4. MONITORING NETWORKS

This chapter discusses the planned monitoring networks needed to guide the Cuyama Basin Groundwater Sustainability Agency (CBGSA) toward their sustainability goals. Monitoring networks need to be established for each sustainability indicator either directly or through monitoring through a proxy. This section satisfies Subarticle 4 of the SGMA regulations. This chapter also discusses the following:

- Monitoring network objectives
- Existing monitoring programs used as part of each network
- Monitoring network establishment for each sustainability indicator
- Monitoring network data gaps, and a plan to fill data gaps if they are present for each monitoring network

4.1 Useful Terms

This chapter describes groundwater wells, water quality measurements, subsidence stations, and other related components. Technical terms are defined below. Figure 4-1 is a diagram of a monitoring well with well-related terms identified on the diagram. Terms are defined here to guide readers through this chapter, and are not a definitive definition of each term:

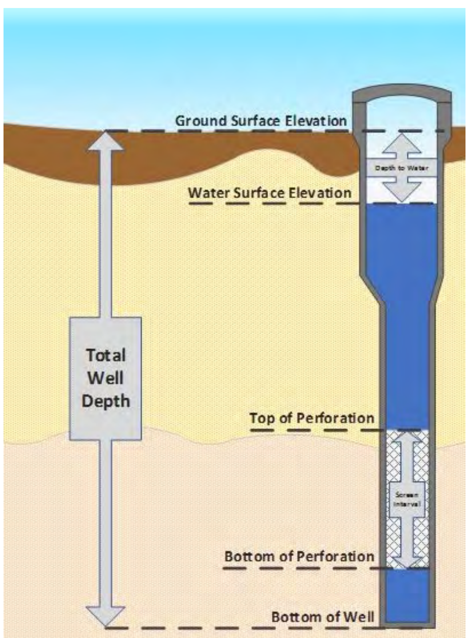

Figure 4-1: Well Completion Diagram

4.1.1 Well-Related Terms

- **Bottom perforation –** The distance to the bottom of the perforation from the ground surface elevation.
- **Depth to water –** The distance from the ground surface or the well' to where water is encountered inside the well
- **Ground surface elevation –** The elevation in feet above mean sea level at the well's location.
- **Screened interval** – The portion of a well casing that is screened to allow water from the surrounding soil into the well pipe. There can be several screened intervals within the same well. Screened interval is usually reported in feet below ground surface (bgs) for both the upper most limit and lower most limit of the screen.
- **Top perforation –** The distance to the top of the perforation from the ground surface elevation.
- **Total well depth** – The depth that a well is installed to. This is often deeper than the bottom of the screened interval.
- **Water surface elevation –** The elevation above mean sea level that water is encountered inside the well

4.1.2 Other Terms

- **Best management practice** – Refers to a practice, or combination of practices, that are designed to achieve sustainable groundwater management and have been determined to be technologically and economically effective, practicable, and based on best available science (Title 23 of the California Code of Regulations [CCR], Article 2).
- **Constituent** – Refers to a water quality parameter measured to assess groundwater quality.
- **Data gap** – Refers to a lack of information that significantly affects the understanding of the Basin setting or evaluation of the efficacy of Plan implementation and could limit the ability to assess whether a Basin is being sustainably managed (Title 23 of the CCR, Article 2).
- **Depth to groundwater –** This is the distance from the ground surface to groundwater typically reported at a well.
- **Historical high groundwater elevations –** This is the highest recorded measurement of static groundwater elevation (closest to the ground surface) in a monitoring well. 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 static 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.

- **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.
- **Representative monitoring** – Refers to a monitoring site within a broader network of sites that typifies one or more conditions within the Basin or an area of the Basin (Title 23 of the CCR, Article 2).
- **Subsidence** – Refers to the sinking or downward settling of the earth's surface, not restricted in rate, magnitude, or area involved, and is often the result of over-extraction of subsurface water. For more information, see the Groundwater Conditions chapter.

4.2 Monitoring Network Objectives

This chapter describes the Basin monitoring networks for the five sustainability indicators that apply to the Basin. The objective of these monitoring networks is to detect undesirable results in the Basin as described in Chapter 3 using the sustainability thresholds described in Chapter 5. Other related objectives of the monitoring network are defined via the SGMA regulations as follows:

- Demonstrate progress toward achieving measurable objectives described in the GSP
- Monitor impacts to the beneficial uses or users of groundwater
- Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds
- Quantify annual changes in water budget components

The monitoring network plan provided to the Basin is intended to monitor:

- Chronic lowering of groundwater levels
- Reduction in groundwater storage
- Degraded water quality
- Land subsidence
- Depletions of interconnected surface water

The monitoring networks described in this chapter were designed by evaluating data provided by DWR, the USGS, participating counties, and private landowners. The monitoring network consists of wells that are already being used for monitoring in the Basin. Decisions to include wells in the monitoring network were based on the criteria described below.

4.2.1 Basin Conditions Relevant to Measurement Density and Frequency

This section summarizes key Basin conditions that influence the development of monitoring networks. These key conditions include hydrogeologic considerations, land use considerations, and historical groundwater conditions.

The Basin, as described in the Section 2.1, is composed of one principal aquifer comprised of three geologic groups: Younger Alluvium, Older Alluvium, and Morales Formation. The majority of groundwater in the aquifer is stored in the Younger and Older alluvium. While there are many faults in the Basin, there are no major stratigraphic aquitards or barriers to vertical groundwater movement among the alluvium and Morales Formation. The aquifer has a wide range of thicknesses that vary spatially, with median reported hydraulic conductivity ranges from 1.22 to 72.1 feet per day (see Table 2-1 in Chapter 2 for detailed values). Figures 2-19 and 2-20 in Chapter 2 show the extent of these formations throughout the Basin.

The largest groundwater uses in the Basin are for irrigated agriculture. The figures shown in Chapter 1, Section 1.2, Plan Area show the extent of land used for irrigated agriculture in the Basin. Based on the most recent data from 2016, there are approximately 53 square miles of agricultural land in the Basin out of approximately 378 square miles, equaling approximately 14 percent of the Basin's land.

Data provided in Chapter 2, Section 2.2 shows the historical decline groundwater levels in the Basin's central portion. Groundwater elevations in this portion of the Basin have decreased by more than 400 feet from the 1940s to the present, as shown in Figure 4-2.

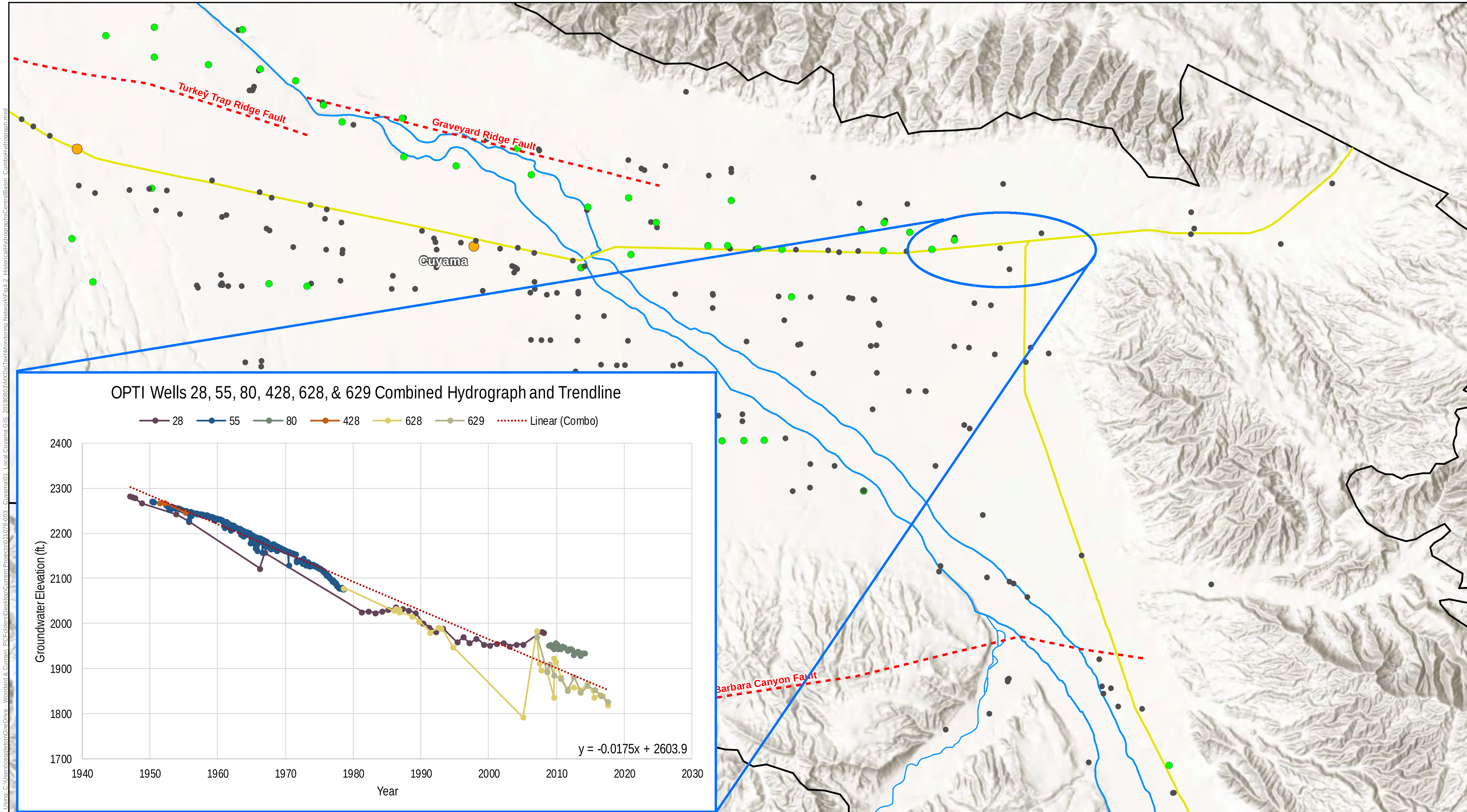

Figure 4-2: Cuyama GW Basin Central Basin with Combined Hydrograph

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

April 2019

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Legend

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

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4.3 Existing Monitoring Used

4.3.1 Groundwater Level Monitoring

This section describes groundwater level monitoring conducted by agencies and private land owners in the Basin.

DWR, Statewide Dataset/CASGEM Program

The State of California has several water-related database portals accessible online. These include the following:

- CASGEM Program
- Water Data Library
- Groundwater Information Center Interactive Map Application

The data for these portals are organized and saved in one master database, where each portal accesses and displays data depending on the search criteria and portal used.

The CBGSA contacted DWR directly to acquire all available data related to the Basin. DWR provided a customized hyperlink for CBGSA representatives to download the State's database in whole. Cuyama Basin data were then extracted from this dataset.

Although the master dataset was used to collect initial data, the CASGEM Program portal was used throughout the planning process to verify that data (DWR CASGEM Online System, 2018). The CASGEM Program is tasked with tracking seasonal and long-term groundwater elevation trends in groundwater basins throughout the State. In 2009, Senate Bill Senate Bill x7-6 establish collaboration between local monitoring parties and DWR, enabling DWR to collect groundwater elevation data, and ultimately establishing the CASGEM Program.

The CASGEM Program allows local agencies to be designated as CASGEM Program monitoring entities for groundwater basins throughout the State (CASGEM Brochure, 2018). CASGEM Program monitoring entities can measure groundwater elevations or compile data from other agencies to fulfill a monitoring plan, and each entity is responsible for submitting that data to DWR. Three monitoring entities operate as CASGEM Program monitoring entities in the Cuyama Basin as follows:

- SBCWA
- VCWPD
- San Luis Obispo Flood Control & Water Conservation District (SLOFC&WCD)

The CASGEM Program includes two kinds of wells in its database as follows:

- CASGEM Program wells, all of which include well construction information
- Voluntary wells that are included in the CASGEM Program database on a volunteer basis; well construction may not be identified or made public

The Basin has six CASGEM Program wells and 107 voluntary wells. Figure 4-3 shows the locations of these wells.

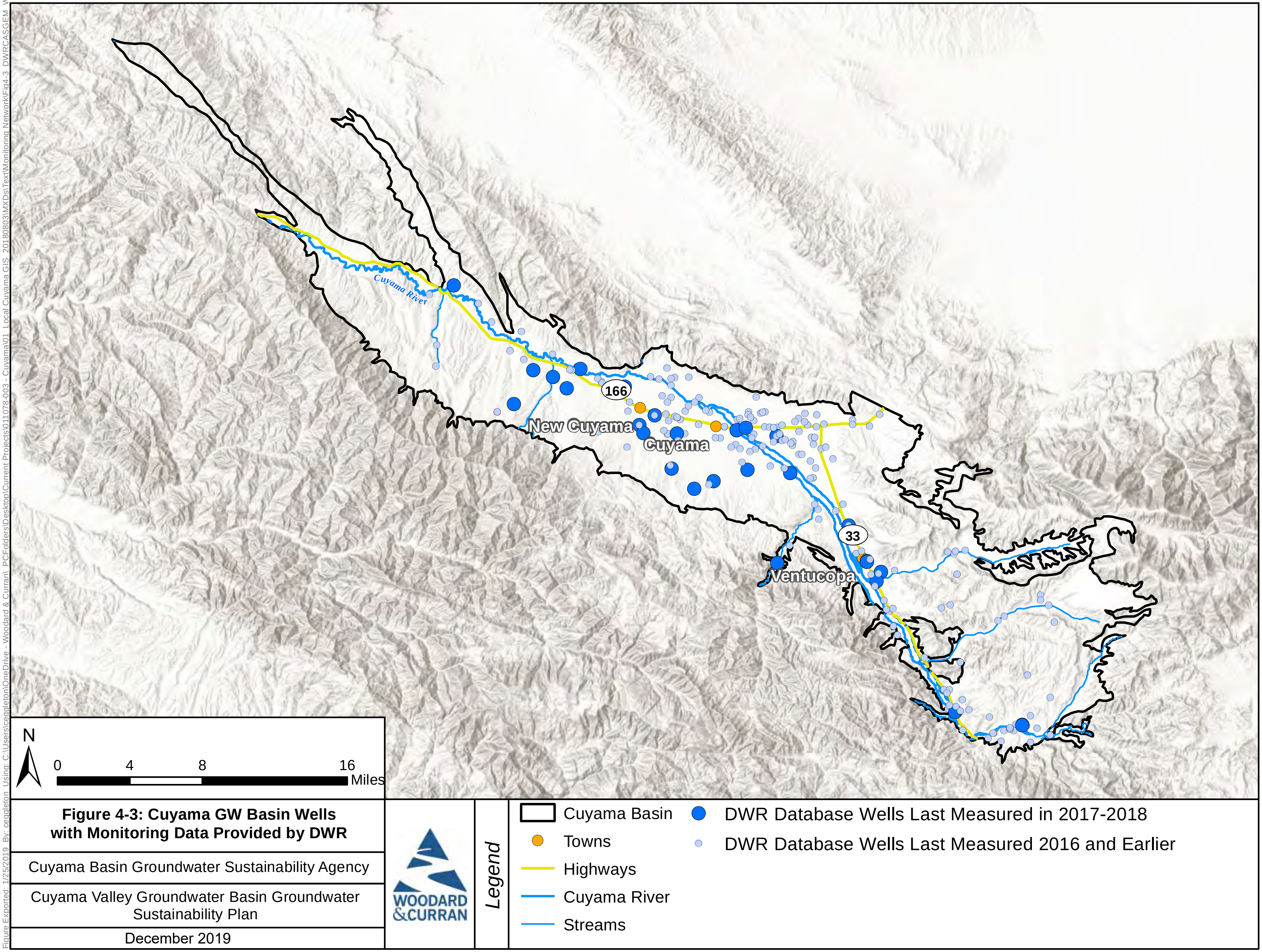

Figure 4-3: Cuyama GW Basin Wells with Monitoring Data Provided by DWR

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

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Most wells are measured on either a semi-annual or annual schedule. Summary statistics about these wells are listed below.

- Number of CASGEM Program wells: 6
- Number of voluntary wells: 107
- Total number of DWR and CASGEM Program wells: 222
- Earliest measurement year: 1946
- Longest period of record: 68 years
- Median period of record: 12 years
- Median number of records for a single well: 19

The greatest well density among current wells is in the central portion of the Basin and in the area around Ventucopa. There are also several monitoring wells in the south eastern portion of the Basin upstream of Ventucopa. CASGEM Program data are sparser along the north facing slopes of the main Cuyama Valley and the western portion of the Basin, as can be seen in Figure 4-3.

USGS

The USGS has the most groundwater elevation monitoring locations in the Basin. Many of these wells were installed for a 1966 groundwater study and have since been retired.

There are significant overlaps between the DWR provided datasets and the USGS provided datasets. Approximately 106 wells appear in both downloaded datasets. Overlapping data is discussed below.

USGS data may be accessed through their online portals for the National Ground-Water Monitoring Network, Groundwater Watch, and the NWIS.

The USGS online data portals provide approved data that has been quality-assured and deemed fit to be published by USGS. The portals also provide provisional data that is unverified and subject to revision. The CBGSA contacted USGS directly and coordinated download of USGS monitoring records in the Basin. The CBGSA used the USGS URL Generation tool was used to download all provisional and approved data about the Basin.

USGS has approximately 476 wells in the Basin. Summary statistics about these wells are listed below.

- Total number of USGS wells: 476
- Earliest measurement date: 1946
- Longest period of record: 68 years
- Median period of record: 2 years
- Median number of records for a single well: 2 years

A significant portion of the wells included in the USGS dataset are located near the Cuyama River and are in the central portion of the Basin. Wells are also found along many of the tributaries that feed the Cuyama River, recording data during large precipitation events. Figure 4-4 shows well locations included in the USGS dataset.

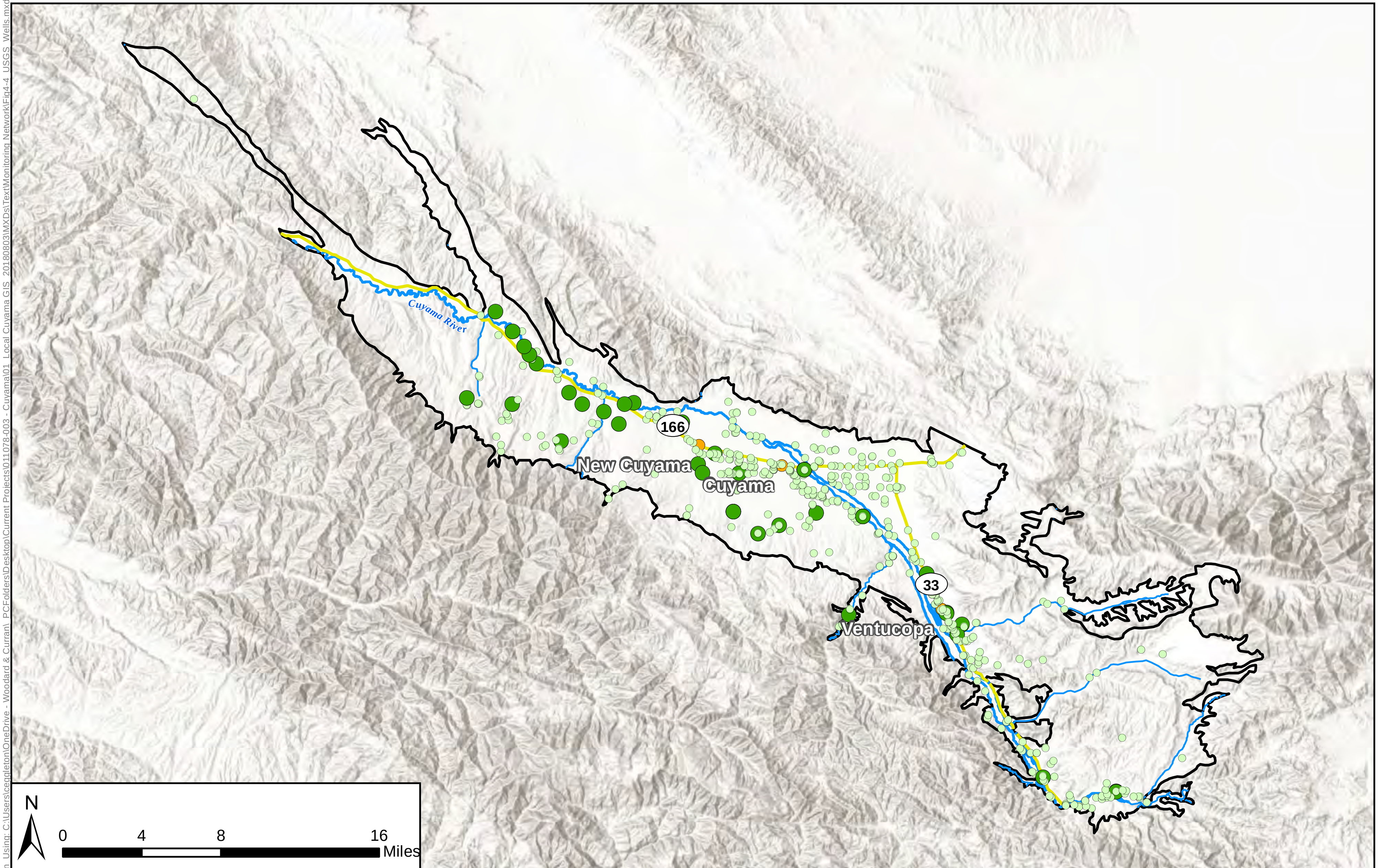

Figure 4-4: Cuyama GW Basin Wells with Monitoring Data Provided by USGS

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Santa Barbara County Water Agency

SBCWA maintains data for 36 wells in the Cuyama Basin. Some of those wells are owned by private land owners, and others are owned by local agencies such as the California Department of Transportation and the California Department of Fish and Wildlife. Summary statistics about these wells are listed below.

