Groundwater Sustainability Plan

JULY 2022

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TO: Paul Gosselin, California Department of Water Resources Deputy Director

FROM: Cuyama Basin Groundwater Sustainability Agency

DATE: July 6, 2022

RE: Revisions to Groundwater Sustainability Plan for the Cuyama Valley Groundwater Basin

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Following submittal of the Groundwater Sustainability Plan (GSP) in January 2020, the Cuyama Valley Groundwater Basin Groundwater Sustainability Agency (CBGSA) received a Determination Letter (Letter) on January 21, 2022 (Supplemental Appendix A) from the California Department of Water Resources (DWR). The Letter provided the CBGSA with an Incomplete Determination for the GSP and the necessary corrective actions required for approval. Per SGMA regulations, the CBGSA was given a 180-day correction period to update and address any deficiencies in the GSP. DWR's Incomplete Determination identified four areas of deficiency that required revisions to and resubmittal of the GSP. The four deficiencies are summarized as follows:

- Potential Corrective Action 1: Provide justification for, and effects associated with, the sustainable management criteria and how they may affect beneficial users.
- Potential Corrective Action 2: Use of groundwater levels as a proxy for depletion of interconnected surface water.
- Potential Corrective Action 3: Further address degraded water quality by providing additional clarification and justification of available data, monitoring, and thresholds.
- Potential Corrective Action 4: Provide explanation for how overdraft will be mitigated in the basin.

To address these deficiencies, the CBGSA developed supplemental information that has been included in this revised version of the GSP. This information is included in a technical memorandum (Supplemental Appendix B) that describes the CBGSA's response to the Letter in detail, with relevant supplemental information inserted into this revised version of the GSP, including:

- Supplemental Table of Contents – This is inserted at the end of the original Table of Contents and provides page numbers of the supplemental text sections.
- Supplemental GSP Subsections – To ensure transparency, all revisions to the original GSP are included as supplemental subsections at the end of each applicable section. These supplemental subsections are on new pages separate from the original GSP, with text in **blue color font**, and with notes to identify what GSP subsections the supplemental information pertains to.

In addition, a recent review of the CBGSA January 2020 submittal to DWR revealed that an incorrect version of Section 7 was submitted to DWR at that time. To accurately reflect the direction of the CBGSA Board, the revised GSP includes the version of Section 7 that was originally approved by the Board in December 2019, with supplemental content added in response to DWR's determination letter as described above. To ensure full transparency and to assist DWR with its review, a pdf comparison between the version submitted to DWR and the version approved by the Board in December 2019 has been provided as Supplemental Appendix C.

The revised version of the GSP, including the supplemental content and appendices described above, was approved by the CBGSA Board on July 6, 2022.

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Cuyama Valley Groundwater Basin

Groundwater Sustainability Plan

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December 2019

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Acronyms

µg/L	micrograms per liter
AF	acre-feet (foot)
AFY	acre-feet per year
AHOGS	automated high output ground seeding system site
Basin	Cuyama Valley Groundwater Basin
BMP	best management practice
CASGEM Program	California Statewide Groundwater Elevation Monitoring Program
CBGSA	Cuyama Basin Groundwater Sustainability Agency
CBWD	Cuyama Basin Water District
CBWRM	Cuyama Basin Water Resources Model
CCR	California Code of Regulations
CCSD	Cuyama Community Services District
CDFW	California Department of Fish and Wildlife
CEDEN	California Environmental Data Exchange Network
CEQA	California Environmental Quality Act
CGPS	continuous global positioning system
CMWC	Cuyama Mutual Water Company
CUVHM	Cuyama Valley Hydrologic Model
DEM	digital elevation model
DMS	data management system
DWR	California Department of Water Resources
EKI	EKI Environment & Water, Inc.
EPA	United States Environmental Protection Agency
GAMA Program	California Groundwater Ambient Monitoring and Assessment Program
GDE	groundwater dependent ecosystem
GPS	global positioning system
GSE	ground surface elevation
GSP	Groundwater Sustainability Plan
HCM	hydrogeologic conceptual model

