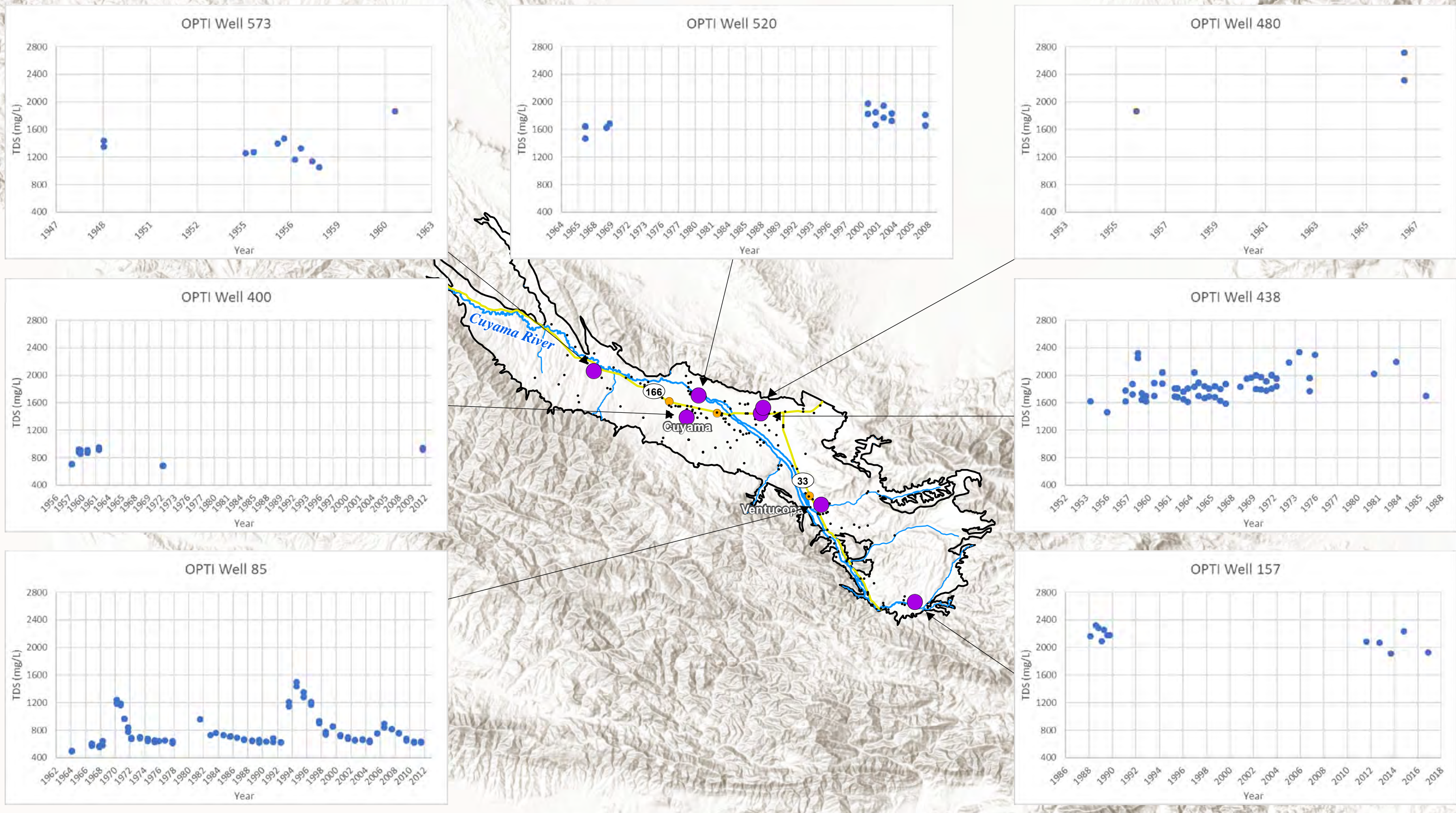


Figure 2.2-25: Cuyama Groundwater Basin Historic TDS Levels in Certain Wells
 Cuyama Basin Groundwater Sustainability Agency
 Cuyama Valley Groundwater Basin Groundwater Sustainability Plan
 August 2018



Legend

- Cuyama Basin
- Cuyama River
- Wells with Graphed Data
- Towns
- Streams
- Location of TDS WQ Measurements
- Highways