- Number of SBCWA-monitored wells: 36
- Earliest measurement date year: 1950
- Longest period of record: 68 years
- Median period of record: 2 years
- Median number of records for a single well: 8

Wells included in the SBCWA dataset are in Santa Barbara County near the Cuyama River, and in the hills to the south of the river. Figure 4-5 shows the locations of these wells.

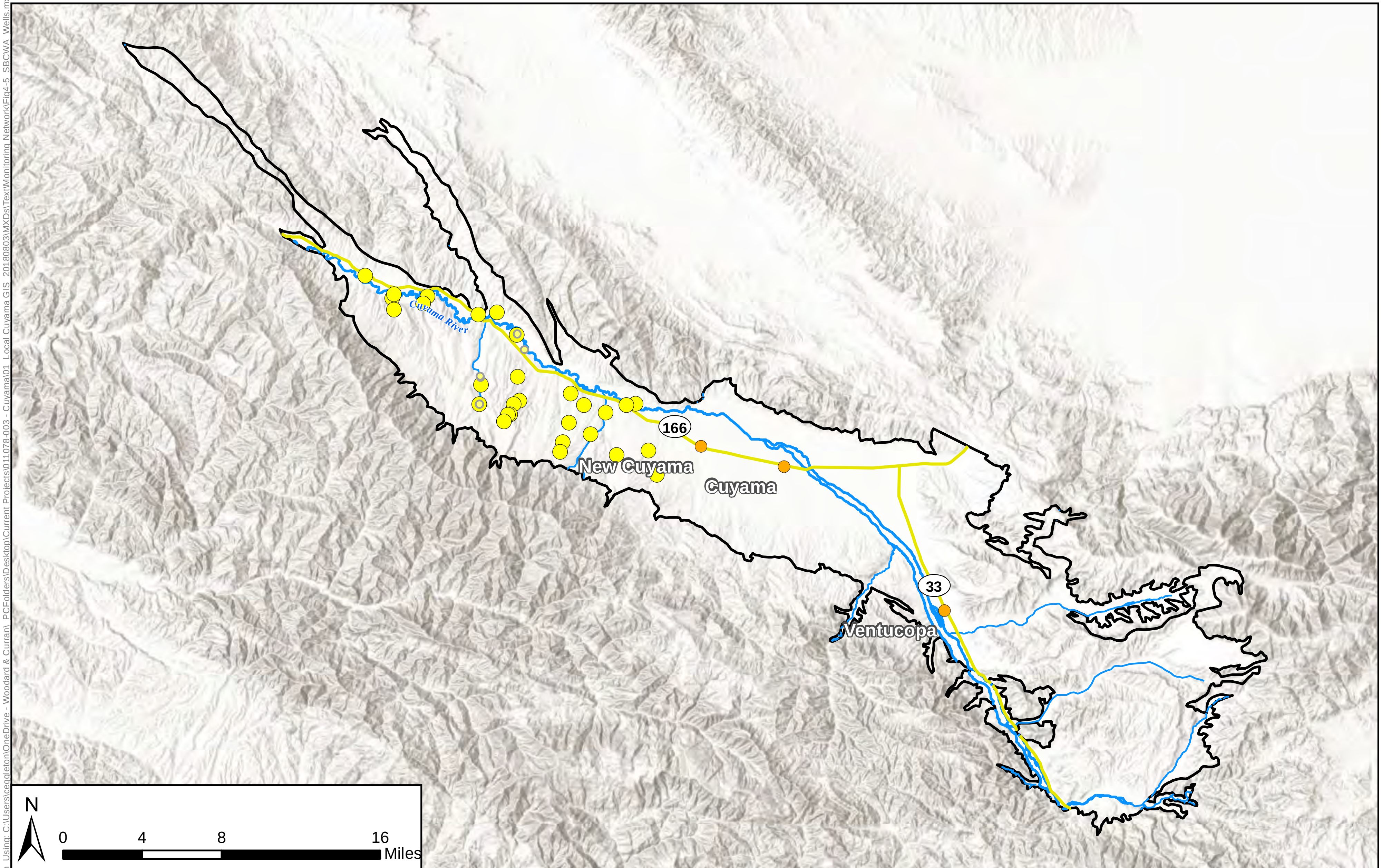

Figure 4-5: Cuyama GW Basin Wells with Monitoring Data Provided by SBCWA

Cuyama Basin Groundwater Sustainability Agency

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Legend

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

San Luis Obispo County Flood Control & Water Conservation District

SLOCFC&WCD maintains data for two wells within the Basin. SLOCFC&WCD also reports theses data to DWR; all data are for the wells is incorporated through the DWR CASGEM Program dataset.

These wells are in the central portion of the Basin, north of the Cuyama River and west of SR 33. Both wells meet the minimum requirements for inclusion in the monitoring network, and summary statistics about these wells are listed below.

- Number of SLOCFC&WCD-monitored wells: 2
- Earliest measurement year: 1990
- Longest period of record: 28 years
- Median period of record: 18 years
- Median number of records for a single well: 35

Figure 4-6 show the well locations.

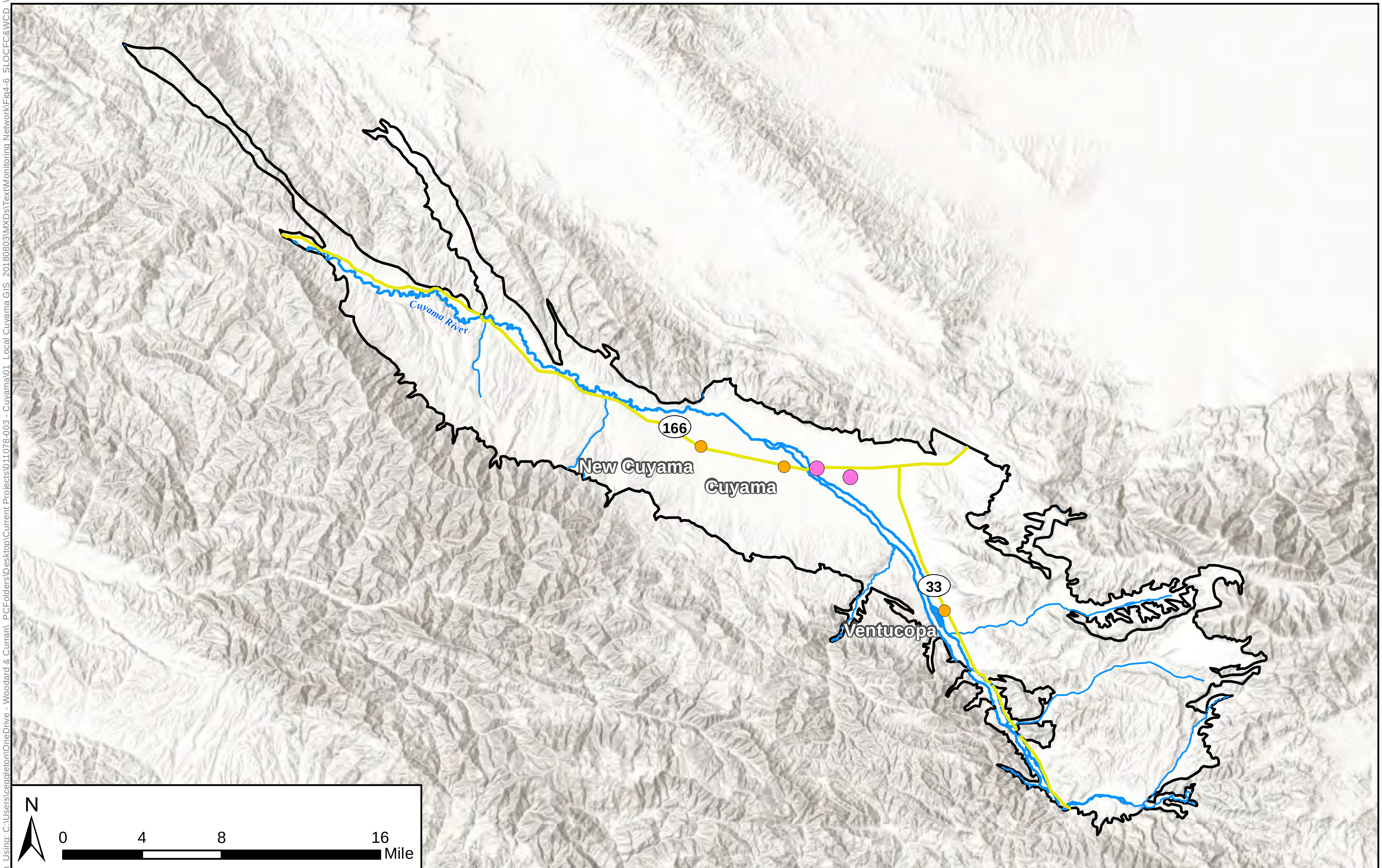

Figure 4-6: Cuyama GW Basin Wells with Monitoring Data Provided by SLOCFC&WCD

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

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Legend

- Cuyama Basin
- San Luis Obispo County Wells Last Measured in 2017-2018
- Towns
- Highways
- Cuyama River
- Streams

Ventura County Water Protection District

VCWPD manages 22 groundwater elevation monitoring wells in the Basin. A total of 20 wells are incorporated in the DWR CASGEM Program dataset.

The majority of wells managed by VCWPD are discontinued, and no longer measure groundwater elevations. Of the 22 wells, five have measured elevation data during the last decade. Summary statistics about these wells are listed below.

- Number of VCWPD-monitored wells: 22
- Earliest measurement year: 1971
- Longest period of record: 46 years
- Median period of record: 5.8 years
- Median number of records for a single well: 21.5

The wells included in the VCWPD dataset are in the southeastern portion of the Basin that intersects with Ventura County. The wells are primarily found near the Cuyama River close to agricultural land. Figure 4-7 shows well locations.

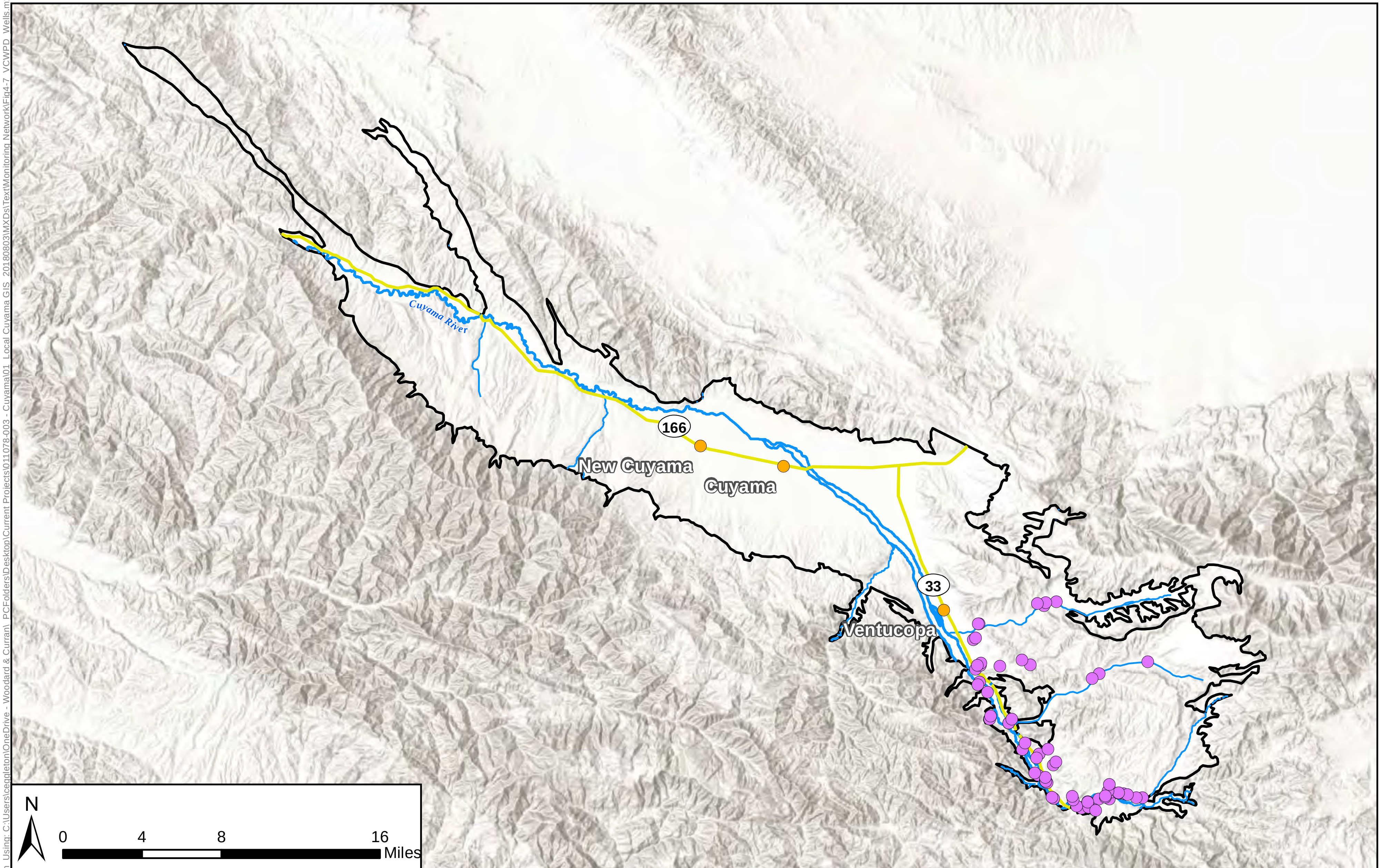

Figure 4-7: Cuyama GW Basin Wells with Monitoring Data Provided by VCWPD

Cuyama Basin Groundwater Sustainability Agency

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Legend

- Cuyama Basin
- Towns
- Highways
- Cuyama River
- Streams
- Ventura County Watershed Protection District

Cuyama Community Services District

The CCSD performs monitoring on its two production wells, one of which has been retired. The CCSD wells are just south of the CCSD. Data for these wells are included in the SBCWA dataset, and in the DWR and USGS datasets. Summary statistics about these wells are listed below. Figure 4-8 shows the location of these wells.

- Number of CCSD-monitored wells: 2
- Earliest measurement year: 1981
- Longest period of record: 37 years
- Median period of record: 26.5 years
- Median number of records for a single well: 79

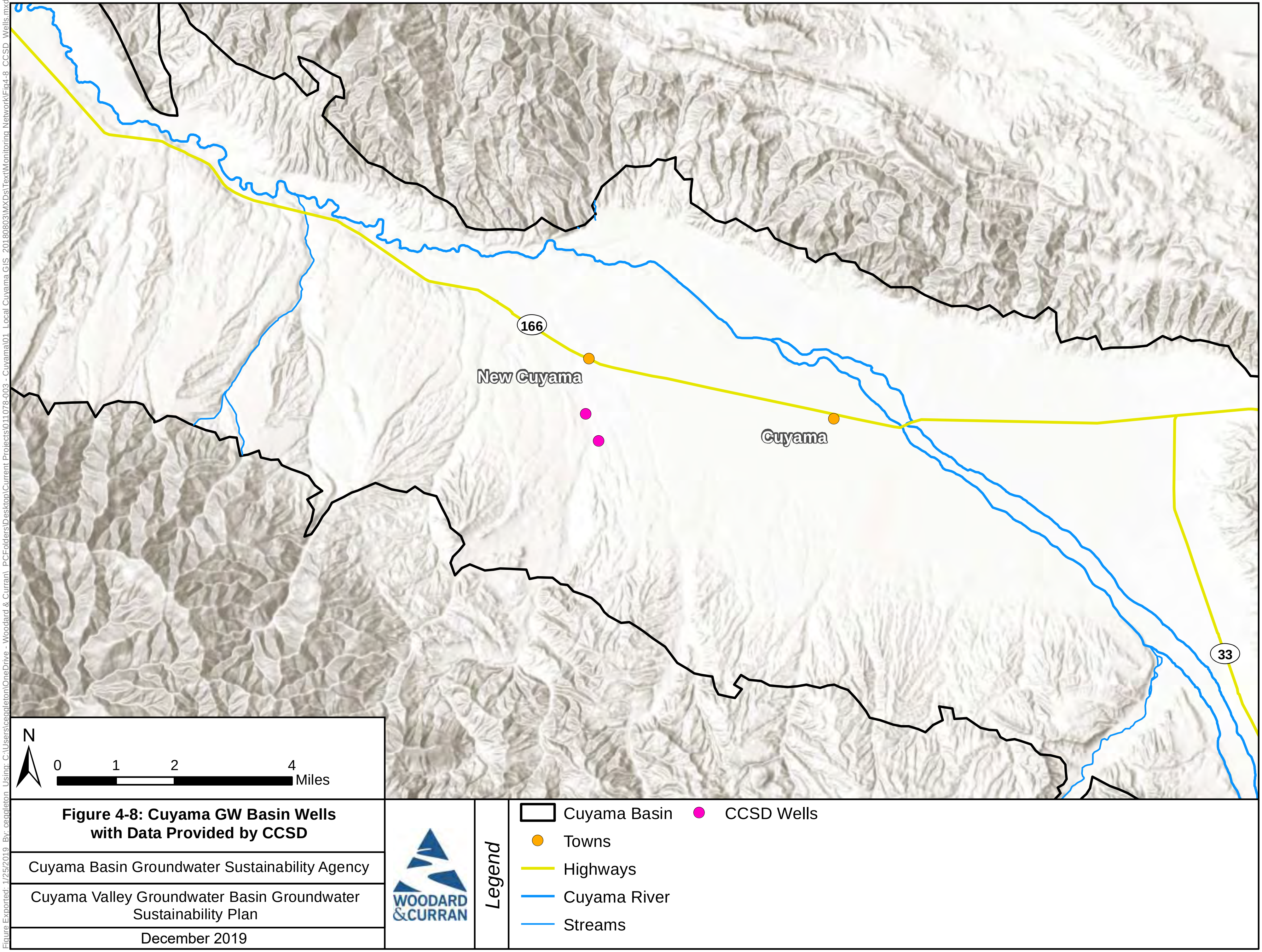

Figure 4-8: Cuyama GW Basin Wells with Data Provided by CCSD

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Private Landowners

Private landowners in the Basin own and operate large numbers of wells, primarily for irrigation and domestic use. Many wells owned by private landowners are included in the databases described above. In addition, and at the request of CBGSA, these landowners have provided additional monitoring data about 99 private wells. Summary statistics about these wells are listed below.

- Number of private landowner wells with monitoring data: 99
- Earliest measurement date year: 1975
- Longest period of record: 42 years
- Median period of record: 15 years
- Median number of records for a single well: 16

The private landowner wells are distributed throughout the Basin. The majority of wells are located in the central portion of the Basin near the Cuyama River and SR 166. There is an additional cluster of wells toward the western portion of the Basin running along the Cuyama River. Figure 4-9 shows private landowner wells.