Acronyms

ID	identification number
ILRP	Irrigated Lands Regulatory Program
IM	interim milestone
InSAR	interferometric synthetic aperture radar
IRWM	Integrated Regional Water Management
LID	low impact development
LiDAR	light detection and ranging
Ma	million years
MCL	maximum contaminant level
mg/L	milligrams per liter
MO	measurable objective
MSC	Master State Well Code
MT	minimum threshold
NAVSTAR	Original name for the Global Positioning System; satellite-based radionavigation system owned by the United States government and operated by the United States Air Force
NCCAG	Natural Communities Commonly Associated with Groundwater
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NRCS	Natural Resources Conservation Service
NWIS	National Watershed Information System
NWQMC	National Water Quality Monitoring Council
PBO	Plate Boundary Observatory
PG&E	Pacific Gas & Electric
PRISM	Parameter-Elevation Regressions on Independent Slopes Model
RCD	Resource Conservation District
RWQCB	Regional Water Quality Control Board
SAGBI	Soil Agricultural Groundwater Banking Index
SBCF	Santa Barbara Canyon Fault
SBCWA	Santa Barbara County Water Agency

Acronyms

SGMA	Sustainable Groundwater Management Act
SLOCFC&WCD	San Luis Obispo County Flood Control & Water Conservation District
SR	State Route
TDS	total dissolved solids
TSS	Technical Support Services
UNAVCO	University NAVSTAR Consortium, a non-profit, university-governed consortium facilitating geoscience research and education using geodesy
USGS	United States Geological Survey
VCWPD	Ventura County Watershed Protection District
VWSC	Ventucopa Water Supply Company
WDL	Water Data Library
WMP	Water Management Plan

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2022 Update

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EXECUTIVE SUMMARY

Introduction

In 2014, the California legislature enacted the Sustainable Groundwater Management Act (SGMA) in response to continued overdraft of California's groundwater resources. The Cuyama Groundwater Basin (Basin) is one of 21 basins and subbasins identified by the California Department of Water Resources (DWR) as being in a state of critical overdraft. SGMA requires preparation of a Groundwater Sustainability Plan (GSP) to address measures necessary to attain sustainable conditions in the Basin. Within the framework of SGMA, sustainability is generally defined as the conditions that result in long-term reliability of groundwater supply, and the absence of undesirable results.

Critical Dates for the Cuyama Basin

- 2020 By January 31: submit GSP to DWR
- 2025 Review and update GSP
- 2030 Review and update GSP
- 2035 Review and update GSP
- 2040 Achieve sustainability for the Basin

In 2017, in response to SGMA, the Cuyama Basin Groundwater Sustainability Agency (CBGSA) was formed. The CBGSA is a joint-powers agency that is comprised of Kern, Santa Barbara, San Luis Obispo and Ventura counties, the Cuyama Community Services District and the Cuyama Basin Water District. The CBGSA is governed by an 11-member Board of Directors, with one representative from Kern, San Luis Obispo and Ventura counties, two representatives from Santa Barbara County, one member from the Cuyama Community Services District, and five members from the Cuyama Basin Water District.

This Draft GSP is now available for public review and comment. SGMA requires the CBGSA to develop a GSP that achieves groundwater sustainability in the Basin by 2040. Although SGMA references 2015 as a basis for groundwater planning, SGMA does not require a GSP to address undesirable results that occurred before 2015. This Draft GSP outlines the need for significant reductions in pumping in the central portion of the Basin, and has identified two projects for potential development that could help offset the projected reductions in pumping. Although current analysis indicates groundwater pumping reductions on the order of 50 to 67 percent may be required Basin-wide to achieve sustainability, additional efforts are required to confirm the amount and location of pumping reductions required to achieve sustainability. These efforts include collecting additional data and a review of the Basin's groundwater model, along with other efforts as outlined in this document.

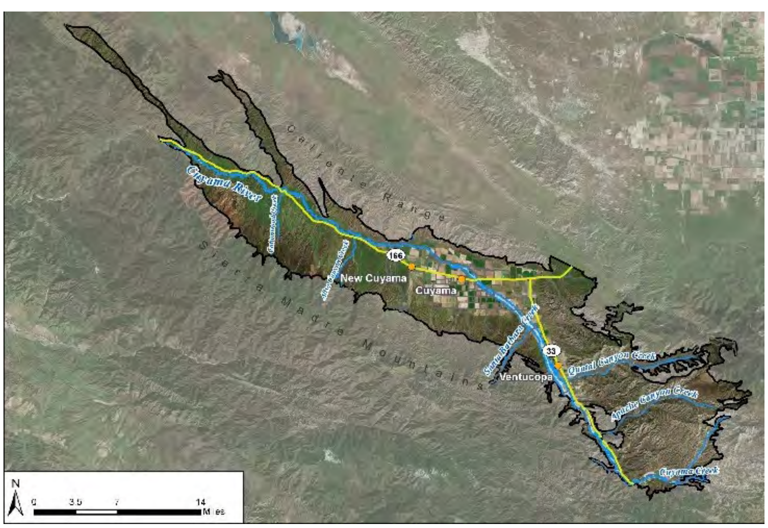

Figure ES-1: GSP Plan Area

Plan Area

The CBGSA's jurisdictional area is defined by DWR's 2013 Bulletin 118, and in the 2016 Interim Update[1]. The Basin generally underlies the Cuyama Valley, as shown in Figure ES-1, left.