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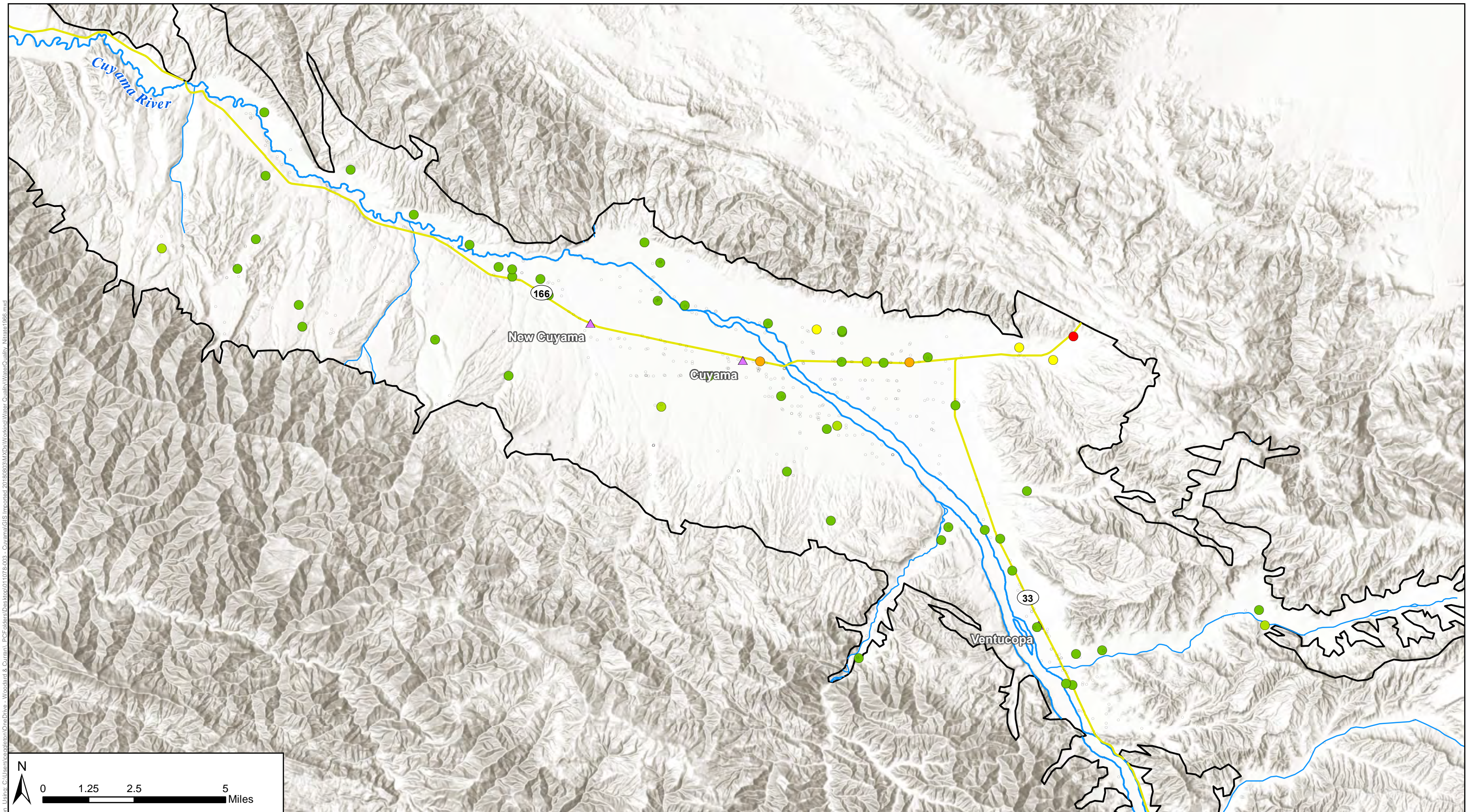


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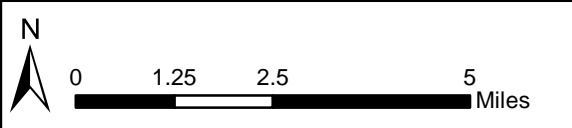


Figure 2.2-26: 1966 Average Well Measurements of Nitrate (NO₃) as Nitrogen
 Cuyama Basin Groundwater Sustainability Agency
 Cuyama Valley Groundwater Basin Groundwater Sustainability Plan
 August 2018



Legend

Nitrate (NO ₃) as N, mg/L	
○ No Measurements	● 10 - 15 mg/L
● < 5 mg/L	● 15 - 20 mg/L
● 5 - 8 mg/L	● > 20 mg/L
● 8 - 10 mg/L	