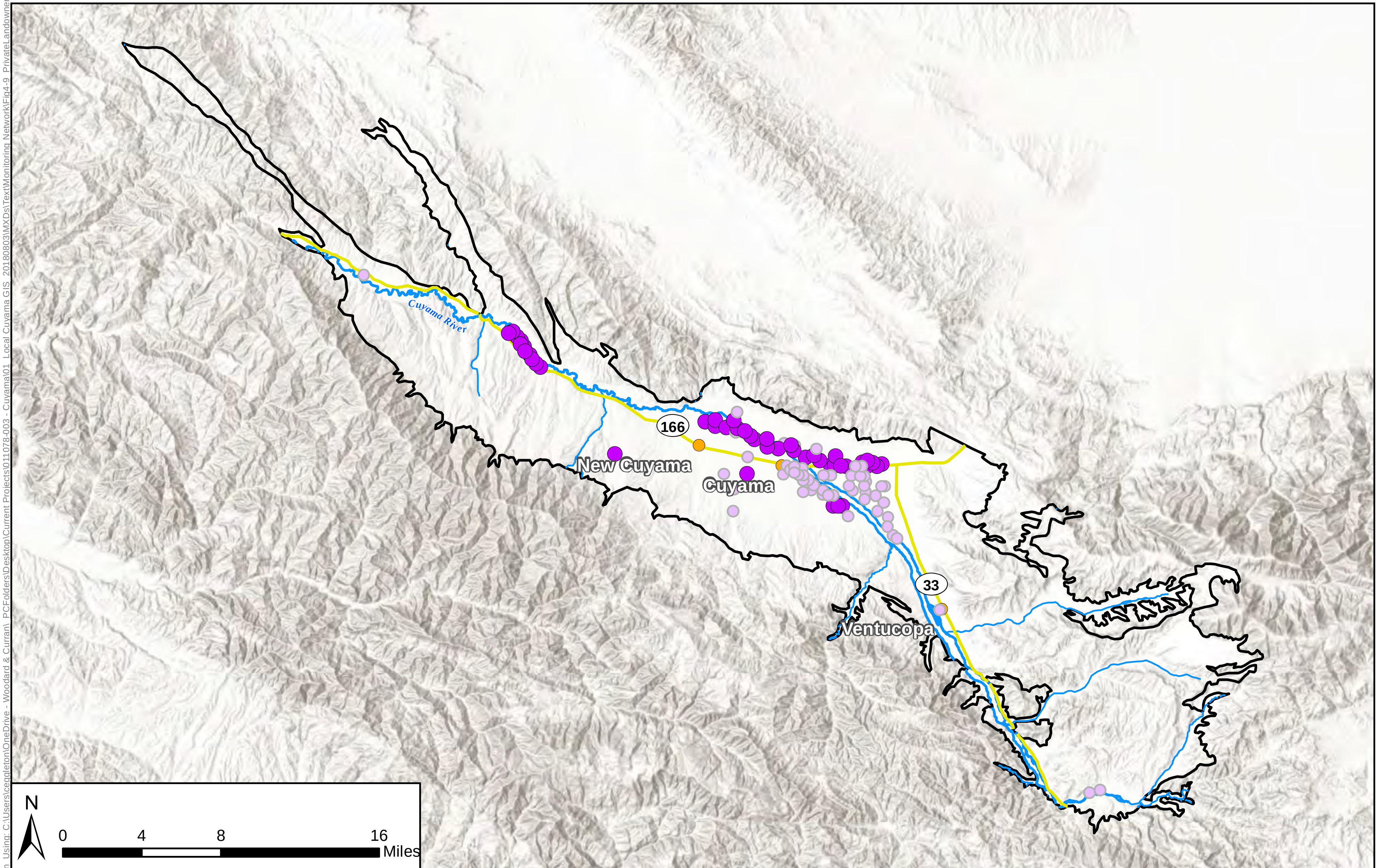

Figure 4-9: Cuyama GW Basin Wells with Monitoring Data Provided by Private Landowners

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

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Legend

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

4.3.2 Overlapping and Duplicate Data

Many of the data sources used to compile and create the Cuyama Basin database contain duplicate entries for wells, metadata, groundwater level measurements, and groundwater quality measurements. Much of the well information managed by counties in the Basin is also provided and incorporated into the DWR dataset. Many of the USGS wells and DWR wells overlap between datasets.

To avoid duplicate entries when compiling the Cuyama Basin database, wells were organized by their State Well Number, Master Site Code, USGS identification number, local name, and name. Analysts identified duplicates and removed or combined entries as necessary. Each unique well was then assigned an OPTI ID which was used as the primary identification number for all other processes and mapping exercises. Additional information about the management of well data is provided in Chapter 6.

OPTI IDs were used to identify Basin wells in the database because not all data sources use similar identification methods, as shown in Table 4-1 below.

Table 4-1: Well Identification Matrix

Data Maintaining Entity	State Well Number	CASGEM ID	USGS ID	Master Site Code	Local Name	Name
DWR	✔ (green)	✔ (green)		✔ (green)		
USGS	✔ (black)		✔ (green)		✔ (red)	
SLOCFC&WCD	✔ (green)					
SBCWA	✔ (black)		✔ (red)		✔ (black)	
VCWPD	✔ (green)					
Private Landowners					✔ (black)	✔ (green)

✔ (green) = All wells had this information, ✔ (black) = Some wells had the information, ✔ (red) = Few wells had the information

4.3.3 Groundwater Quality Monitoring (Combined Existing Programs)

This section discusses existing groundwater quality monitoring programs in the Cuyama Basin.

National Water Quality Monitoring Council (NWQMC)/USGS/Irrigated Land Regulatory Program (ILRP)

The NWQMC was created in 1997 to provide a collaborative, comparable, and cost-effective approach for monitoring and assessing the United States' water quality. Several organizations contribute to the database, including the Advisory Committee on Water Information, the United States Department of Agriculture's (USDA's) Agricultural Research Service, the United States Environmental Protection Agency (EPA), and USGS (NWQMC, 2018).

A single online portal provides access to data from the contributing agencies. Data are included from the USGS NWIS, the EPA Storage and Retrieval Data Warehouse, and the USDA's Agricultural Research Service Program, Sustaining The Earth's Watersheds – Agricultural Research Database System. Data incorporate hundreds of different water quality constituents from the different contributing agencies. Initial water quality data for the Cuyama Basin was downloaded through NWQMC, and included data about USGS monitoring sites and ILRP monitoring sites. ILRP was initiated in 2003 to prevent agricultural runoff from impairing surface waters, and in 2012, groundwater regulations were added to the program. ILRP water quality measurements are sampled from surface locations (DWR ILRP, 2018). There are currently five ILRP measurement sites in the Cuyama Basin. ILRP uses the California Environmental Data Exchange Network (CEDEN) to manage associate program data. CEDEN data are then integrated with USGS data, and then included in the NWQMC database (DWR CEDEN, 2018).

The NWQMC database provides TDS data about 180 water quality monitoring sites. This database also provides data for a variety of constituents not included here.

Summary statistics for the NWQMC, USGS and ILRP monitoring sites is shown below.

- Number of measurement sites: 180
- Earliest measurement date year: 1940
- Longest period of record: 53 years
- Median period of record: less than 1 year
- Median number of records for a single site: 2

The majority of the water quality monitoring sites included in the NWQMC database are located in the central portion of the Basin and along the Cuyama River as it follows SR 33. Figure 4-10 shows these monitoring sites.

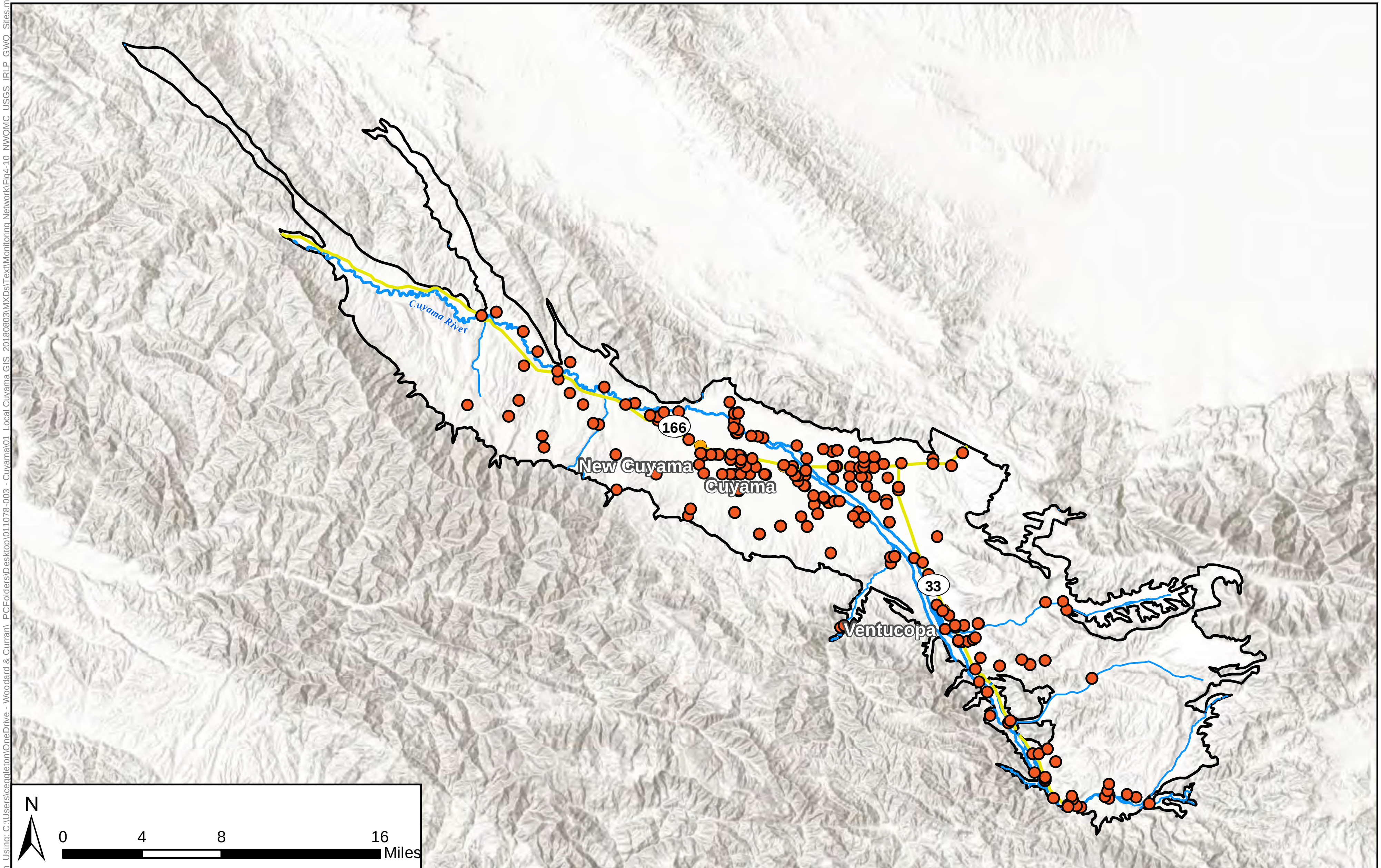

Figure 4-10: Cuyama GW Basin USGS/NWQMC/ IRLP Groundwater Quality Monitoring Sites

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Cuyama Basin

USGS/NWQMC/IRLP Groundwater Quality Sites

Towns

Highways

Cuyama River

Streams

GAMA Program/DWR

The GAMA Program is the State of California's groundwater quality monitoring program created by the State Water Resources Control Board in 2000. Assembly Bill 599 later expanded the Groundwater Quality Monitoring Act of 2001 (DWR GAMA, 2018). The purpose of GAMA is to improve statewide comprehensive groundwater monitoring and increase the availability of information to the general public about groundwater quality and contamination information. Additionally, the GAMA Program aims to establish groundwater quality on basin-wide scales, continue with groundwater quality sampling and studies, and centralize the information and data for the public and decision makers to enhance groundwater resource protection.

DWR also publishes statewide water quality data via the California Natural Resources Agency. Access to DWR and GAMA information and data are accessible through separate online portals.

There are 213 GAMA and DWR groundwater quality monitoring sites in the Basin. Summary statistics for these sites is shown below.

- Number of measurement sites: 213
- Earliest measurement date year: 1942
- Longest period of record: 41 years
- Median period of record: less than 1 year
- Median number of records for a single site: 2

The GAMA/DWR groundwater quality monitoring locations are spread throughout the Basin, loosely following the Cuyama River. There are 60 water quality monitoring sites per 100 square miles in the Basin. Figure 4-11 shows these locations.

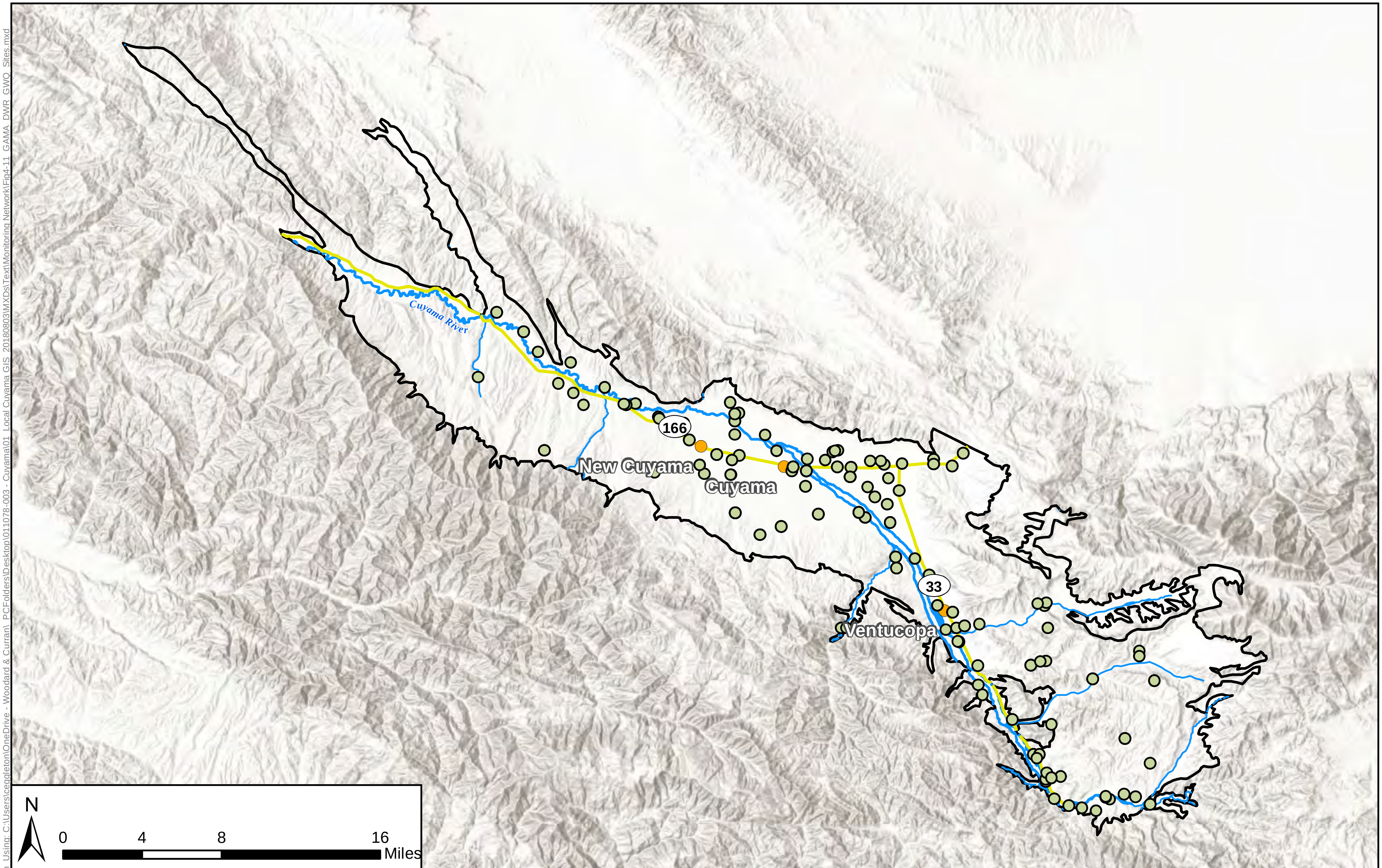

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Figure 4-11: Cuyama GW Basin GAMA/DWR Groundwater Quality Monitoring Sites

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Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

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Legend

- Cuyama Basin
- GAMA/DWR Groundwater Quality Sites
- Towns
- Highways
- Cuyama River
- Streams

Cuyama Community Services District

CCSD currently operates one production well for residential distribution in the Basin. Although some data for this well are included in the NWQMC dataset, annual Consumer Confidence Reports from 2011 to 2017 were processed for additional water quality data measurements. Summary statistics for the CCSD well are listed below and the well location is shown in Figure 4-12.

- Number of measurement sites: 1
- Earliest measurement date: 2008
- Period of record: 10 years
- Number of records: 21

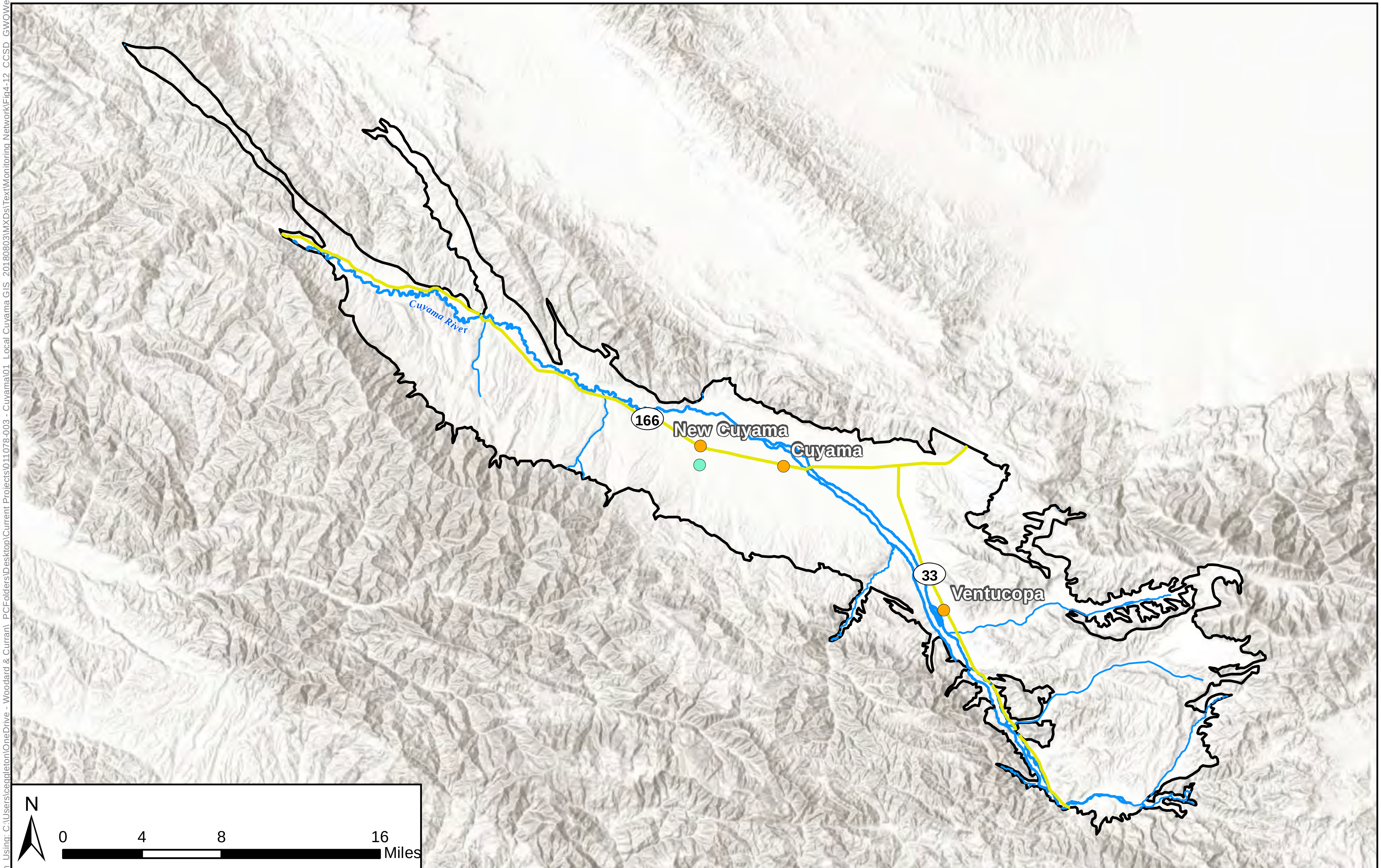

Figure 4-12: Cuyama GW Basin
CCSD Groundwater Quality Well

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Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

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Legend

- Cuyama Basin
- Towns
- Highways
- Cuyama River
- Streams
- Cumaya Community Services District Water Quality Monitoring Well

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Ventura County Water Protection District

VCWPD has 51 groundwater wells that are used for groundwater quality monitoring in the Basin. All of the wells are incorporated into the DWR, GeoTracker, or USGS datasets. Sampling data include numerous water quality constituents; however, this GSP only addresses TDS. Summary statistics for the wells are listed below, and locations of these wells are included in Figure 4-13.