Outreach Efforts

Figure ES 2: Community Workshops

A stakeholder engagement strategy was developed to ensure that the interests of all beneficial users of groundwater in the Basin were considered. The strategy incorporated monthly CBGSA Standing Advisory Committee (SAC) meetings, monthly CBGSA Board meetings, quarterly community workshops, and information distribution to all property owners and residents in the Basin. A total of 55 public meetings were held between June 2017 and July 2019 as summarized in the table below. Figure ES-2 shows attendees at one of the community workshops conducted during development of the GSP.

Public Meeting	Number
Cuyama Basin GSA Board Meetings	23
Cuyama Basin GSA Standing Advisory Committee Meetings	19
Joint Meetings of Cuyama Basin GSA Board and Standing Advisory Committee	7
Community Workshops	6

The SAC was established to encourage active involvement from diverse social, cultural, and economic elements of the population in the Basin. The SAC members represent large and small landowners and growers from different geographic locations in the Basin, longtime residents including Hispanic community members, and a manager of an environmental educational non-profit organization. The community workshops were conducted in both English and Spanish creating an opportunity for local individuals to engage in the GSP development process.

[1] https://water.ca.gov/Programs/Groundwater-Management/Bulletin-118

Basin Setting

The Basin is at the southeastern end of the California Coast Ranges, near the San Andreas and Santa Maria River fault zones, and is bounded on the north and south by faults. These faults create several constraints on groundwater flow through the Basin. Groundwater and surface water generally flow from the eastern portions of the Basin toward the westernmost portion of the Basin. The major surface stream is the Cuyama River. Multiple smaller streams flow into the Cuyama River; and the Cuyama River flows to the west and eventually joins with the Santa Maria River. The location of the Basin is shown in Figure ES-3.

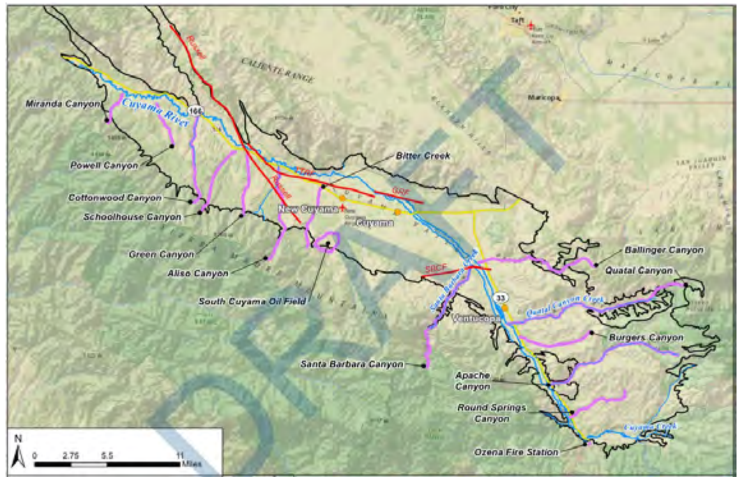

Figure ES-3: Basin Setting

Existing Groundwater Conditions

Groundwater levels in some portions of the Basin have been declining for many years, while other areas of the Basin have experienced no significant change in groundwater levels. Figure ES-4 shows depth-to-groundwater contours for spring 2018, which reflects the most recent recorded status of groundwater levels in the Basin. The change in groundwater levels vary across the Basin, with the greatest declines occurring in the central portion of the Basin, where the greatest concentration of irrigated agriculture occurs. The western and eastern portions of the Basin have experienced significantly less change in groundwater levels. However, additional irrigated agricultural acreage has been developed recently in the western portion of the Basin, warranting additional levels of monitoring to determine if there are any impacts to long-term groundwater levels and sustainability.