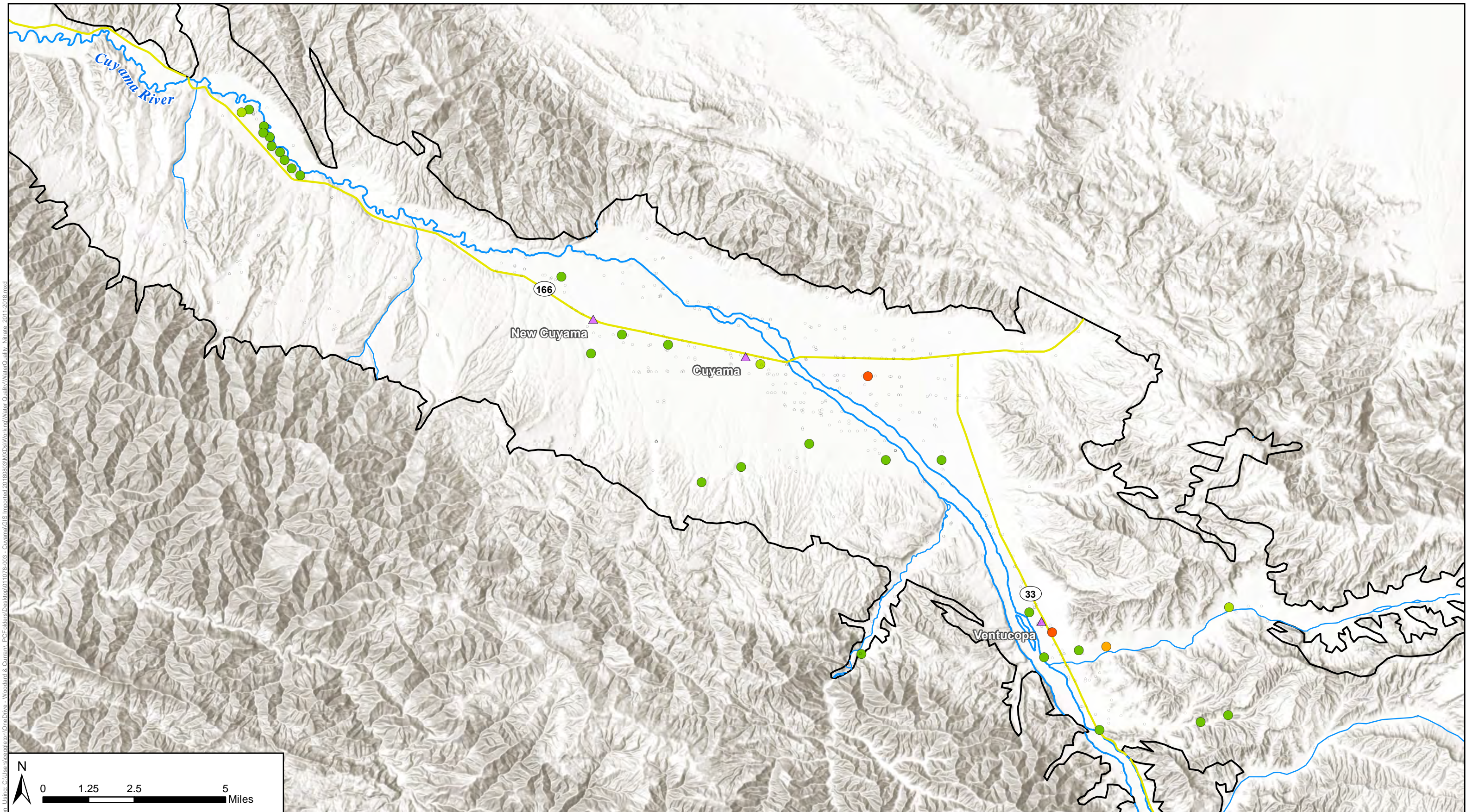


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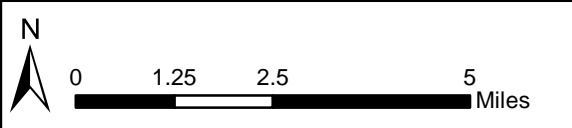


Figure 2.2-27: 2011-2018 Average Well Measurements of Nitrate (NO₃) as Nitrogen
 Cuyama Basin Groundwater Sustainability Agency
 Cuyama Valley Groundwater Basin Groundwater Sustainability Plan
 August 2018



Legend

Nitrate (NO ₃) as N, mg/L	
○ No Measurements	● 10 - 15 mg/L
● < 5 mg/L	● 15 - 20 mg/L
● 5 - 8 mg/L	● > 20 mg/L
● 8 - 10 mg/L	