Number of measurement sites: 51
Earliest measurement date: 1957
Longest period of record: 45
Median period of record: 7
Median number of records for a single site: 5

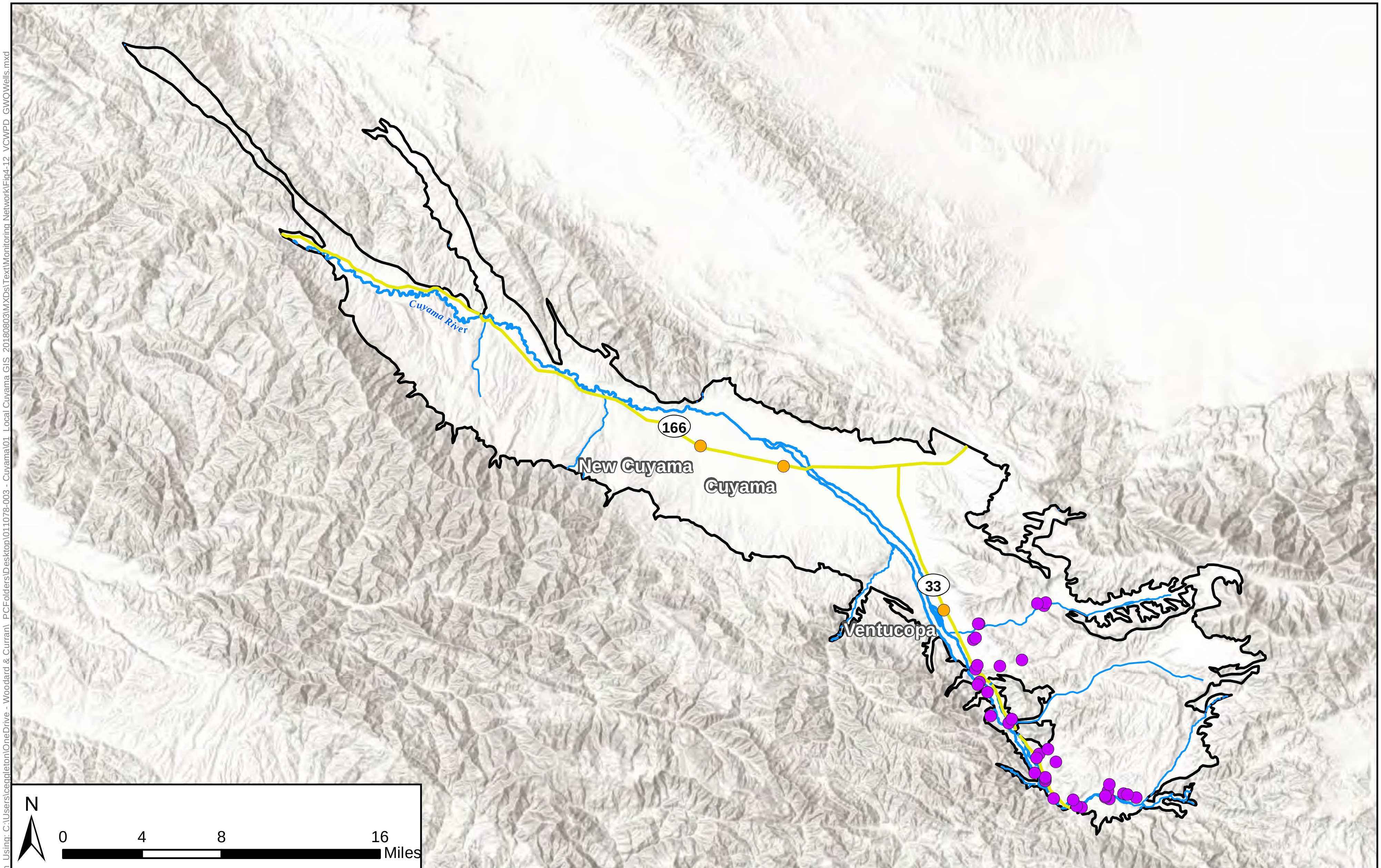

Figure 4-13: Cuyama GW Basin
VCWPD Groundwater Quality Wells

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

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WOODARD & CURRAN

Legend

- Cuyama Basin
- Towns
- Highways
- Cuyama River
- Streams
- Ventura County Watershed Protection District Groundwater Quality Monitoring Wells

Private Landowners

Private landowners in the Basin conducted groundwater quality testing, which has been incorporated into this document and associated analysis. In 2015, 11 wells measured for TDS. Summary statistics about these wells are listed below, and locations are shown in Figure 4-14.

- Number of measurement sites: 11
- Earliest measurement date: January 12, 2015
- Longest period of record: Not applicable
- Median period of record: Not applicable
- Median number of records for a single site: 1

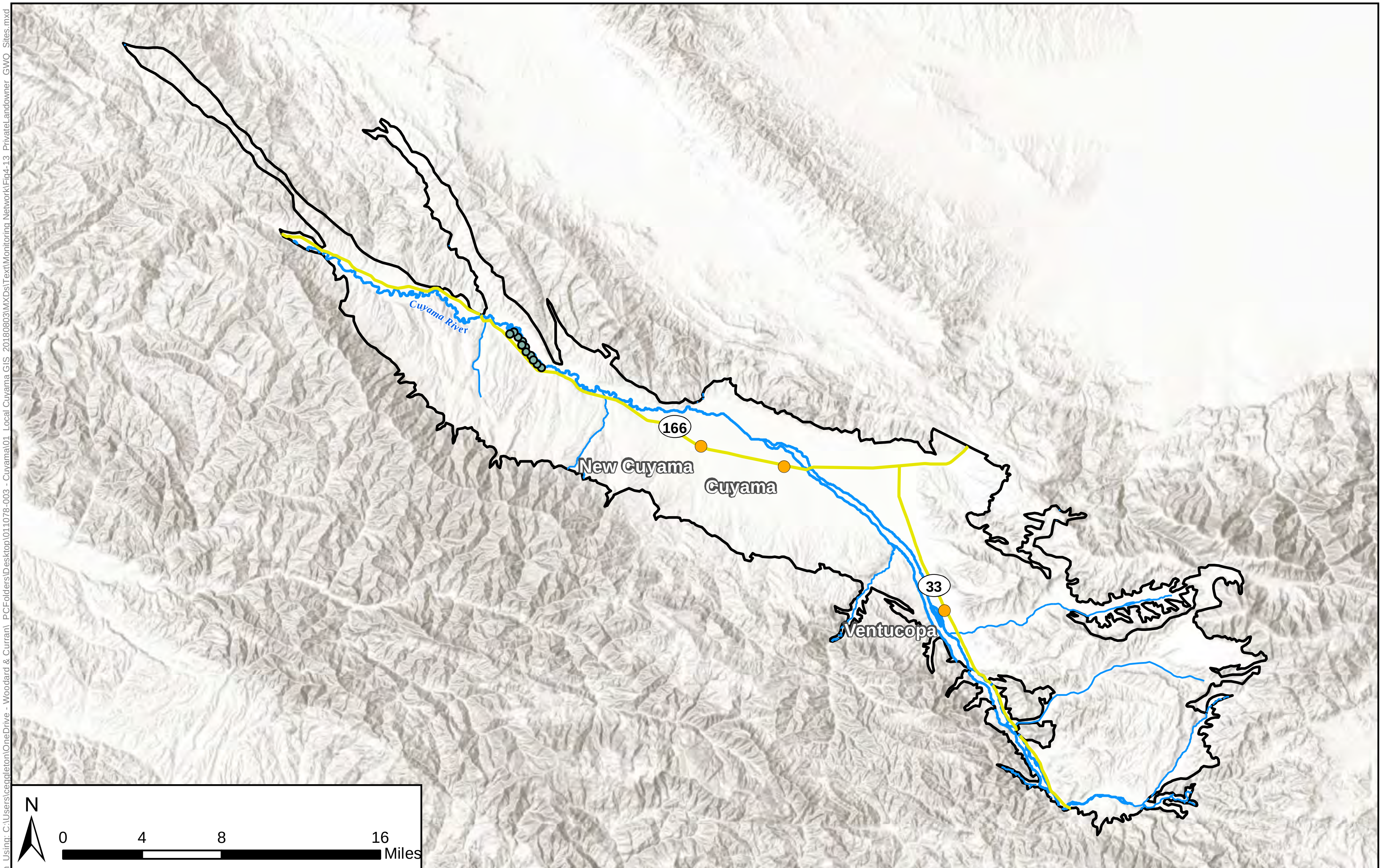

Figure 4-14: Cuyama GW Basin Private Landowner Groundwater Quality Monitoring Sites

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

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Legend

Cuyama Basin

Private Landowner Groundwater Quality Monitoring Sites

Towns

Highways

Cuyama River

Streams

Figure Exported: 9/14/2018 By: ceggleton Using: C:\Users\ceggleton\OneDrive - Woodard & Curran_PCFolders\Desktop\011078-003 - Cuyama\01_Local Cuyama GIS_20180803\MXDs\Text\Monitoring Network\Fig4-13_PrivateLandowner_GWQ_Sites.mxd

4.3.4 Subsidence Monitoring

Subsidence is the sinking or downward settling of the earth's surface, and is often the result of over-extraction of subsurface water. Subsidence can be directly measured using a few different methods, such as light detection and ranging (LiDAR), InSAR, CGPS, extensometers, and spirit leveling. For more information, see Appendix B in Chapter 2, which contains further information about these methods and the physics behind land subsidence. The subsidence monitoring network described below assumes the use of extensometers to monitor subsidence in the Basin. However, the CBGSA should evaluate other methods, including LiDAR and InSAR during the implementation phase to identify an optimal approach.

The Basin hosts two CGPS stations, and three others are just outside the Basin's boundary, as shown in Figure 2-51. CGPS stations measure surface movement in all three axis directions (i.e., up, down, east, west, north, and south). CGPS stations are in the center of the Cuyama Valley, and measure subsidence, while other are placed on ridges around the valley to also measure tectonic movement.

4.3.5 Surface Water Monitoring

Surface water monitoring in the Basin is conducted through stream and river gages placed along the Cuyama River or one of its tributaries. USGS manages most flow gages in California, and currently operates one active stream gage along Santa Barbara Creek. There is an additional gage (1136800) along the Cuyama River downstream of the Basin before Twitchell Reservoir; however, this gage also receives water from non-Cuyama Basin watershed areas. Data for surface flow gages are obtained through the NWIS Mapping portal (USGS NWIS, 2017). Existing and discontinued gages are shown in Figure 4-15.

USGS has operated three additional gages in the Basin; however, two of those gages were discontinued in the 1970s. Gage 1136500 operated from 1945 to 1958 and was brought back into service from 2009 to 2014.

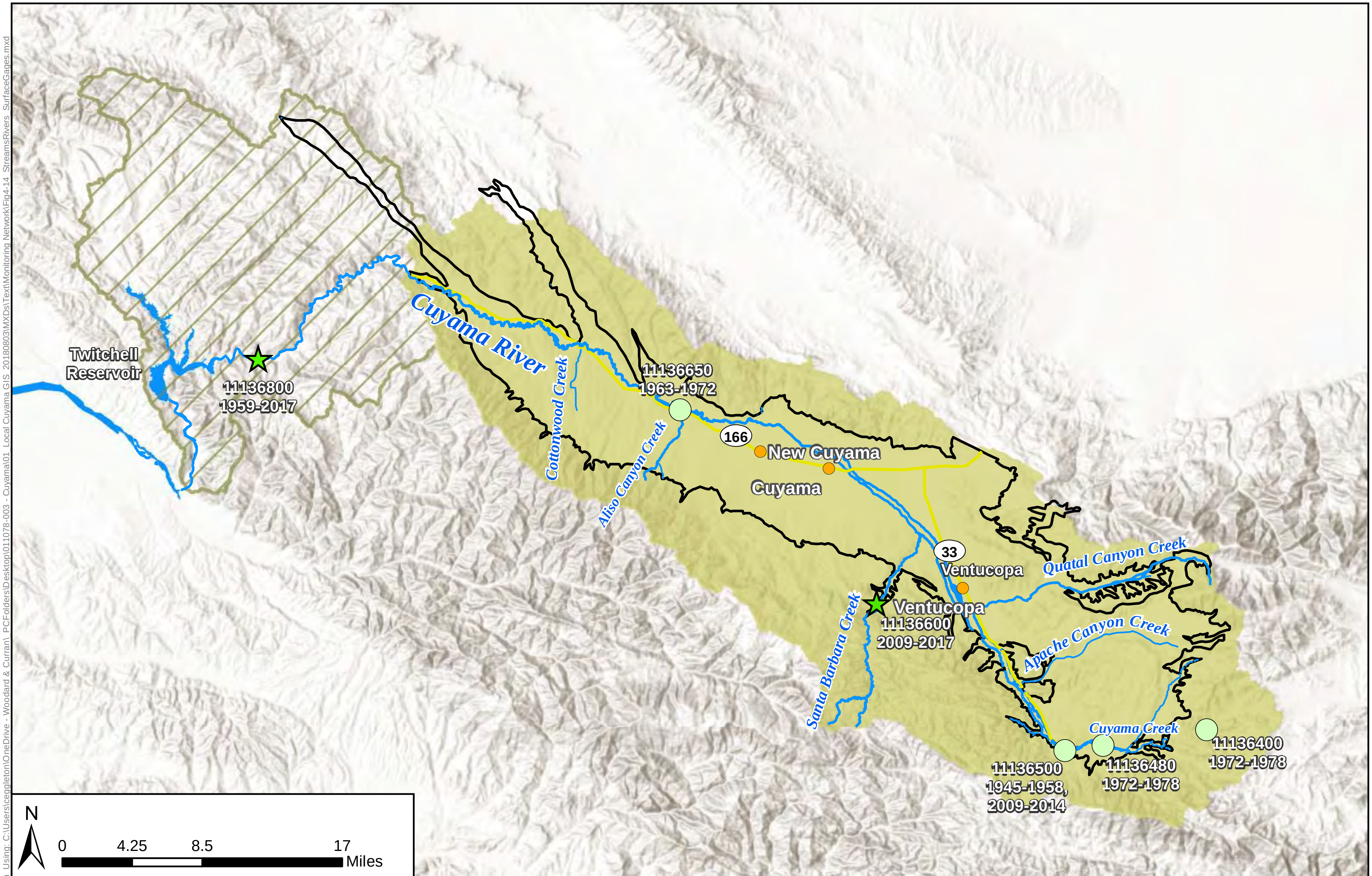

Figure 4-15: Rivers, Streams, and Surface Flow Gages

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Legend

- Cuyama Basin
- Towns
- Highways
- Cuyama River
- Inactive Flow Gages
- Active Flow Gages

Cuyama Watershed

- Contributes to Cuyama GW Basin
- Does Not Contribute to Cuyama GW Basin

4.4 Monitoring Rationales

This section discusses the reasoning behind monitoring network selection. Monitoring networks in the CBGSA area were developed to ensure they could detect changes in Basin conditions so CBGSA could manage the Basin and ensure sustainability goals were met. Additionally, monitoring can help assure that no undesirable results are present after 20 years of sustainable management.

The monitoring networks were selected specifically to detect short-term, seasonal, and long-term trends in groundwater levels and storage. The monitoring networks were also selected to include information about temporal frequency and spatial density so the CBGSA can evaluate information about groundwater conditions necessary to evaluate project effectiveness and the effectiveness of any management actions undertaken by the CBGSA.

Chapter 8 describes how each monitoring network will be developed and implemented as individual projects the CBGSA will undertake as part of GSP implementation. The schedule and costs associated with developing and implementing each monitoring network are discussed in the Chapter 8.

4.5 Groundwater Level Monitoring Network

Groundwater level monitoring is conducted through a groundwater well monitoring network. This section will provide information about how the level monitoring network was developed, the criteria for selecting representative wells, monitoring frequency, spatial density, summary protocols, and identification and strategies to fill data gaps.

4.5.1 Monitoring Wells Selected for Monitoring Network

A set of well tiering criteria were created to rank existing groundwater level measuring sites in the Basin, and were arranged into six different tiers, as shown in Figure 4-16.

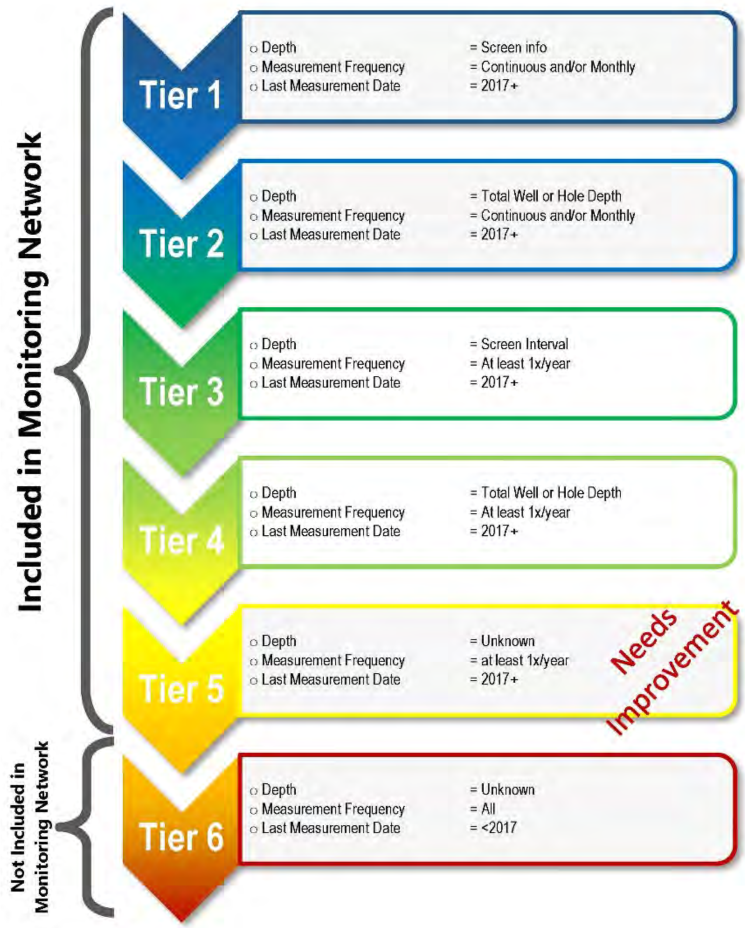

Figure 4-16: Cuyama Well Tiering Criteria

Tier 1 in the figure above shows wells with the most amount of metadata and consistent water elevation data that are still operating and functional. As tiering levels increase, requirements around well metadata and frequency of monitoring decrease; however, all wells are still active and functioning. Tier 5 captures the remaining active wells, but the metadata and/or frequency of monitoring would benefit from improvement.

Tier 6 includes all other wells that are no longer operational, which are categorized as those who do not have recorded data from January 1, 2017 to August 1, 2018 This approximate two-year cut off was determined as a reasonable amount of time for a monitoring agency or organization to obtain, log, and report well information and measurements, and as an indicator of whether a well was currently monitored or not.

Table 4-2 shows the number of monitoring wells selected from each existing monitoring data maintaining entity. Utilization these each wells for monitoring purposes will require consent agreements with each well owner, which will be sought during GSP implementation.

Table 4-2: Number of Wells Selected for Monitoring Network

Monitoring Data Maintaining Entity	Number of Wells Selected for Monitoring Network
CASGEM Program	28
USGS	43
SBCWA	36
SLOCFC&WCD	2
VCWPD	5
CCSD	1
Private Landowner	48
Total	**101**
Note: Total does not equal sum of rows due to duplicate entries in multiple databases	

Figure 4-17 shows the Monitoring Network wells by their tier level.