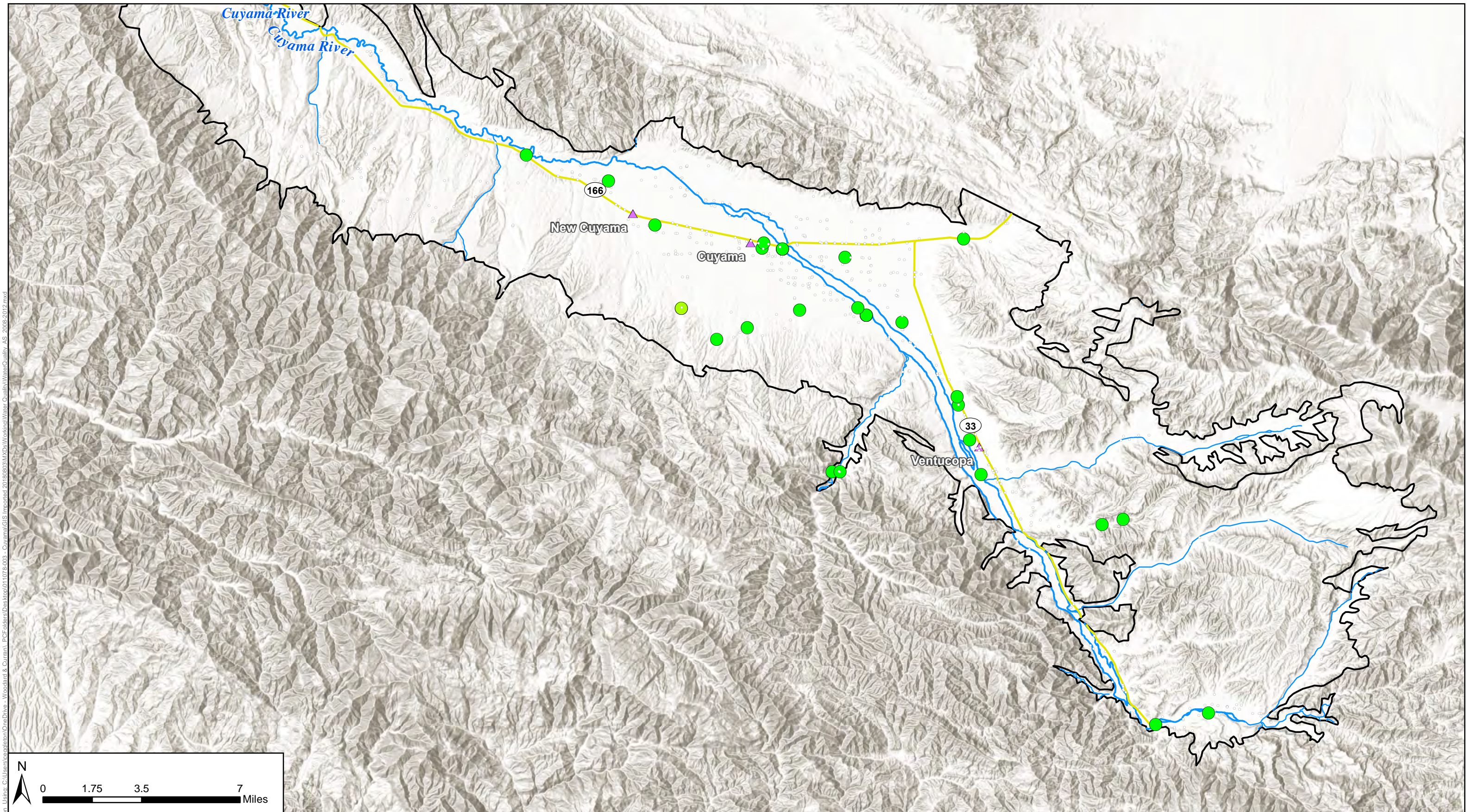


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Figure 2.2-28: 2008-2018 Average Well Measurements of Arsenic, ug/L

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

August 2018



Legend

- Arsenic (As), ug/L**
- No Measurements
 - < 5 ug/L
 - 5 - 10 ug/L
 - 10 - 20 ug/L
 - > 20 ug/L

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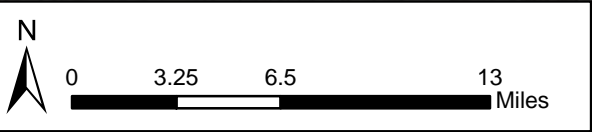
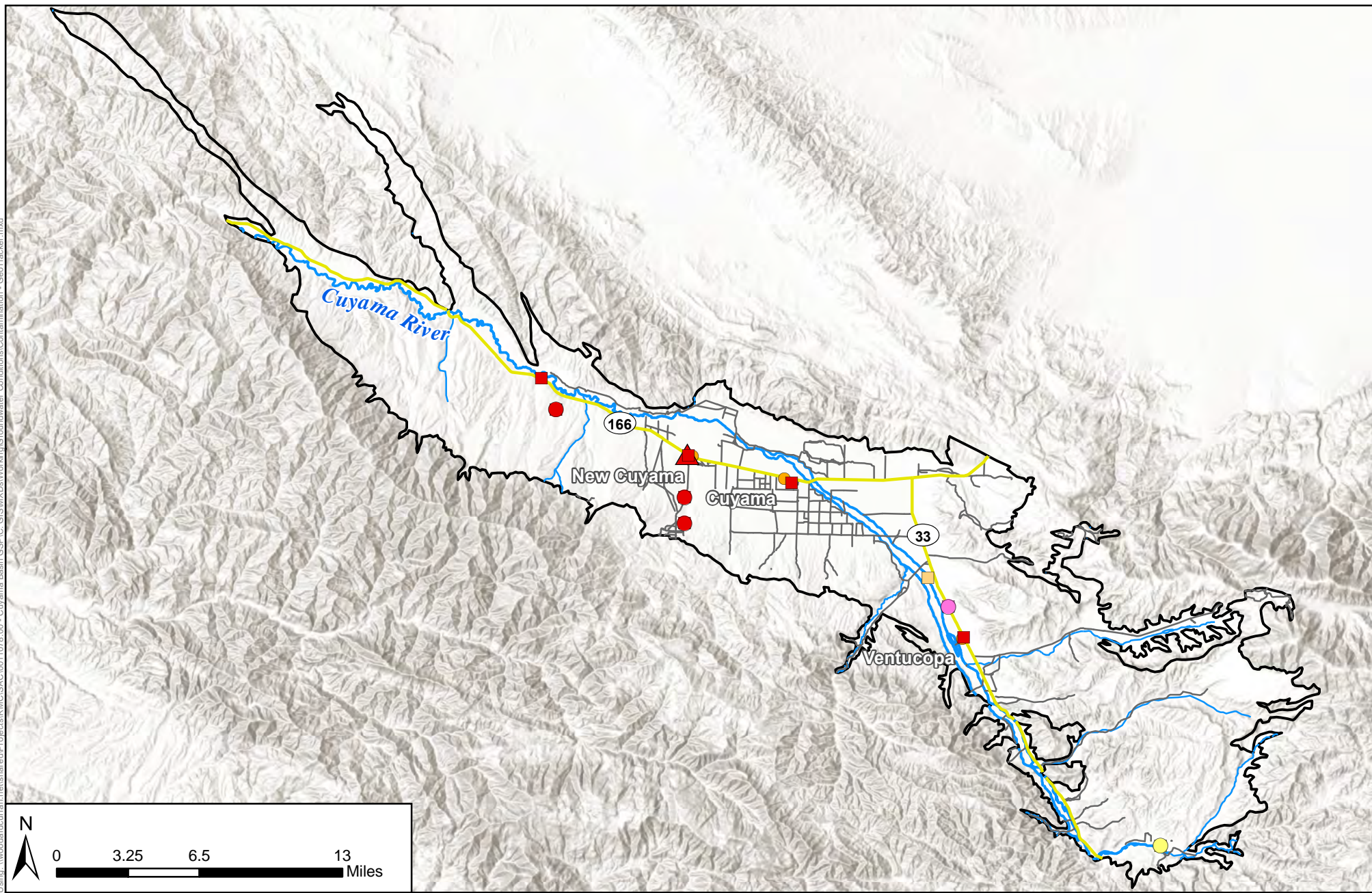


Figure 2.2-29 - Sites with Water Quality Concerns
Cuyama Basin Groundwater Sustainability Agency
Cuyama Valley Groundwater Basin Groundwater Sustainability Plan
August 2018



Legend

Cuyama Basin	Cuyama River	Site Status	Contaminant of Concern
Towns	Streams	Open Sites	Gas, Oil &/or Diesel
Highways		Closed Sites	TPH & Lead
Local Roads		Permitted UST	VOCs
			Alcohols

Literature Review

In 1970, Singer and Swarzenski reported that TDS was as high as 1,500 to 1,800 mg/L TDS, and that the cations that contributed to the TDS and the amount of TDS varied by location in the basin. They reported that TDS was lower (400 to 700 mg/L) in areas downstream from the Sierra Madre Mountains where TDS was made up of sodium or calcium bicarbonate, and higher (3,000-6,000 mg/L) in wells close to the Caliente Range and in the northeastern part of the valley. They state that the high TDS is generated by mixing of water from marine rocks with more recent water from alluvium. They determined that groundwater movement favors movement of brackish water from the north of the Cuyama River towards areas of groundwater depletion, and that return of some water applied during irrigation and needed for leaching the soil carries dissolved salts with it to the water table (Singer and Swarzensky, 1970).

In 2008, the USGS reported the results of the GAMA study, which sampled 12 wells for a wide variety of constituents. The locations of the wells provided in the GAMA study are shown in Figure 2.2-30. The study identified that specific conductance ranged from 637 to 2,380 uS/cm across the study's 12 wells. The GAMA study reported that the following constituents were not detected at levels above the MCL for each constituent in any samples for the following constituents:

- Pesticides or pesticide degradates
- Gasoline and refrigerants
- Aluminum, antimony, barium, beryllium, boron, cadmium, copper, iron, and lead
- Ammonia and phosphate
- Lithium, Molybdenum, Nickel, Selenium, Strontium, Thallium, Tungsten, Uranium, Vanadium, and Zinc
- Bromide, Calcium, Chloride, Fluoride, Iodide, Magnesium, Potassium, Silica, and Sodium

The GAMA study reported that there were detections at levels above the MCL for the following constituents:

- Manganese exceeded its SMCL in two wells.
- Arsenic exceeded the MCL in one well.
- Nitrate exceeded the MCL in two wells
- Sulfate exceeded its MCL in eight wells
- TDS exceeded its MCL in 7wells
- VOCs detected in one well.