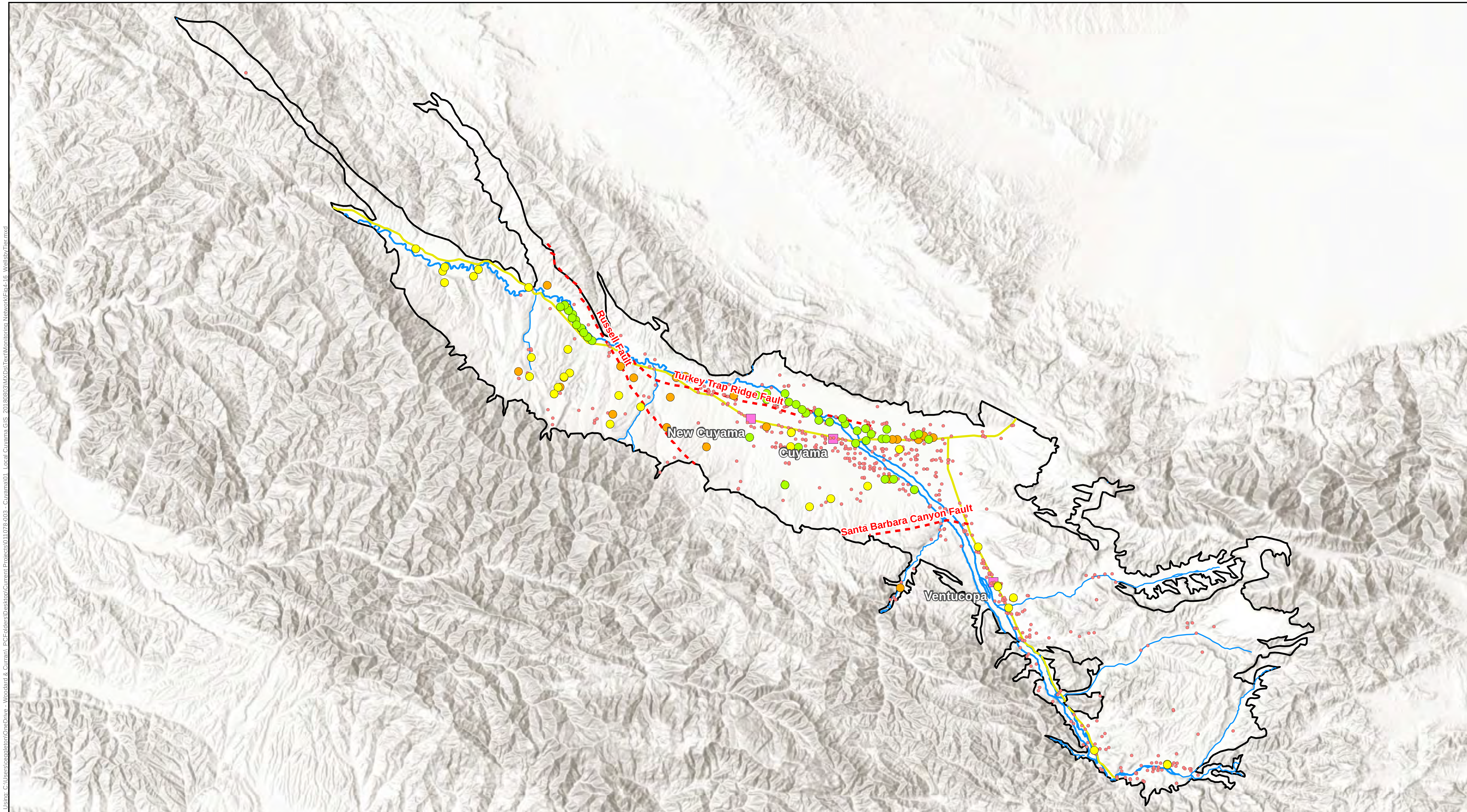

Figure 4-17: Cuyama GW Basin Groundwater Level Wells by Tier

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Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

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Legend

Cuyama Basin
Faults
Towns
Highways
Cuyama River
Streams

Monitoring Network Wells

Tier 1
Tier 2
Tier 3
Tier 4
Tier 5
Tier 6

N

0 2.5 5 10 Miles

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4.5.2 Monitoring Frequency

A successful monitoring frequency and schedule should allow the monitoring network to adequately interpret fluctuations over time of the groundwater system based on shorter-term and longer-term trends and conditions. These changes may be the result of storm events, droughts or other climatic variations, seasons, and anthropogenic activities such as pumping.

Monitoring frequency must, at a minimum, occur within the same designated time-period for all wells to ensure that measurements represent the same condition for the aquifer.

The BMPs published by DWR provides guidance for monitoring frequency based on the discussion presented in the *National Framework for Ground-water Monitoring in the United States* (Advisory Committee on Water Information, 2013). This analysis and discussion provide guidance on monitoring frequency based on aquifer properties and degree of use, as shown in Table 4-3.

The BMP guidance recommends that initial characterization of monitoring locations use frequent measurements to establish the dynamic range at each monitoring site and to identify external stresses affecting groundwater levels. An understanding of these conditions based on professional judgement should be reached before normal monitoring frequencies are followed.

Table 4-3: Monitoring frequency Based on Aquifer Properties and Degree of Use

Aquifer Type	Nearby Long-Term Aquifer Withdrawals		
	Small Withdrawals	Moderate Withdrawals	Large Withdrawals
Unconfined Aquifer			
Low recharge (<5 inches/year)	Quarterly	Quarterly	Monthly
High recharge (>5 inches/year)	Quarterly	Monthly	Daily
Confined Aquifer			
Low hydraulic conductivity (<200 feet/day)	Quarterly	Quarterly	Monthly
High hydraulic conductivity (>200 feet/day)	Quarterly	Monthly	Daily

The Basin is an unconfined aquifer with large withdrawals, with a low recharge rate of less than 5 inches per year. According to the data in Table 4-3, which is provided by DWR, the Basin's groundwater monitoring frequency should be monthly. This GSP recommends monitoring the groundwater level network monthly for the first three years of GSP implementation and consideration of reducing monitoring frequency to quarterly measurements after that. Ideally, the monitoring network would be monitored simultaneously to gain a snapshot of groundwater conditions. As this is not practical currently, monitoring of the level network should be conducted within one week for each measurement period.

4.5.3 Spatial Density

Spatial density of the monitoring network was considered both for the selection of the entire monitoring network, and for the selection of representative wells (Section 4.5.4) The goal of the groundwater level monitoring network is to provide adequate coverage of the entire Basin aquifer. This includes the ability to monitor and identify groundwater changes across the Basin over time. Consideration of the spatial location of monitoring wells should include proximity to other monitoring wells and ensure adequate coverage near other prominent features, such as faults or production wells. Monitoring wells in close proximity to active pumping wells could be influenced by groundwater withdrawals, thus skewing static level monitoring.

The *Monitoring Networks and Identification of Data Gaps BMP* published by DWR provides different sources and condition dependent densities to guide monitoring network implementation (Table 4-4). This information was adapted from the *CASGEM Groundwater Elevation Monitoring Guidelines* (DWR, 2010). While these estimates provide guidance to monitoring well site spatial densities, monitoring points should primarily be influenced by local geology, groundwater use, and GSP-defined undesirable rates. Professional judgment is essential when determining final locations.

Table 4-4: Monitoring Well Density Considerations

Reference	Monitoring Well Density (wells per 100 square miles)
Heath (1976)	0.2-10
Sophocleous (1983)	6.3
Hopkins (1994)	
Basins pumping more than 10,000 AF per year per 100 square miles	4.0
Basins pumping between 1,000 and 10,000 AF per 100 square miles	2.0
Basins pumping between 250 and 1,000 AF per year per 100 square miles	1.0
Basins pumping between 100 and 250 AF per year per 100 square miles	0.7

The Basin has 378 square miles of area. According to Hopkins (1994) well density estimate guidelines, the Basin should have four monitoring wells per 100 square miles. Sophocleous (1983) recommends 6.3 monitoring wells per 100 square miles. According to Heath (1976), the Basin should have between 0.2 and 10 monitoring wells per 100 square miles. Due to geologic and topographic variability in the Basin, the severity of groundwater declines, and hydrogeologic uncertainty in various portions of the Basin, this GSP recommends a density greater than the most conservative estimate of 10 wells per 100 square miles, which is over 38 monitoring wells.

4.5.4 Representative Monitoring

There are two categories of wells identified within the monitoring network as follows:

- **Representative Wells.** These wells will be used to monitor sustainability in the Basin. Minimum thresholds and measurable objectives will also be calculated for these wells.
- **Supplemental Wells.** Other wells are included in the monitoring network to provide redundancy for representative wells, and to maintain a robust network for evaluation as part of five-year GSP updates.

Representative monitoring wells were selected as part of monitoring network development. Representative monitoring wells are wells that represent conditions in the Basin, and are in locations that allow monitoring to indicate long-term, regional changes in its vicinity.

Representative groundwater level and groundwater storage sites within each management area were selected by several different criteria. These criteria include the following:

- **Adequate Spatial Distribution –** Representative monitoring does not require the use of all wells that are spatially grouped together in a portion of the Basin. Adequately spaced wells will provide greater Basin coverage with fewer monitoring sites.
- **Robust and Extensive Historical Data –** representative monitoring sites with longer and more robust historical data provide insight into long-term trends that can provide information about groundwater conditions through varying climatic periods such as droughts and wet periods. Historical data may also show changes in groundwater conditions through anthropogenic effects. While some sites chosen may not have extensive historical data, they may still be selected because there are no wells nearby with longer records.
- **Increased Density in Heavily Pumped Areas –** Selection of additional wells in heavily pumped areas such as in the central portion of the Basin and other agriculturally intensive areas will provide additional data where the most groundwater change occurs.
- **Increased Density near Areas of Geologic, Hydrologic, or Topologic Uncertainty** – Having a greater density of representative wells in areas of uncertainty, such as around faults or large elevation gradients may provide insightful information about groundwater dynamics to improve management practices and strategies.
- **Wells with Multiple Depths** – The use of wells with different screen intervals is important for collecting data about groundwater conditions at different elevations in the aquifer. This can be achieved by using wells with different screen depths that are close to one another, or by using multi-completion wells.
- **Consistency with BMPs –** Using published BMPs provided by DWR will ensure consistency across all basins and ensure compliance with established regulations.

- **Adequate Well Construction Information –** Well information such as perforation depths, construction date, and well depth should be considered and encouraged when considering wells to be included.
- **Professional Judgment** – Professional judgment is used to make the final decision about each well, particularly when more than one suitable well exists in an area of interest.
- **Maximum Coverage** – Any monitoring network well that was suitable for use in the representative network was used to maximize spatial and vertical density of monitoring.

4.5.5 Groundwater Level Monitoring Network

The groundwater level monitoring network is comprised of 101 of wells in the Basin. A total of 61 of those wells are representative wells. Overall well density is 26.7 wells per 100 square miles.

Figure 4-18 shows the locations of the groundwater level monitoring network monitoring wells and representative wells.

Table 4-5 lists the wells in the groundwater level monitoring network. Representative wells, those with sufficient data and representative trends within the Basin, are identified with the asterisk (*) next to the OPTI ID and are sorted first. Metadata for the wells are also included.

The proposed monitoring frequency is monthly for the first three years of GSP implementation, with an option to reduce to quarterly monitoring if the CBGSA Board decides that is appropriate. This monitoring frequency captures short-term, seasonal, and long-term trends in groundwater levels. A well density of 26.7 wells per 100 square miles in the monitoring network provides a spatial density that adequately covers the primary aquifer in the Basin, and is useful for determining flow directions and hydraulic gradients, as well as changes in storage calculations for use in future water budgeting efforts in portions of the Basin with significant land use.

Table 4-5: Wells included in the Groundwater Levels and Storage Monitoring Network

OPTI ID	Data Maintaining Entity as of 2018	Well Construction Date	Well Depth (feet)	Hole Depth (feet)	Screen Interval (feet)	Well Elevation (feet above mean sea level)	Reference Point Elevation (feet above mean sea level)	First Measurement Year	Last Measurement Year	Measurement Period (years)	Measurement Count
2*	Ventura County	--	73.0	--	--	3,720	--	2011	2017	6	17
62*	SBCWA	--	212	--	--	2,921	--	1966	2018	52	65
72*	SBCWA	1/1/1980	790	820	350 – 340	2,171	--	1981	2018	37	114
74*	SBCWA	--	--	--	--	2,193	--	2008	2018	10	45
77*	SBCWA	12/4/2008	980	1,003.5	980 – 960	2,286	--	2009	2018	9	47
84	SBCWA	--	200	--	--	2,923	--	2008	2018	10	28
85*	SBCWA	--	233	--	--	3,047	--	1950	2018	68	282
89*	VWPD	1/1/1965	125	--	--	3,461	--	1965	2017	52	68
91*	SBCWA	9/29/2009	980	1,000	980 – 960	2,474	--	2009	2018	9	47
93*	SBCWA	10/18/1967	151	165	--	2,928	--	1971	2018	47	36
95*	SBCWA	4/9/2009	805.	825	--	2,449	--	2009	2018	9	32
96*	SBCWA	2/1/1980	500	--	--	2,606	--	1983	2018	35	61
98*	SBCWA	--	750	--	--	2,688	--	2008	2018	10	32
99*	SBCWA	9/10/2009	750	906	750 – 730	2,513	--	2009	2018	9	43
100*	SBCWA	11/1/1988	284	302	--	3,004	--	2010	2018	8	28
101*	SBCWA	--	200	220	--	2,741	--	2008	2018	10	42
102*	SBCWA	--	--	--	--	2,046	--	2010	2018	8	22
103*	SBCWA	7/23/2010	1,030	1,040	--	2,289	--	2012	2018	6	25
104	Unknown	--	640	--	638.64 – 478.64	2,299	2301	2008	2017	9	32
105	SLOCF&CWC	--	750	--	--	2,374	2375	1990	2017	27	38
106*	Unknown	--	227.5	--	--	2,327	2327	2016	2018	2	9
107*	Unknown	1/1/1950	200	--	--	2,482	--	1950	2018	68	12
108*	Private Landowner	--	328.75	--	--	2,629	2630	2016	2018	2	8
110	Unknown	1/1/1948	603	--	--	2,046	--	1950	2018	68	17
112*	Unknown	--	441	--	--	2,139	--	1966	2018	52	10
114*	DWR	1/1/1947	58.0	--	--	1,925	--	1967	2017	50	9
115	Private Landowner	--	1200	--	--	2,276	2278	2016	2018	2	4
116	Private Landowner	10/1/1980	700	--	700 – 240	2329	2329	1980	2018	38	6
117*	Private Landowner	--	212	--	--	2,098	2095	2016	2018	2	10

Table 4-5: Wells included in the Groundwater Levels and Storage Monitoring Network

OPTI ID	Data Maintaining Entity as of 2018	Well Construction Date	Well Depth (feet)	Hole Depth (feet)	Screen Interval (feet)	Well Elevation (feet above mean sea level)	Reference Point Elevation (feet above mean sea level)	First Measurement Year	Last Measurement Year	Measurement Period (years)	Measurement Count
118*	Private Landowner	--	500	--	--	2,270	2271	2016	2018	2	11
119	DWR	--	92.0	--	--	1,713	--	1955	2017	62	10
120	Private Landowner	--	15.4	--	--	1,705	1707	2016	2017	1	2
121	Private Landowner	--	98.25	--	--	1,984	1985	2016	2018	2	16
122	Private Landowner	--	63.2	--	--	2,129	2131	2016	2018	2	16
123*	Private Landowner	--	138	--	--	2,165	2167	2016	2018	2	14
124*	Private Landowner	--	160.55	--	--	2,287	2288	1988	2018	30	22
125	Private Landowner	--	26	--	--	2,283	2284	2016	2018	2	9
127*	Private Landowner	--	100.25	--	--	2,364	2365	2016	2018	2	14
128	Unknown	3/15/1990	140	150	--	3,721	--	2014	2017	3	8
316*	Unknown	9/29/2009	830	1,000	--	2,474	--	2009	2018	9	27
317*	Unknown	9/29/2009	700	1,000	--	2,474	--	2009	2018	9	28
322*	Unknown	4/9/2009	850	906	--	2,513	--	2009	2018	9	27
324*	Unknown	9/10/2009	560	906	--	2,513	--	2009	2018	9	26
325*	Unknown	9/10/2009	380	906	--	2,513	--	2009	2018	9	26
420*	Unknown	12/4/2008	780	1,003.5	--	2,286	--	2009	2018	9	29
421*	Unknown	12/4/2008	620	1,003.5	--	2,286	--	2009	2018	9	29
422*	Unknown	12/4/2008	460	1,003.5	--	2,286	--	2009	2018	9	28
467	Unknown	1/1/1963	1,140	1,215	--	2,224	--				
474*	Unknown	--	213	--	--	2,369	--	1955	2017	62	6
564	Unknown	1/1/1920	--	--	--	2,172	--	2017	2017	0	1
566	Unknown	--	500	520	--	2,263	--				
568*	Unknown	1/1/1948	188	188	--	1,905	--	1967	2018	51	22
571*	Private Landowner	1/1/1951	280	--	--	2,307	--	2016	2018	3	14
573*	Unknown	--	404	--	--	2,084	--	1950	2018	68	12
584	Unknown	--	450	606	--	1,753	--	2018	2018	0	1
586	Unknown	--	620	622	--	1,761	--				
587	Unknown	12/29/2014	900	960	--	1,713	--	2018	2018	0	1
591	Unknown	--	720	740	--	1,715	--	2017	2018	1	2

Table 4-5: Wells included in the Groundwater Levels and Storage Monitoring Network

OPTI ID	Data Maintaining Entity as of 2018	Well Construction Date	Well Depth (feet)	Hole Depth (feet)	Screen Interval (feet)	Well Elevation (feet above mean sea level)	Reference Point Elevation (feet above mean sea level)	First Measurement Year	Last Measurement Year	Measurement Period (years)	Measurement Count
597	Unknown	--	390	670	--	1,694	--	2017	2018	1	2
601	Private Landowner	6/14/1905	723	--	723 – 338	2,074	--	1993	2017	24	32
602	Private Landowner	6/12/1905	725	--	725 – 325	2,114	--	1992	2017	25	29
603	Private Landowner	6/15/1905	800	--	800 – 398	2,097	--	1994	2017	23	33
604*	Private Landowner	--	924	--	924 – 454	2,125	--	1995	2017	22	28
608*	Private Landowner	6/10/1905	745	--	745 – 440	2,224	--	1995	2017	22	26
609*	Private Landowner	6/15/1905	970	--	970 – 476	2,167	--	1995	2017	22	31
610*	Private Landowner	--	780	--	780 – 428	2,442	--	1995	2017	22	27
612*	Private Landowner	--	1070	--	1,070 – 657	2,266	--	1995	2017	22	24
613*	Private Landowner	--	830	--	830 – 330	2,330	--	1995	2017	22	24
614	Private Landowner	--	745	--	745 – 405	2,337	--	1995	2017	22	25
615*	Private Landowner	--	865	--	865 – 480	2,327	--	1995	2017	22	22
618	Private Landowner	6/18/1905	927	--	927 – 496	2,163	--	1996	2017	21	31
619	Private Landowner	6/19/1905	1,040	--	1,040 – 569	2,307	--	1997	2017	20	28
620*	Private Landowner	6/19/1905	1,035	--	1,035 – 50	2,432	--	1997	2017	20	25
621	Private Landowner	6/19/1905	974	--	974 – 540	2,126	--	1998	2017	19	30
623	Private Landowner	6/21/1905	1,040	--	1,040 – 530	2,288	--	1999	2017	18	29
627	Private Landowner	6/23/1905	960	--	960 – 460	2,279	--	2001	2017	16	19
628	Private Landowner	5/31/1905	941	--	941 – 593	2,388	--	1978	2017	39	32
629*	Private Landowner	--	1,000	--	1,000 – 500	2,379	--	2005	2017	12	13
630	Private Landowner	--	900	--	900 – 360	2,371	--	1991	2017	26	22
631	Private Landowner	5/31/1905	960	--	960 – 600	2,367	--	1986	2017	31	22
633*	Private Landowner	--	1,000	--	1,000 – 500	2,364	--	1998	2017	19	23
635	Private Landowner	--	1,050	--	1,050 – 549	2,356	--	2003	2017	14	10
636	Private Landowner	5/27/1905	924	--	924 – 474	2,348	--	1975	2017	42	15
637	Private Landowner	6/30/1905	980	--	980 – 540	2110	--	2009	2017	8	10
638	Private Landowner	6/30/1905	1,006	--	1,006 – 526	2,437	--	2008	2017	9	9
640	Private Landowner	6/30/1905	840	--	840 – 400	2,239	--	2008	2017	9	16
641	Private Landowner	7/2/1905	800	--	800 – 360	2,204	--	2010	2017	7	7

Table 4-5: Wells included in the Groundwater Levels and Storage Monitoring Network

OPTI ID	Data Maintaining Entity as of 2018	Well Construction Date	Well Depth (feet)	Hole Depth (feet)	Screen Interval (feet)	Well Elevation (feet above mean sea level)	Reference Point Elevation (feet above mean sea level)	First Measurement Year	Last Measurement Year	Measurement Period (years)	Measurement Count
638	Private Landowner	6/30/1905	1,006	--	1,006 – 526	2,437	--	2008	2017	9	9
640	Private Landowner	6/30/1905	840	--	840 – 400	2,239	--	2008	2017	9	16
641	Private Landowner	7/2/1905	800	--	800 – 360	2,204	--	2010	2017	7	7
642	Private Landowner	7/2/1905	1,000	--	1,000 – 550	2,232	--	2010	2017	7	8
644	Private Landowner	7/5/1905	950	--	950 – 490	2,143	--	2013	2017	4	10
830*	SBCWA	--	77.2	--	--	1,571	--	2017	2018	1	6
831*	SBCWA	--	213.75	--	--	1,557	--	2017	2018	1	6
832*	SBCWA	--	131.8	--	--	1,630	--	2016	2018	2	8
833*	SBCWA	--	503.55	--	--	1,457	--	2017	2018	1	6
834*	SBCWA	--	320	--	--	1,508	--	2017	2018	1	2
835*	SBCWA	--	162.2	--	--	1,555	--	2017	2018	1	6
836*	SBCWA	--	325	--	--	1,486	--	2017	2018	1	6
840*	Private Landowner	11/21/2014	900	--	1,513 – 833	1,713	--	2015	2018	3	7
841*	Private Landowner	12/12/2014	600	--	1,591 – 1,181	1,761	--	2015	2018	3	11
843*	Private Landowner	1/5/2015	620	--	1,701 – 1,161	1,761	--	2015	2018	3	9
845*	Private Landowner	7/12/2015	380	--	1,612 – 1,352	1,712	--	2015	2018	3	8
849*	Private Landowner	6/23/2015	570	--	1,563 – 1,163	1,713	--	2015	2018	3	10

*Denotes a representative well

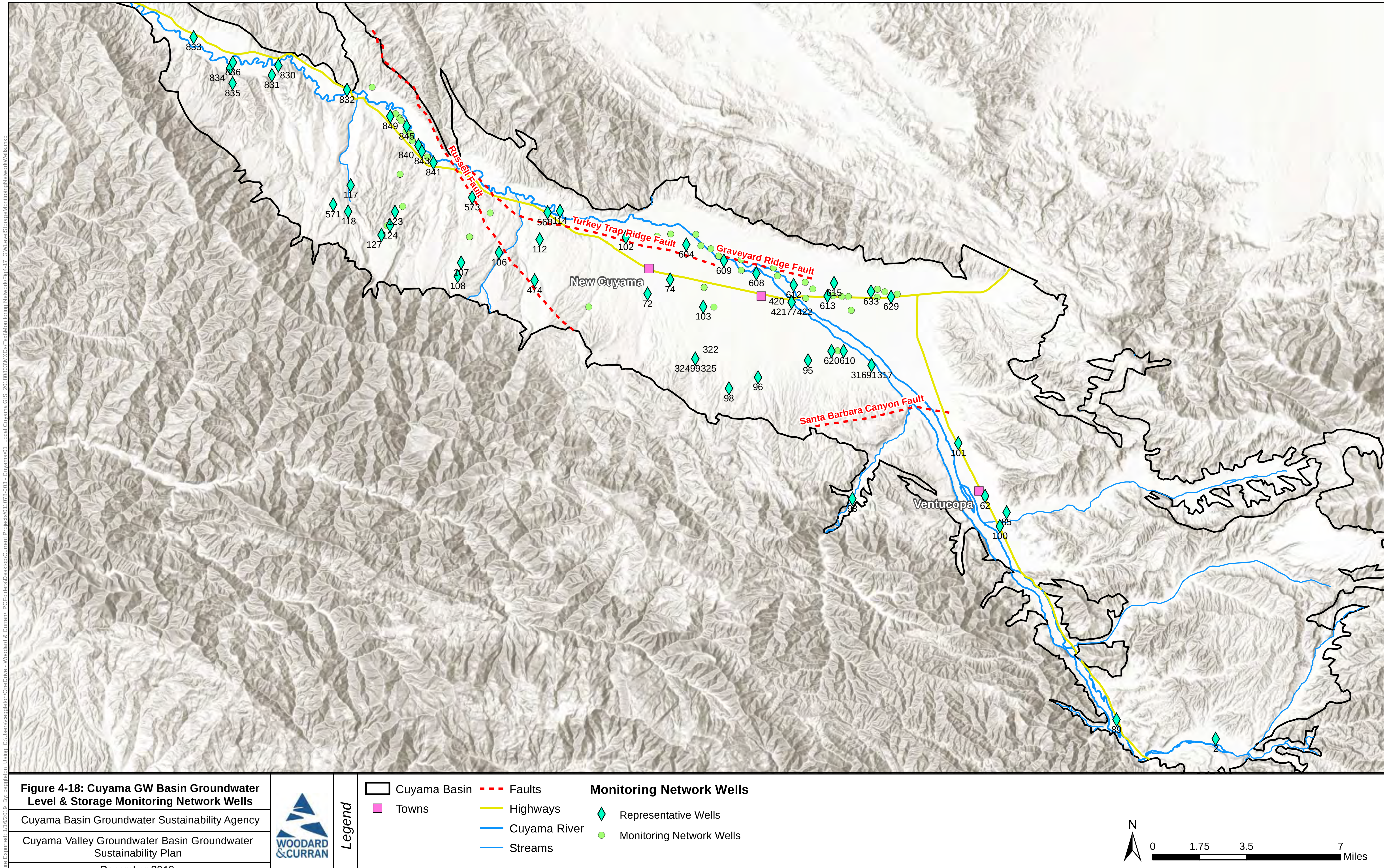

Figure 4-18: Cuyama GW Basin Groundwater Level & Storage Monitoring Network Wells

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4.5.6 Monitoring Protocols

For additional monitoring recommended below, the monitoring protocols will use DWR's *Monitoring Networks and Identification of Data Gaps BMP*, which sites the DWR's 2010 publication *California Statewide Groundwater Elevation Monitoring (CASGEM) Program Procedures for Monitoring Entity Reporting* (Appendix A) for the groundwater level sampling protocols. This publication includes protocols for equipment selection, setup, use, field evaluation, and sample collection techniques..

4.5.7 Data Gaps

Groundwater level monitoring data gaps are the result of poor spatial distribution among available wells in the Basin, and a lack of well construction information.

The spatial distribution of groundwater level monitoring network wells provides coverage of the majority of the Basin. However, there are several areas, identified by the red ovals in Figure 4-19, that do not have adequate monitoring. If additional monitoring wells were added in these areas, they may provide more information that could be used to detect changes in Basin conditions,

Well construction information is not available for many wells in the Basin. Monitoring wells with construction information featuring total depth and screened interval are preferred for inclusion in the monitoring network, because that information is useful in understanding what monitoring measurements mean in terms of Basin conditions at different depths.

4.5.8 Plan to Fill Data Gaps

This GSP identifies a number of ways to refine the groundwater level monitoring network and improve reporting.

The CBGSA has been awarded a Proposition 1 Category 1 Grant, which includes a task to expand the groundwater level monitoring network. This task includes identification of additional monitoring wells for hand measurements and installation of continuous monitoring equipment into 10 existing wells, which could be used to augment the existing monitoring network. This task would both increase the spatial distribution of the monitoring network and temporal coverage in the wells with additional continuous monitoring.

The CBGSA has applied for assistance from DWR's Technical Support Services (TSS), which provides support to GSAs as they develop GSPs. TSS opportunities include help installing new monitoring wells, and downhole video logging services. New wells drilled by DWR's TSS will improve the density and sampling frequency for level monitoring in the Basin. Downhole video logging will provide more well construction information to better utilize well data in the Basin. As of Draft GSP publication, the DWR TSS program has not provided any TSS services for the Cuyama Basin.

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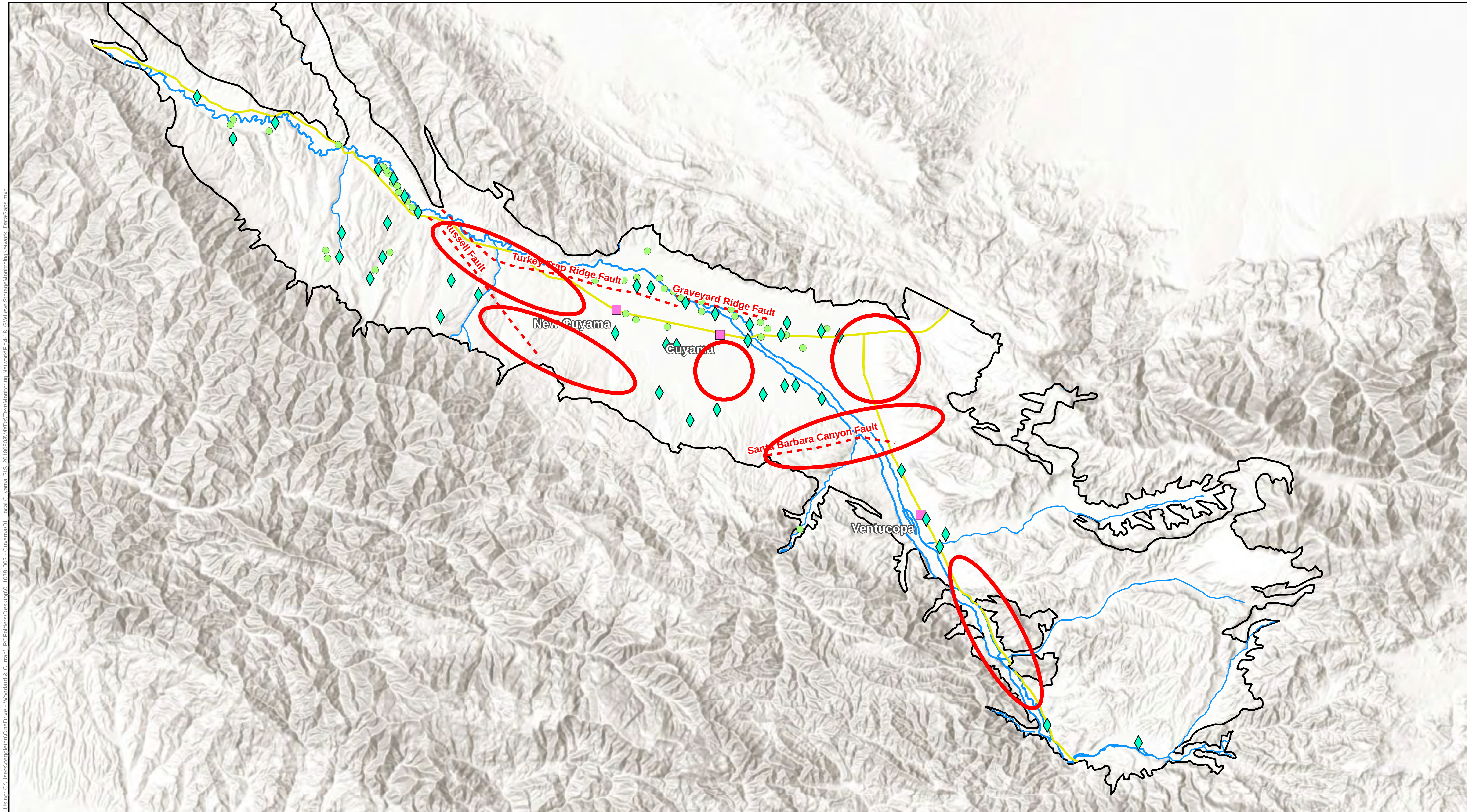

Figure 4-19: Cuyama GW Basin Groundwater Level & Storage Monitoring Network Data Gaps

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

April 2018

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Legend

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

Monitoring Network Wells

- Representative Wells
- Monitoring Network Wells

N

0 2 4 8 Miles

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4.6 Groundwater Storage Monitoring Network

Groundwater in storage is monitored through the measurement of groundwater levels. Therefore, the groundwater storage monitoring network will use the groundwater level monitoring network. Thresholds for groundwater storage are be discussed in Chapter 5.

4.7 Seawater Intrusion Monitoring Network

The Basin is geographically and geologically isolated from the Pacific Ocean and any other large source of saline water. As a result, the Basin is not at risk for seawater intrusion. Salinity (i.e., TDS) is monitored as part of the groundwater quality network, but seawater intrusion is not a concern for the Basin.

4.8 Degraded Groundwater Quality Monitoring Network

Salinity (measured as TDS), arsenic, and nitrates have all been identified by local stakeholders as potentially being of concern for water quality in the Basin. However, as noted in the Groundwater Conditions chapter, there have only been two nitrate measurements and fewer than 10 arsenic measurements in recent years that exceeded maximum contaminant levels. Furthermore, and in contrast to salinity, there is no evidence to suggest a causal nexus between potential actions under the CBGSA's authority and arsenic or nitrates. In the case of arsenic, the high concentration measurements have been taken either at CCSD Well 2, which is no longer in operation, or at groundwater depths of greater than 700 feet, which is outside of the range of pumping for drinking water. Because arsenic occurs in the subsurface at different elevations and densities throughout the Basin, arsenic issues are localized and different at each well location. Since the CBGSA is only granted authority to affect the amount of water pumped across portions of the Basin, it is not possible for the CBGSA to successfully manage arsenic levels, and setting thresholds on an unmanageable constituent could cause unnecessary intervention by the SWRCB. Therefore, the groundwater quality network has been established to monitor for salinity but does not consider arsenic or nitrates at this time. The CBGSA will cooperate with other agencies that may perform monitoring of other constituents to the extent possible.

4.8.1 Management Areas

Management Areas have not been selected at the time of publishing the Draft GSP. Management Areas may allow flexibility in establishing monitoring networks both spatially and temporally to match conditions and use in the Management Area. Given the scarcity of monitored sites, the CBGSA should use the same monitoring network selection criteria across all management areas in the Basin.

4.8.2 Monitoring Sites Selected for Monitoring Network

Table 4-6 lists the monitoring sites selected for the groundwater quality monitoring network by monitoring group. Monitoring sites selected for inclusion in the network were monitored from 2008 to 2018. It was assumed that wells that had previously been monitored for salinity prior to 2008 are unlikely to be monitored again by that monitoring agency. Due to the overlap of wells in both the USGS and DWR networks, the 64 selected groundwater quality networks wells is less than the sum of wells shown in Table 4-6. Use of these wells for monitoring will require consent agreements with each well owner, which will be sought during GSP implementation.

Table 4-6: Groundwater Quality Monitoring Sites by Source

Monitoring Data Maintaining Entity	Number of Wells Selected for Monitoring Network
NWQC, USGS, ILRP	43
GAMA Program, DWR	20
BCWPD	7
Private Landowner	11
Total	**64**

Note: Total does not equal sum of rows due to duplicate entries in multiple databases

4.8.3 Monitoring Frequency

The Basin, in coordination with partnering agencies, will compile salinity samples once a year. Monitoring agencies such as USGS and DWR were contacted to inquire about when they would monitor their sites for groundwater quality, including salinity. These agencies stated they usually monitor annually, but the timing of that monitoring was not set, and changes from year to year. Additionally, depending on funding and staff availability, there may be years where no groundwater quality monitoring is conducted by an agency.

Although DWR does not provide specific recommendations on the frequency of monitoring in relationship to the described groundwater characteristics, concentrations of groundwater quality, especially salinity, do not fluctuate significantly over a year to require multiple samples per year.

4.8.4 Spatial Density

DWR's *Monitoring Networks and Identification of Data Gaps BMP* states "The spatial distribution must be adequate to map or supplement mapping of known contaminants." Using this guidance, professional judgment was used to identify representative wells in each management area. Heavily pumped areas, such as the central portion of the Basin, require additional monitoring sites, while areas of lower pumping or less agricultural or municipal groundwater use need less monitoring.

Any well measured from 2008 to June 2018 was included in the monitoring network. The overall monitoring network was selected as representative monitoring. The selected groundwater quality representative and monitoring wells provide adequate coverage of the Basin's aquifer. The groundwater quality monitoring network is composed of 64 of wells in the Basin, which providing a monitoring site density of 17 sites per 100 square miles. This exceeds the density recommended by reference materials for groundwater level density shown in Table 4-4.

4.8.5 Representative Monitoring

Representative monitoring sites were selected for groundwater quality using the criteria used to select representative groundwater level monitoring wells (Section 4.5.4). Due to the uncertainty of monitoring frequency, all monitoring network wells were selected as representative wells in the monitoring network.

4.8.6 Groundwater Quality Monitoring Network

Figure 4-20 shows the monitoring network, and representative and monitoring sites. The monitoring network is comprised of 64 wells, all of which are representative wells.

Table 4-7 shows the wells in the groundwater quality monitoring network. Metadata for the wells is also included.

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Table 4-7: Wells Included in the Groundwater Quality Monitoring Network

OPTI ID	Managing Agency as of 2018	Well Construction Date	Well Depth (feet)	Hole Depth (feet)	Screen Interval	Well Elevation (feet)	First Measurement Date	Last Measurement Date	Measurement Period (years)	Measurement Count
61*	DWR	--	357		Unknown	3,681	2008-09-25	2008-09-25	0	3
72*	SBCWA	1/1/1980	790	820	340 – 350	2,171	2008-09-15	2017-07-14	9	13
73*	SBCWA	8/26/1982	880	1021.	Unknown	2,252	2010-08-03	2011-07-12	1	2
74*	SBCWA	--			Unknown	2,193	2008-09-17	2017-07-13	9	11
76*	USGS	9/1/1960	720		Unknown	2,277	1960-09-22	2008-09-17	48	10
77*	SBCWA	12/4/2008	980	1003.5	960 – 980	2,286	2009-04-08	2009-04-08	0	1
79*	USGS	--	600	750	Unknown	2,374	2008-07-08	2011-08-11	3	7
81*	USGS	--	155		Unknown	2,698	2011-08-16	2011-08-16	0	1
83*	SBCWA	1/1/1972	198		Unknown	2,858	2011-08-16	2011-08-16	0	1
85*	SBCWA	--	233		Unknown	3,047	1964-02-07	2011-07-12	47	46
86*	USGS	1/1/1995	230		Unknown	3,141	--	--	--	0
87*	USGS	--	232		Unknown	3,546	--	--	--	0
88*	USGS	9/4/2007	400	400.	Unknown	3,549	2011-08-18	2011-08-18	0	1
90*	SBCWA	8/8/2006	800	800	Unknown	2,552	2008-09-17	2012-09-20	4	6
91*	SBCWA	9/29/2009	980	1000	960 – 980	2,474	2009-11-05	2009-11-05	0	1
94*	USGS	--	550	720	Unknown	2,456	2008-07-29	2010-07-29	2	6
95*	SBCWA	4/9/2009	805	825.	Unknown	2,449	2011-08-19	2011-08-19	0	1
96*	SBCWA	2/1/1980	500		Unknown	2,606	2011-08-19	2011-08-19	0	1
98*	SBCWA	--	750		Unknown	2,688	2011-08-16	2011-08-16	0	1
99*	SBCWA	9/10/2009	750	906	73 – 750	2,513	2009-11-04	2009-11-04	0	1
101*	SBCWA	--	200	220	Unknown	2,741	2008-09-25	2008-09-25	0	3
102*	SBCWA	--			Unknown	2,046	2011-08-15	2017-07-13	6	7
130*	USGS	--			Unknown	3,536	2011-08-19	2011-08-19	0	1
131*	USGS	--			Unknown	2,990	2011-08-17	2011-08-17	0	1
157*	USGS	--	71		Unknown	3,755	--	--	--	0
196*	USGS	--	741	755	Unknown	3,117	--	--	--	--
204*	USGS	1/1/1935			Unknown	3,693	2011-08-18	2011-08-18	0	1
226*	USGS	1/1/1971		220.	Unknown	2,945	2011-08-18	2011-08-18	0	1
227*	USGS	--			Unknown	3,002	1966-07-01	2011-08-17	45	2