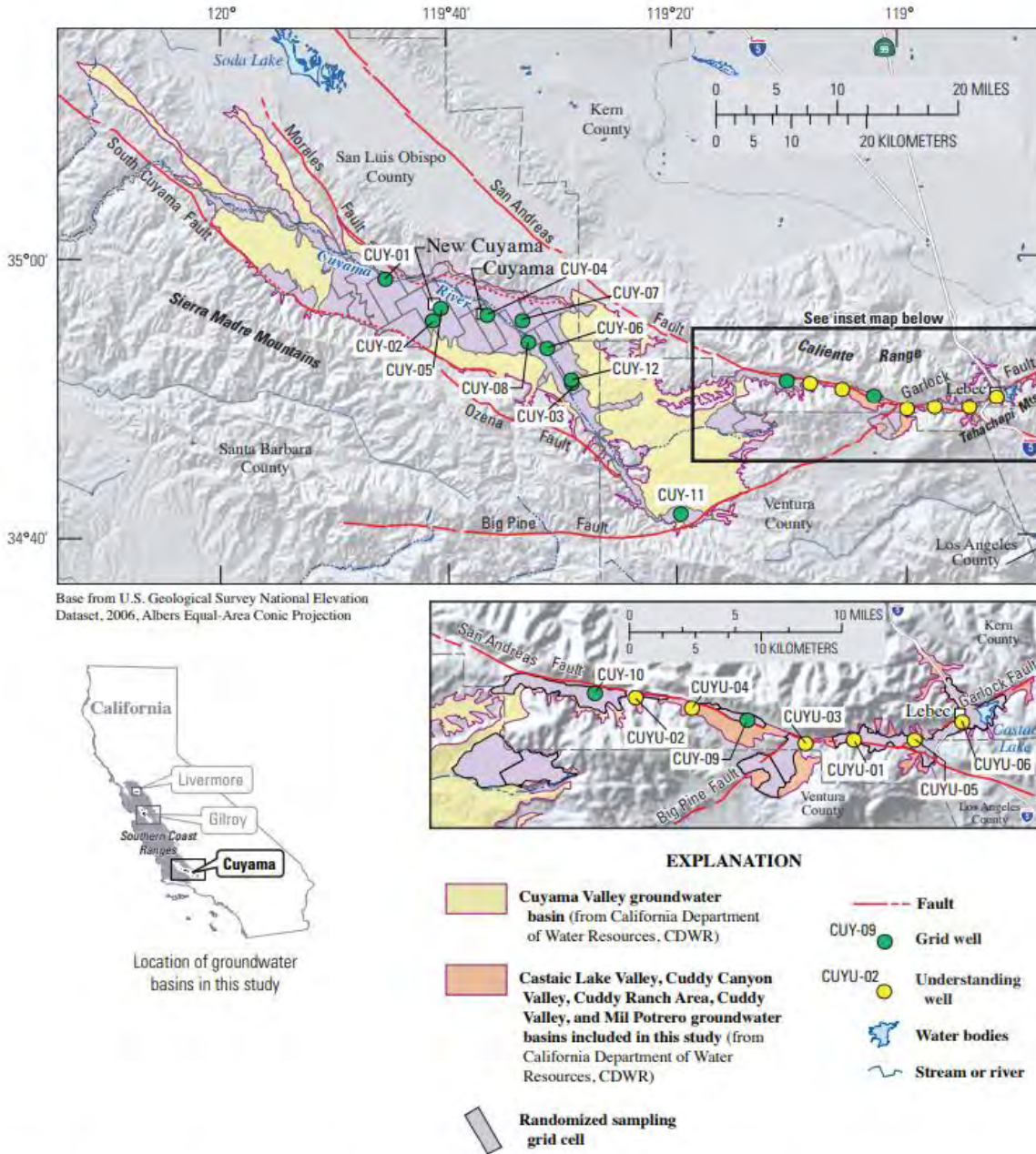


Figure 5. The South Coast Interior Basins Groundwater Ambient Monitoring and Assessment (GAMA) study unit showing the distribution of the Cuyama study-area grid cells, the location of sampled grid wells and understanding wells, the Cuyama Valley, Castaic Lake Valley, Cuddy Canyon Valley, Cuddy Ranch Area, Cuddy Valley, and Mil Potrero groundwater-basin boundaries (as defined by the California Department of Water Resources, CDWR), major cities, major roads, topographic features, and hydrologic features. Alphanumeric identification numbers for grid wells

Source: USGS, 2008

Figure 2.2-30: Locations of GAMA Sample Locations

In 2011, SBCWA reported that TDS in the basin typically ranges from 1,500 to 1,800 mg/L in the main part of the basin, while the Cuyama Badlands in the eastern part where Ballinger, Quatal, and Apache Canyons are has better water quality with TDS typically ranging rom 400 to 700mg/L. SBCWA noted spikes in TDS on the Badlands Well which followed wet rainfall years of 1969 and 1994 and state that the spikes are attributable to overland flow from rainfall which is flushing the upper part of the basin after dry periods.

SBCWA reported that boron is generally higher in the upper part of the basin and is of higher concentration in the uplands than in the deeper wells in the central part of the basin. Toward the northeast end of the basin at extreme depth there exists poor quality water, perhaps connate (trapped in rocks during deposition) from rocks of marine origin.

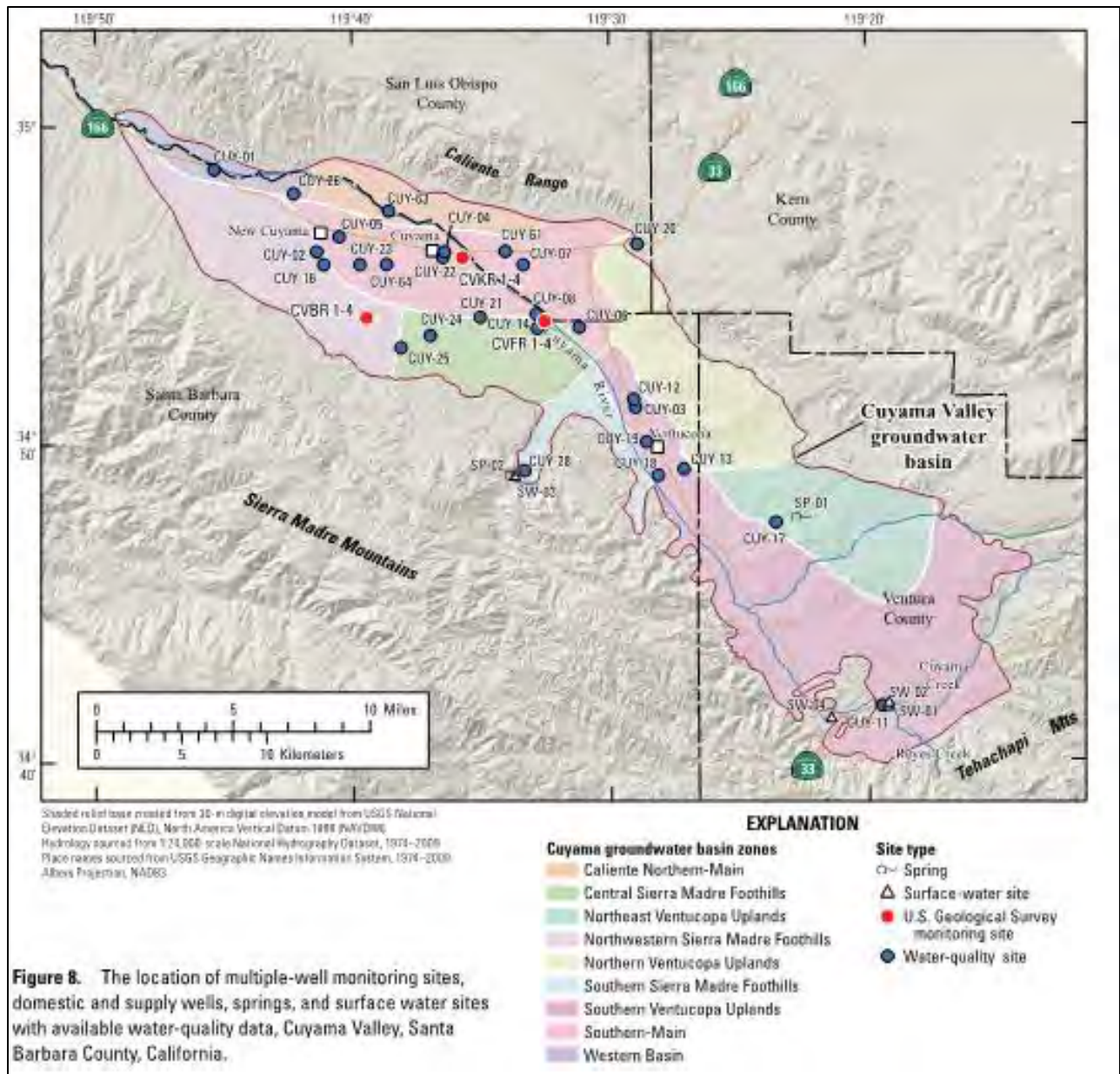
SBCWA also reported: “There was little change in TDS, calcium, magnesium, nitrates and sulfates during the 2009- 2011 period. In some cases, concentrations of these nutrients actually fell during the period, most likely due to a lack of rainfall, recharge and flushing of the watershed. As the Cuyama watershed is mostly dry, water quality data must be examined with caution as sometimes overland flow from rainfall events “flushes” the watershed and inorganic mineral concentrations actually peak during storm flows. Typically, in other areas of Santa Barbara County mineral concentrations are diluted during widespread storm runoff out of natural watersheds.”