Table 4-7: Wells Included in the Groundwater Quality Monitoring Network

OPTI ID	Managing Agency as of 2018	Well Construction Date	Well Depth (feet)	Hole Depth (feet)	Screen Interval	Well Elevation (feet)	First Measurement Date	Last Measurement Date	Measurement Period (years)	Measurement Count
242*	USGS	--	155	187	Unknown	2,933	2012-07-18	2012-07-18	0	1
269*	USGS	1/1/1951			Unknown	2,756	2008-09-16	2008-09-16	0	3
309*	USGS	2/2/1980	1,100	1100	Unknown	2,513	2011-08-11	2011-08-11	0	1
316*	USGS	9/29/2009	830	1000	Unknown	2,474	2009-11-05	2009-11-05	0	1
317*	USGS	9/29/2009	700	1000	Unknown	2,474	2009-11-05	2009-11-05	0	1
318*	USGS	9/29/2009	610	1000	Unknown	2,474	2009-11-04	2009-11-04	0	1
322*	USGS	4/9/2009	850	906	Unknown	2,513	2009-11-03	2009-11-03	0	1
324*	USGS	9/10/2009	560	906	Unknown	2,513	2009-11-04	2009-11-04	0	1
325*	USGS	9/10/2009	380	906	Unknown	2,513	2009-11-04	2009-11-04	0	1
400*	USGS	--	2,120	2200.	Unknown	2,298	1958-05-26	2011-08-15	53	8
420*	USGS	12/4/2008	780	1003.5	Unknown	2,286	2009-04-07	2009-04-07	0	1
421*	USGS	12/4/2008	620	1003.5	Unknown	2,286	2009-04-07	2009-04-07	0	1
422*	USGS	12/4/2008	460	1003.5	Unknown	2,286	2009-04-08	2009-04-08	0	1
424*	USGS	--	1,000	1020.	Unknown	2,291	2011-08-15	2011-08-15	0	1
467*	USGS	1/1/1963	1,140	1215.	Unknown	2,224	2012-07-18	2017-07-13	5	6
568*	USGS	1/1/1948	188	188	Unknown	1,905	2008-09-15	2008-09-15	0	3
702*	USGS	--	--		Unknown	3,539	--	--	--	--
703*	USGS	--	--		Unknown	1,613	--	--	--	--
710*	DWR	--	--		Unknown	2,942	--	--	--	--
711*	DWR	--	--		Unknown	1,905	--	--	--	--
712*	DWR	--	--		Unknown	2,171	--	--	--	--
713*	DWR	--	--		Unknown	2,456	--	--	--	--
721*	DWR	--	--		Unknown	2,374	--	--	--	--
758*	DWR	--	--		Unknown	3,537	--	--	--	--
840*	Private Landowner	11/21/2014	900		200 – 880	1,713	--	--	--	--
841*	Private Landowner	12/12/2014	600		170 – 580	1,761	--	--	--	--
842*	Private Landowner	12/19/2014	450		60 – 430	1,759	--	--	--	--
843*	Private Landowner	1/5/2015	620		60 – 600	1,761	--	--	--	--
844*	Private Landowner	7/17/2015	730		100 – 720	1,713	--	--	--	--

Table 4-7: Wells Included in the Groundwater Quality Monitoring Network

OPTI ID	Managing Agency as of 2018	Well Construction Date	Well Depth (feet)	Hole Depth (feet)	Screen Interval	Well Elevation (feet)	First Measurement Date	Last Measurement Date	Measurement Period (years)	Measurement Count
845*	Private Landowner	7/12/2015	380		100 – 360	1,712	--	--	--	--
846*	Private Landowner	6/15/2015	610		130 – 590	1,715	--	--	--	--
847*	Private Landowner	7/26/2015	600		180 – 580	1,733	--	--	--	--
848*	Private Landowner	6/30/2015	390		110 – 370	1,694	--	--	--	--
849*	Private Landowner	6/23/2015	570		150 – 550	1,713	--	--	--	--
850*	Private Landowner	8/13/2015	790		180 – 780	1,759	--	--	--	--

*Denotes a representative well

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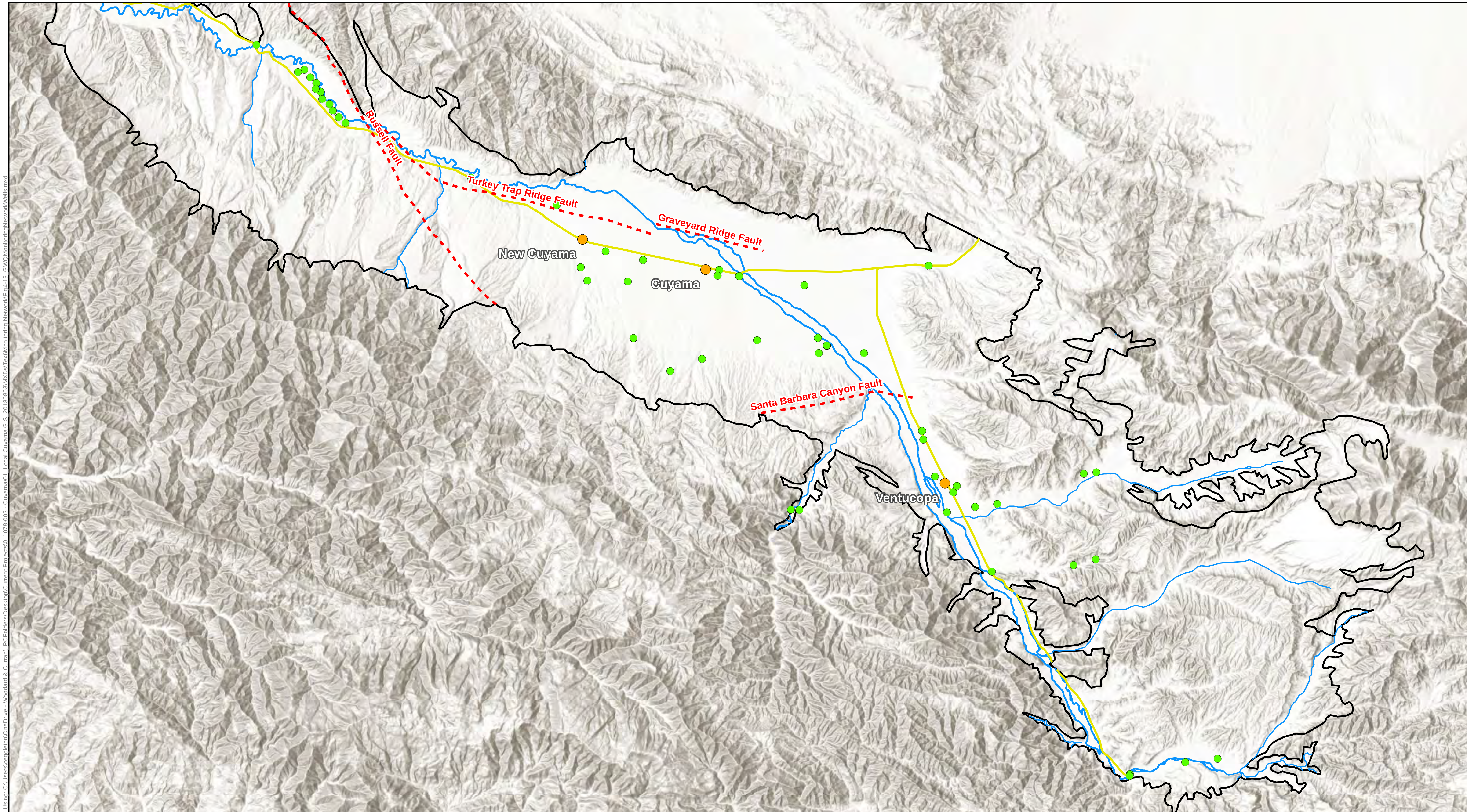

Figure 4-20: Cuyama GW Basin Groundwater Quality Monitoring Network Wells

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Legend

- Cuyama Basin
- Towns
- Highways
- Cuyama River
- Streams
- Faults
- Representative Wells and Groundwater Quality Monitoring Network Wells

All wells included in the Groundwater Quality Monitoiring Network have been measured since 1/1/2008. Wells measured prior to 2008 are not included.

N

0 1.75 3.5 7 Miles

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4.8.7 Monitoring Protocols

For additional monitoring recommended in Section 4.5.8, the monitoring protocols will use DWR's *Monitoring Networks and Identification of Data Gaps BMP*, which sites the USGS's 1995 publication *Ground-Water Data-Collection Protocols and Procedures for the National Water-Quality Assessment Program: Collection and Documentation of Water-Quality Samples and Related Data* (Appendix B) for the groundwater quality sampling protocols. This publication includes protocols for equipment selection, setup, use, field evaluation, sample collection techniques, sample handling, and sample testing.

4.8.8 Data Gaps

Groundwater quality monitoring data gaps have three components as follows:

- Spatial distribution of the wells
- Well/measurement depths for three-dimensional constituent mapping
- Temporal sampling

The spatial distribution of the groundwater quality monitoring network provides coverage of several portions of the Basin. There are several areas, identified by the red ovals in Figure 4-21, that do not have adequate monitoring. Additional samples taken in these identified areas will provide more information about salinity in the indicated locations.

Well construction for existing salinity sampling efforts is mostly unknown, and the depth of water used for sampling is not known at most monitoring sites. The monitoring network will collect additional information about how salinity may change at different depths in the aquifer, which will require taking samples from wells that have more detailed construction information.

Water quality sampling is inconsistently performed throughout the Basin; as a result, the Basin itself is identified as a groundwater quality monitoring temporal data gap. In September 2018, a CBGSA representative contacted management entities in the Basin responsible for groundwater quality sampling, to help understand the timing of current monitoring schedules, and to determine whether those management entities intended to continue quality monitoring in the future. This GSP assumes all management entities anticipate continuing groundwater quality sampling in the Basin; however, this will need to be confirmed, and the anticipated schedule of sampling by each entity will also need to be confirmed.

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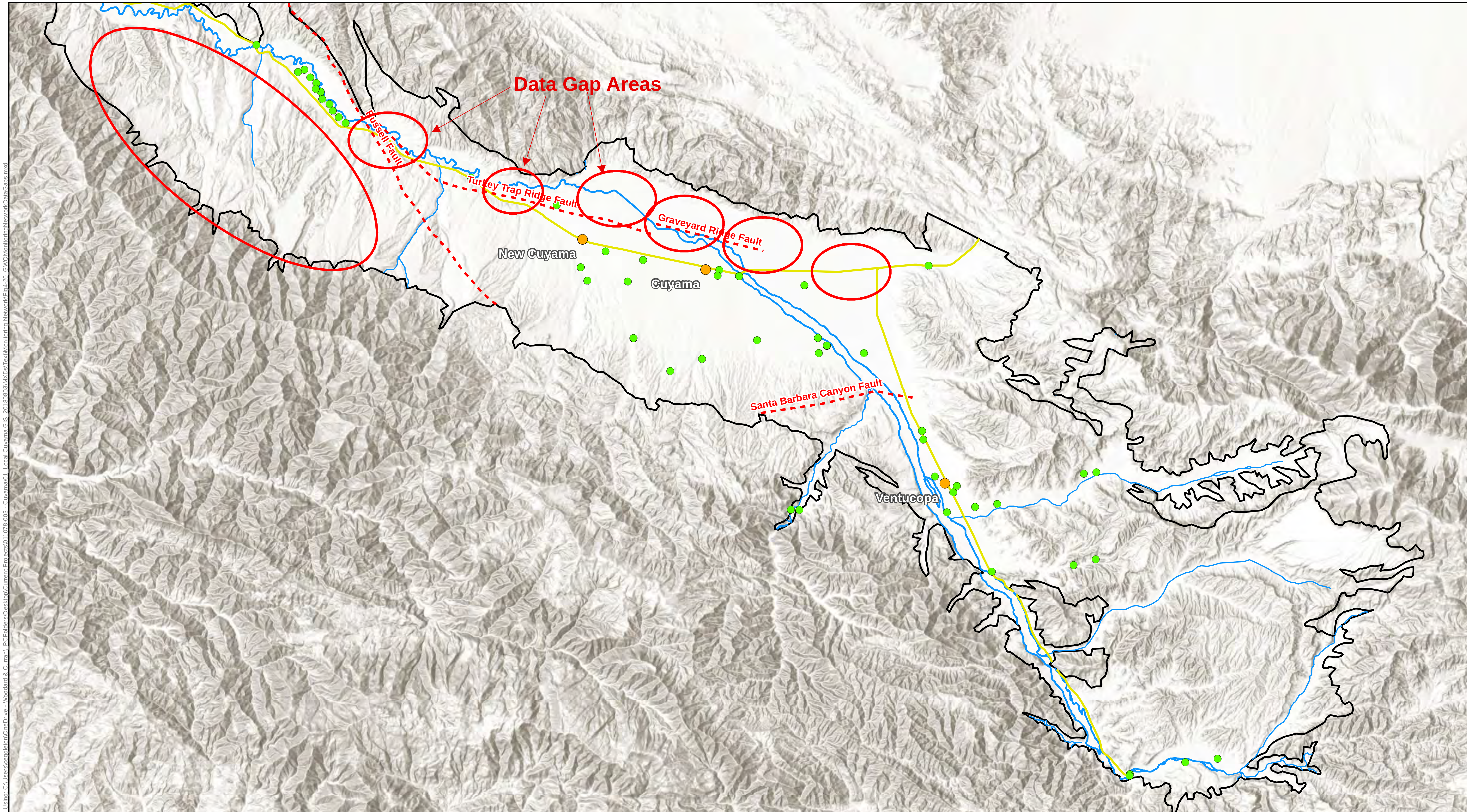

Figure 4-21: Cuyama GW Basin Groundwater Quality Monitoring Network Data Gaps

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4.8.9 Plan to Fill Data Gaps

The CBGSA will fill the temporal and spatial data gaps by implementing its own salinity sampling program, and will fill the well construction knowledge gap at least partially by using DWR's TSS program to perform downhole logging of a subset of wells.

The CBGSA will develop and perform a project to perform annual monitoring of salinity in the Basin. This new monitoring program will focus on using wells that have both construction information and pumps installed. Details of the new monitoring program, such as the targeted number and distribution of sampling sites will be detailed as a project in the projects and management actions section of this GSP (Chapter 6).

DWR's TSS supports GSAs as they develop GSPs. Downhole video logging performed by TSS in existing salinity monitoring wells could provide more well construction information, which may help to better use well data in the Basin.

4.9 Land Subsidence Monitoring Network

4.9.1 Management Areas

Subsidence is managed basin-wide; as a result, no management areas are used.

4.9.2 Monitoring Sites Selected for Monitoring Network

There are two subsidence monitoring stations in the Basin, and three outside of the Basin. Figure 4-22 shows the locations of existing subsidence monitoring stations, which make up the current subsidence monitoring network. The two stations in the Basin, sites CUHS and VCST, are both included in the monitoring network because they are active and provide Basin-specific data. The three stations located outside of the Basin, sites P521, BCWR, and OZST, are also included in the monitoring network. These stations are important for understanding general dynamic movement trends in the Basin because they detect tectonic movement in the Basin.

4.9.3 Monitoring Frequency

Subsidence monitoring frequencies should capture long-term and seasonal fluctuations in ground level changes. DWR's *Monitoring Networks and Identification of Data Gaps BMP* does not provide specific monitoring frequency or interval guidance. However, CGPS stations allow for data sampling several times a minute, which is sufficient for seasonal fluctuations to be captured in the data. Long-term trends are compiled from continuous data. Therefore, the CBGSA will use the same monitoring frequency currently used by the CGPS stations.

4.9.4 Spatial Density

Because there are only two monitoring stations, the current spatial density of subsidence monitoring in the Basin is 0.5 stations per 100 square miles. These stations are included in Figure 4-22. DWR's *Monitoring Networks and Identification of Data Gaps BMP* does not provide specific spatial density guidelines for subsidence monitoring networks, and thus relies on professional judgment for site identification. Current stations, both in and outside of the Basin, do not adequately cover the Basin for capturing subsidence variations. Potential areas for new stations are discussed below.

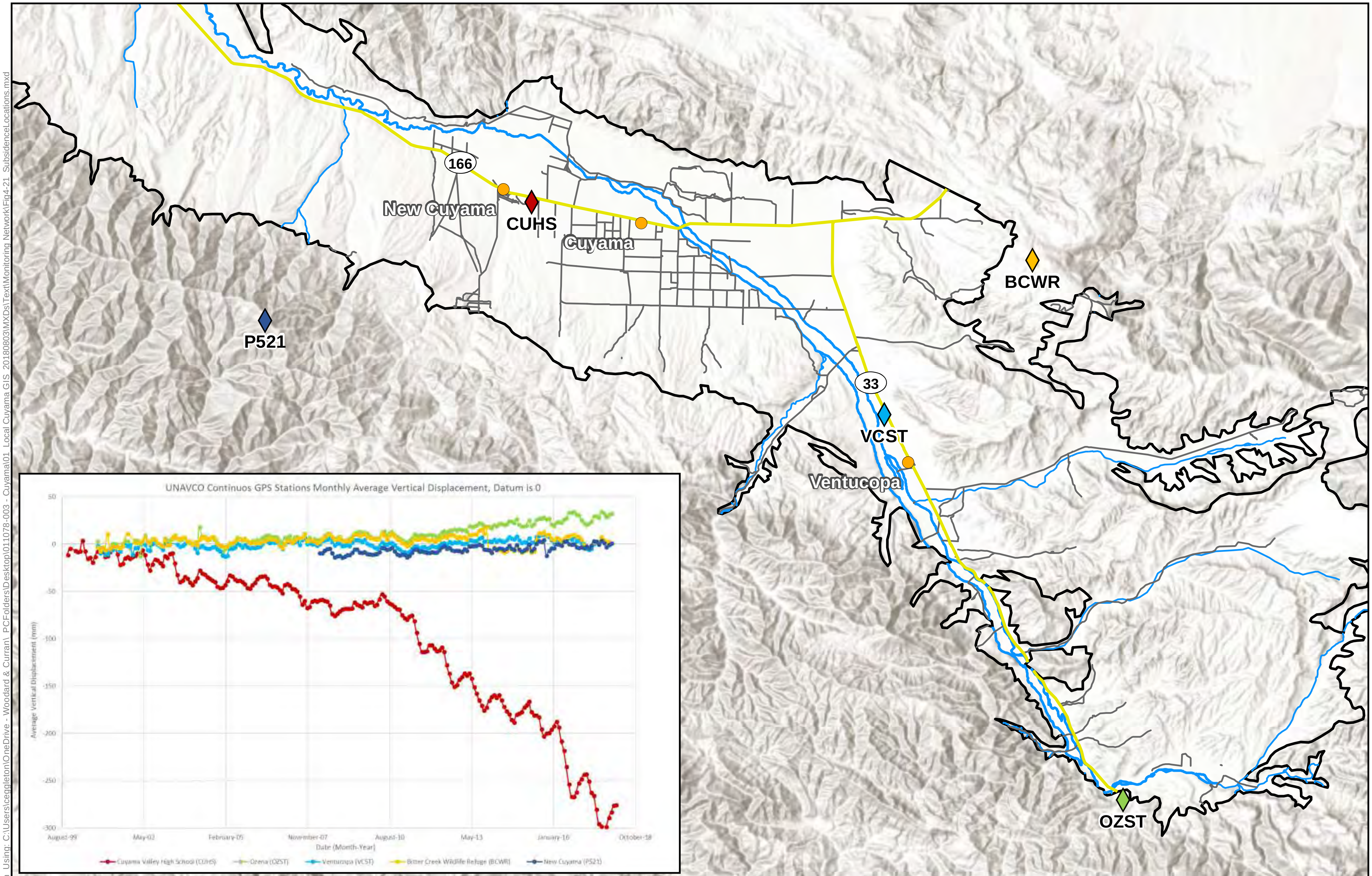

Figure 4-22: Subsidence Stations In and Around the Cuyama Basin

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4.9.5 Monitoring Protocols

DWR's provided *Monitoring Networks and Identification of Data Gaps BMP* does not provide specific monitoring protocols for subsidence monitoring networks. CGPS station measurements are logged digitally, and depending on the station and network setup, either require downloading at the physical station site or are uploaded automatically to a server. Data management will also depend on the monitoring agency. Current operating stations will continue to be managed by their current entity, and the CBGSA will be responsible for downloading data on a fixed schedule. The addition of new stations will require developing procedures for downloading and storing data, and for a quality assurance review of the data.

Data should be saved in the Cuyama Basin data management system on a regular annual schedule. All data should be reviewed for quality and logged appropriately.