In 2013, USGS reported that they collected groundwater quality samples at 12 monitoring wells, 27 domestic wells, and 2 springs for 53 constituents including: field parameters (water temperature, specific conductance, pH, DO, alkalinity), major & minor ions, nitrate, trace elements, stable isotopes of hydrogen and oxygen, tritium and carbon-14 activities, arsenic, iron, and chromium. The USGS sampling locations are presented in a figure from the report in Figure 2.2-31. The USGS reported the results of the sampling as:

- Groundwater in the alluvial aquifer system has high concentrations of TDS and sulfate
- 97% of samples had concentrations greater than 500 mg/L for TDS
- 95% of samples had concentrations greater than 250 mg./L for sulfate
- 13% of samples had concentrations greater than 10 mg/L for nitrate
- 12% of samples had concentrations greater than 10 ug/L for arsenic
- 1 sample had concentrations greater than the MCL for fluoride
- 5 samples had concentrations greater than 50 mg/L for manganese
- 1 sample had concentration of iron greater than 300 mg/L for iron
- 1 sample had concentration of aluminum greater than 50 mg/L

The USGS reported the following about nitrate as nitrogen in the basin. Nitrate was detected in five locations above the MCL of 10 mg/L. Four wells where nitrate levels were greater than the MCL were in the vicinity of the center of agricultural land-use area. Irrigation return flows are possible source of high nitrate concentrations. There was a decrease in concentrations with depth in the agricultural land use area which indicated the source of higher nitrate concentrations likely to be near the surface. The lowest nitrate levels were outside the agricultural use area, and low concentrations of nitrate (less than 0.02 mg/L) in surface water samples indicated surface water recharge was not a source of high nitrate

The USGS reported that arsenic was found in greater concentration than the MCL of 10 ug/L in 4 of the 33 wells sampled, and samples of total chromium ranged from no detections to 2.2 ug/L, which is less than the MCL of 50 ug/L. Hexavalent chromium ranged from 0.1 to 1.7 ug/L which is less than the MCL of 50 ug/L.



USGS 2013c

Figure 2.2-31: USGS 2013c Water Quality Monitoring Sites

2.2.8 Interconnected Surface Water Systems

This section is under development and will feature outputs from model development. This section will include the following:

- Identification of interconnected surface water systems
- Estimates of timing and quantity of depletions
- Map of interconnected surface water systems
- Consideration of ephemeral and intermittent streams, and where they may cease to flow if applicable

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2.2.9 Groundwater Dependent Ecosystems

This section is under development and study is being performed by a biologist. This section will include the following:

- Summary of Groundwater Dependent Ecosystem (GDE) analysis
- Describe locations and types of GDEs
- Map of GDEs

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2.2.10 Data Gaps

This subsection will be used to document identified data gaps in the groundwater conditions section of the GSP. Feedback from stakeholders is essential in identifying data gaps.

2.2.11 References

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Appendix X - Hydrographs

This appendix presents hydrographs of every monitoring well with groundwater elevation data that was collected during development of the GSP. Each hydrograph has been assigned a database number, and the maps at the front of this section should be used to find the location of hydrographs of interest to the reader. The beginning of this appendix presents a map showing the locations of four detailed maps with the well identification numbers. The four location maps are intended to facilitate identifying the location of a specific hydrograph.

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Appendix Y - Groundwater Contours

This appendix includes groundwater elevation and depth to water contour maps for the following periods:

- Figure Y-1: Fall 2017 Groundwater Elevation
- Figure Y-2: Fall 2017 Depth to Water
- Figure Y-3: Spring 2017 Groundwater Elevation
- Figure Y-4: Spring 2017 Depth to Water
- Figure Y-5: Spring 2015 Groundwater Elevation
- Figure Y-6: Spring 2015 Depth to Water
- Figure Y-7: Fall 2014 Groundwater Elevation
- Figure Y-8: Fall 2014 Depth to Water

Descriptions of each contour map are included in 2.2.3 Groundwater Trends.

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Appendix Z - Subsidence Information White Paper

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