4.9.6 Data Gaps

New subsidence monitoring sites should be chosen to provide data on areas most at risk for land subsidence. Six potential new locations were identified in the Basin, as shown in Figure 4-23. These locations were identified by focusing on areas with significant or new groundwater pumping that did not have subsidence monitoring nearby. Criteria for selection are as follows:

- Identified as an area with relatively new and increased agricultural activity and pumping with no nearby stations.
- Identified because there are currently no nearby stations and the Russell Fault bisects this area
- Identified because of the CCSD and proximity to the heavily pumped central portion of the Basin
- Identified because this is the most heavily pumped portion of the Basin and there are currently no nearby stations
- Identified because of its proximity to the heavily pumped portion of the Basin, on the north facing slop of the valley; additionally, there are currently no stations nearby
- Identified because this is the transition into the heavily pumped central portion of the Basin near current agricultural pumping; this is also an area with faults

4.9.7 Plan to Fill Data Gaps

New monitoring sites should be located near areas with the greatest groundwater pumping, or where pumping is new. This is because pumping is the driving force for subsidence in the Basin. Although there are multiple ways to measure subsidence, CGPS stations are likely the best option for the Basin. CGPS stations are relatively low cost when compared to gathering data via labor-intensive land surveys, construction of borehole extensometers, and frequent satellite data processing. CGPS stations require comparatively little maintenance and provide continuous information allowing detailed land subsidence analysis.

Increasing data collection about subsidence for the Basin requires addition of several new CGPS stations. These stations could be managed solely by the CBGSA, or could be incorporated into the Continuously Operating Reference Station (CORS) via coordination with USGS. Site selection, equipment, and management will require coordination with USGS.

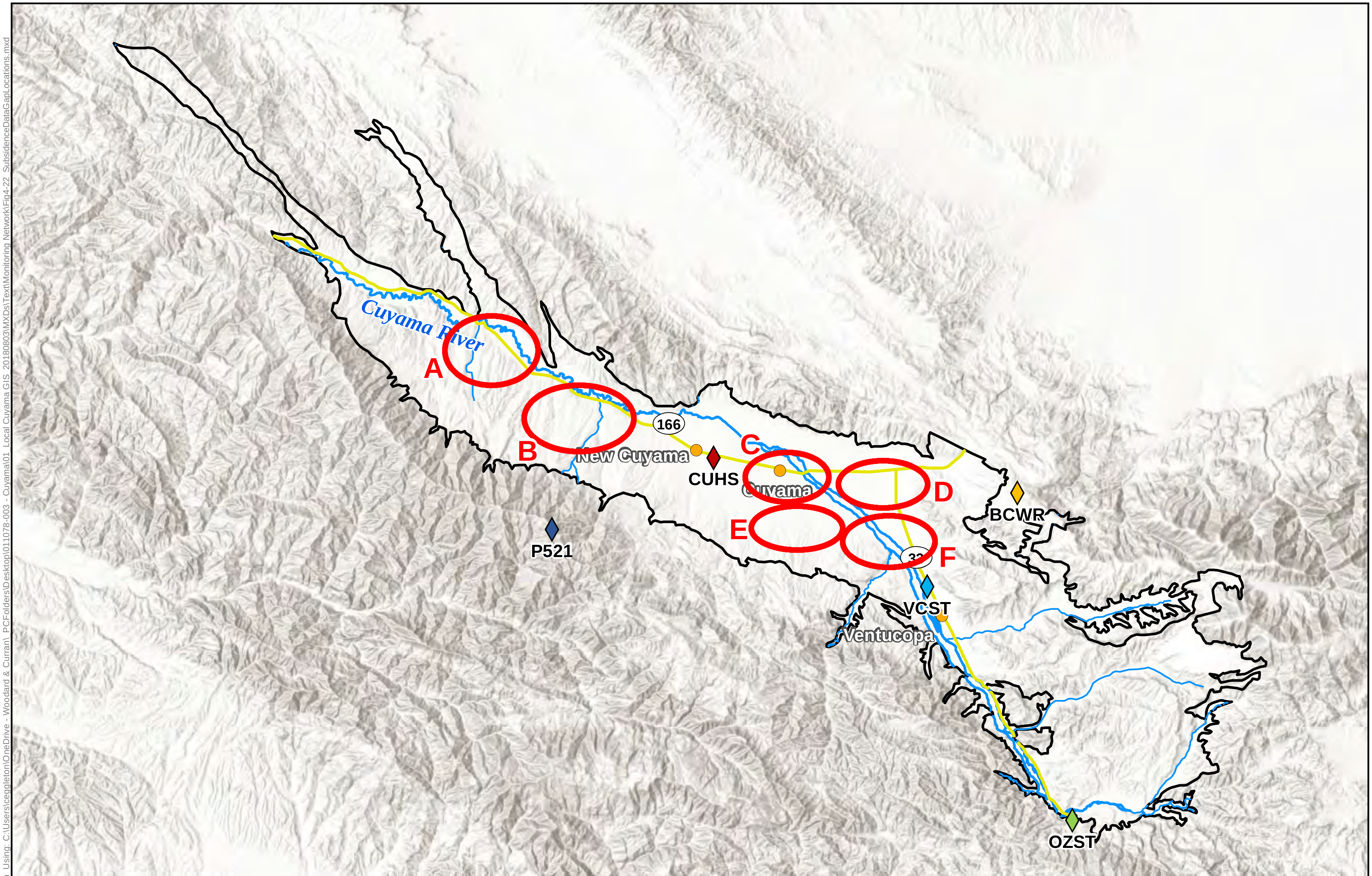

Figure 4-23: Subsidence Monitoring Location Data Gap Areas

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4.10 Depletions of Interconnected Surface Water Monitoring Network

DWR's emergency regulations Section 354.28 (c)(6) states that "The minimum threshold for depletions of interconnected surface water shall be the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results. The minimum threshold established for depletions of interconnected surface water shall be supported by the following: (A) The location, quantity, and timing of depletions of interconnected surface water, and (B) A description of the groundwater and surface water model used to quantify surface water depletion."

Since the emergency regulations require a numerical model to estimate the depletions of interconnected surface water, there is no functional monitoring network that can be used to measure depletions of interconnected surface water. Therefore, the monitoring networks for depletions of interconnected surface water will include two components as follows:

- Groundwater level monitoring to serve as monitoring by proxy of depletions of interconnected surface water
- Pursuit of additional surface water gage stations to improve numerical model accuracy

Because there are currently no operating stream gage stations on the Cuyama River in the Basin, the CBGSA is pursuing installation of three stream gages to assist in filling the data gap.

4.11 References

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4.10 Supplemental Section 4.10: Monitoring Networks, Depletions of Interconnected Surface Water Monitoring Network

The CBGSA believes that identifying a subset of groundwater level representative monitoring wells for use in ISW monitoring, and providing a rationale for their selection, adequately addresses concerns provided in the Letter and provides adequate data collection and monitoring for ISWs.

Summary of Potential Undesirable Results for Interconnected Surface Waters

Depletions of ISW are related to chronic lowering of groundwater levels via changes in the hydraulic gradient and piezometric surface elevation. Therefore, declines in groundwater elevations in portions of the river system that are hydrologically connected to the river system can lead to increased stream losses and depletion of surface water flows. As shown in Figure 4-24, an analysis of the results of the historical simulation of the Cuyama Basin Water Resources Model (CBWRM) reveals that many portions of the stream system in the Basin were already disconnected as of 2015 and therefore ISW flows in these stream reaches would not be affected by further changes in groundwater levels. The primary areas of concern for ISW are on stretches of the Cuyama River upstream of Ventucopa and downstream of the Russell Fault, and on the four major contributing streams to the Cuyama River, including Aliso Creek, Santa Barbara Creek, Quantal Canyon Creek, and Cuyama Creek.

Because the Cuyama River does not flow during most days of the year and the river is not subject to environmental flow regulations, the primary beneficial uses of Cuyama River streamflows are GDEs and water users who utilize water that may flow into Lake Twitchell downstream of the Basin boundary. Lowering groundwater levels could result in reduced streamflows for beneficial use by these users. Therefore, the intent of the ISW monitoring network and sustainability criteria are to ensure that long-term groundwater level declines do not occur in the vicinity of these interconnected surface water flow reaches of the Cuyama River system.

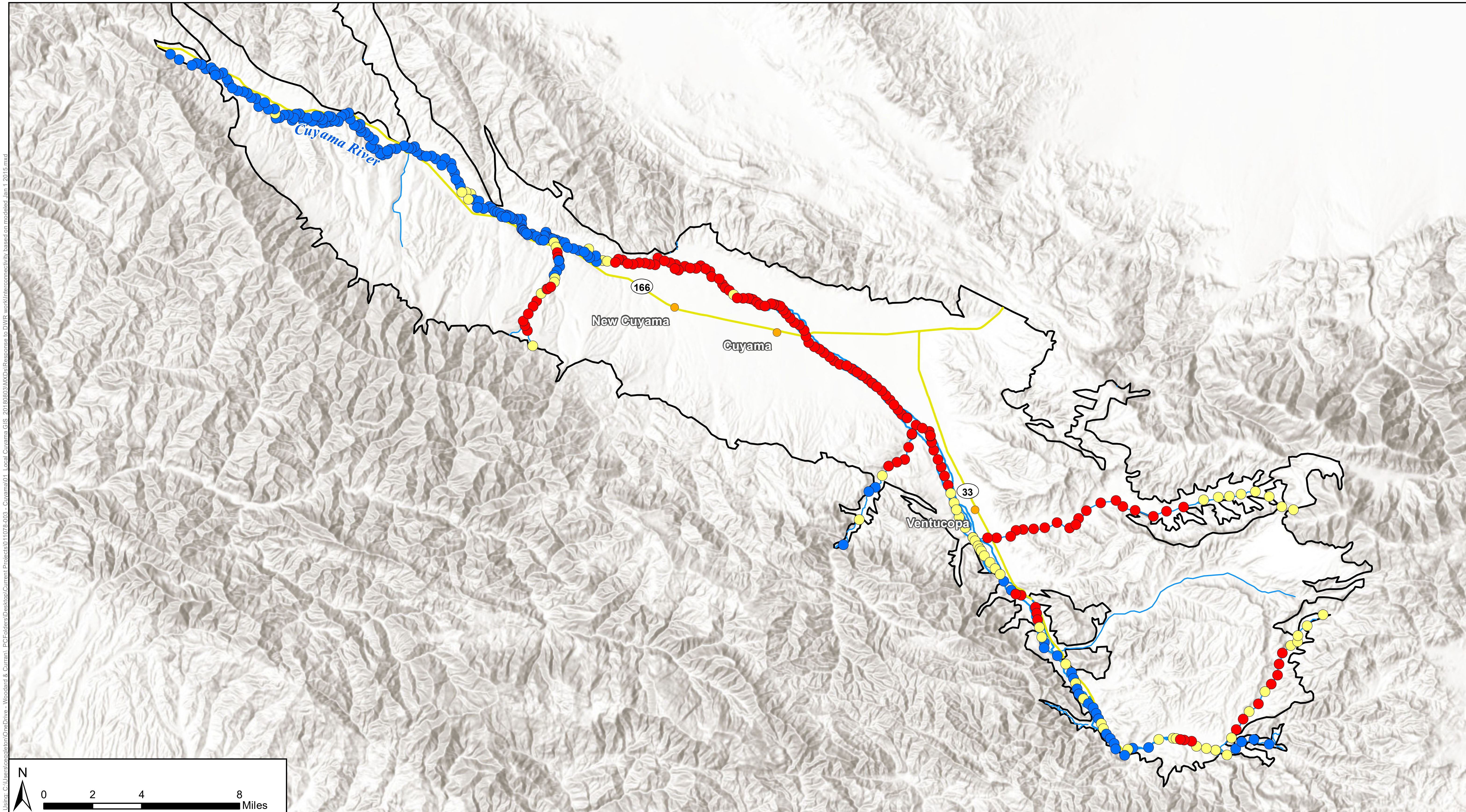

Figure 4-24: Potential Stream Interconnectivity using Modeled Conditions in January 2015

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Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

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- Cuyama Basin
- Cuyama River
- Streams

Gaining or Losing and Connected or Disconnected Determination Based on Modeled GW Levels on Jnauary 1, 2015

- Gaining Stream - Connected
- Losing Stream - Connected
- Losing Stream - Disconnected

Approach for ISW Monitoring and Sustainability Criteria

To develop an ISW monitoring network, a subset of wells from the groundwater levels representative monitoring network has been used to create a depletion of ISW representative monitoring network. Wells not included in the groundwater levels monitoring network were also considered; but no additional wells were identified that would be suitable for ISW monitoring. After consulting DWR's BMPs for Monitoring Networks and Identification of Data Gaps, the following criteria were used to select wells to be included in the ISW representative network:

1. Wells that are within 1.5-miles of the Cuyama River and/or 1-mile of one of the four major contributing streams to the Cuyama River, including Aliso Creek, Santa Barbara Creek, Quantal Canyon Creek, and Cuyama Creek,

2. Wells that have screen intervals within 100 feet below ground surface (bgs). In some cases, wells without screen interval information but with well depths greater than 100 feet bgs were included, under the assumption that the top of the screen interval was likely to be less than 100 feet bgs. In many of these wells, recent groundwater depth to water measurements were 40 feet bgs or less.

DWR BMP Monitoring Networks and Identification of Data Gaps, provides the following guidance for well selection: "Identify and quantify both timing and volume of groundwater pumping within approximately 3 miles of the stream or as appropriate for the flow regime." However, the CBGSA has chosen to use a 1.5-mile buffer around the Cuyama River and a 1-mile buffer around the major contributing streams because the Basin's unique and variable geology and topography require a narrower window so that the ISW monitoring network wells would cover just the portion of the Valley in the vicinity of the River system (and not extend into foothill areas with significant topographic relief and no alluvial aquifers).

In addition, depletions of ISWs occur at the interaction of surface and groundwater, which is in the shallow portion of the aquifer. In general, wells with completions or depths within 100 feet bgs are preferable to provide more useful information about this near surface interaction. Common practice is to also only include wells that are in areas of interconnectivity or areas where interconnectivity conditions are close to those that define interconnectivity (for example, areas with groundwater levels between 30 to 50-feet below ground surface). Due to the limited number of available wells in the Cuyama Basin with screen intervals (or where screen interval data is not available, well depth) of less than 100 feet bgs, the proposed ISW network includes only five wells. Additional monitoring locations will need to be identified to fill data gaps in the ISW network as discussed below.

The resulting ISW monitoring network is shown in Table 4-8 and Figure 4-25 below. The monitoring network includes 12 wells, nine of which are representative wells for which minimum thresholds and measurable objective have been defined. The MT, MO, and UR criteria (30 percent of representative wells below their MTs for two consecutive years) are the same as those calculated and provided in the groundwater level representative network for the groundwater level monitoring. MTs at the representative well locations are protective of GDE locations in the upper and lower portions of the river, with MTs less than 30 feet from the bottom of the river channel in the vicinity of four wells (89, 114, 830 and 832). Note that Well 906 is part of a new multi-completion well that was constructed in the summer of 2021 under DWR's Technical Support Services; while Well 906 is a representative well, sustainability criteria will not be developed for this well until a history of groundwater level measurements has been established. While the three non-representative wells in the central portion of the Basin are too deep for direct monitoring of ISW flows, they are included to allow the GSA to monitor potential groundwater level increases that could result in reconnection between the river and aquifer in the central Basin going forward.

Table 4-8: Interconnected Surface Water Monitoring Network

Opti ID	Threshold Region	Well Depth (feet bgs)	Screen Interval	Minimum Threshold (feet bgs)	Measurable Objective (feet bgs)
Representative Wells					
2	Southeastern	73	Unknown	72	55
89	Southeastern	125	Unknown	64	44
114	Central	58	Unknown	47	45
568	Central	188	Unknown	37	36
830	Northwestern	77	Unknown	59	56
832	Northwestern	132	Unknown	45	30
833	Northwestern	504	Unknown	96	24
836	Northwestern	325	Unknown	79	36
906	Northwestern	Unknown	50-70	TBD	TBD
Other Monitoring Network Wells					
101	Central	200	Unknown	n/a	n/a
102	Central	Unknown	Unknown	n/a	n/a
421	Central	620	Unknown	n/a	n/a

The proposed network includes the following data gaps which will need to be filled in the future:

- Due to the shortage of shallow monitoring wells available to include in the network, additional shallow aquifer measurement devices will be needed. As noted above, the CBGSA has called for the installation of piezometers in the vicinity of the streambed.

- A spatial data gap exists along the Cuyama River between Well 89 and Ventucopa. Note that significant stretches of the Cuyama River (particularly in the central area of the Basin) were already disconnected from the groundwater aquifer in 2015 (as discussed in Section 2.2.8).

The CBGSA has requested funding for the installation of six piezometers under the recently awarded DWR SGMA grant. The specific locations for these additional piezometers will be determined through technical analysis and stakeholder and landowner engagement with the goals of filling gaps in the ISW monitoring network and of providing better information regarding the condition of GDEs in the Basin.

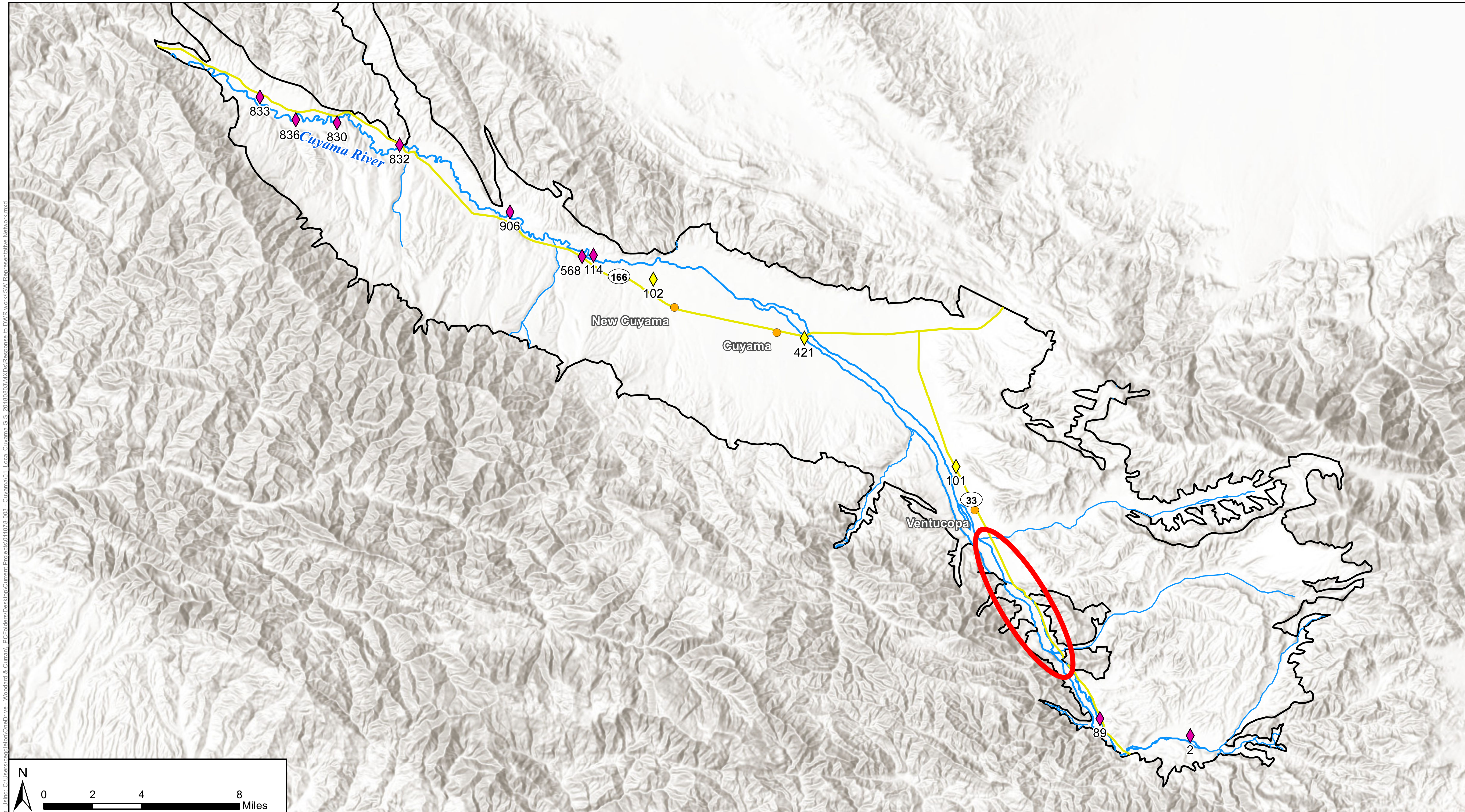

Figure 4-25: Interconnected Surface Water Monitoring Network

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- Cuyama Basin
- Data Gap Areas
- ISW Representative Network Wells
- ISW Non-Representative Network Wells
- Cuyama River
- Streams