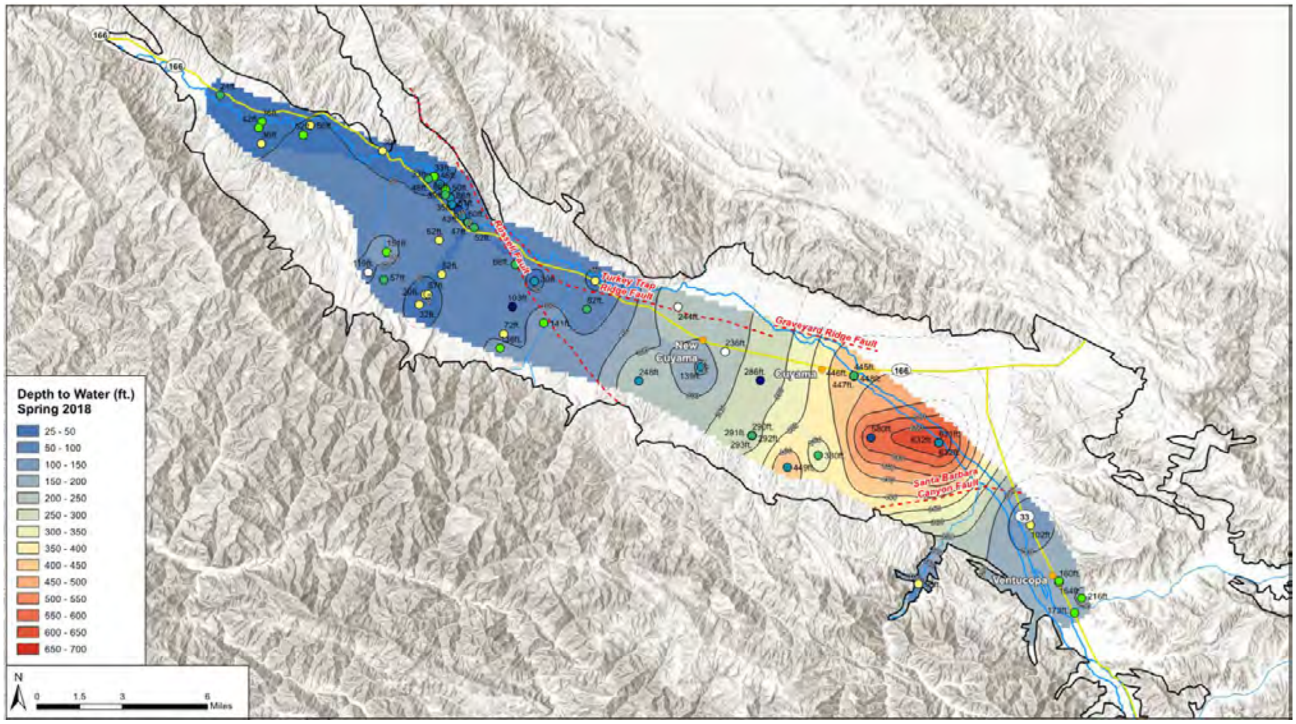

Figure ES-4: Depth-to-Groundwater in Spring 2018

Groundwater quality in the Basin varies, particularly along the Basin boundary. Water quality in the Basin has historically had high levels of total dissolved solids (TDS) and sulfates. The United States Geological Survey (USGS) has conducted several water quality studies in the Basin. High concentrations of other constituents, including nitrate and arsenic, are generally localized and not widespread. Groundwater quality ranges from hard to very hard and is predominantly of the calcium-magnesium-sulfate type. Average TDS concentrations across the Basin are as high as 1,500 to 6,000 milligrams per liter (mg/L) along portions of the Basin's southern boundary. These values exceed the California recommended secondary maximum contaminant level (MCL) for drinking water of 500 mg/L.

Undesirable Results

Undesirable results are conditions that cause significant and unreasonable reduction in the long-term viability of domestic, agricultural, municipal, or environmental uses of the Basin's groundwater. SGMA identifies six defined areas for classification of undesirable results, as shown in the adjacent callout. The one undesirable result that does not impact the Basin is seawater intrusion. Water quality in the Basin is generally poor due to high TDS and other constituents, and there is limited subsidence in the Basin, but the major areas of undesirable results are associated with the following:

- Chronic lowering of groundwater levels
- Significant and unreasonable reduction in groundwater storage
- Depletions of interconnected surface water

Undesirable Results Categories

- Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon
- Significant and unreasonable reduction of groundwater storage
- Significant and unreasonable seawater intrusion (does not apply in the Basin)
- Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies
- Significant and unreasonable land subsidence that substantially interferes with surface land uses
- Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water

Figure ES-5 is a graph showing the modeled annual and cumulative long-term reduction in groundwater storage in the Basin. This reduction in groundwater storage coincides with the observed lowering of groundwater levels.

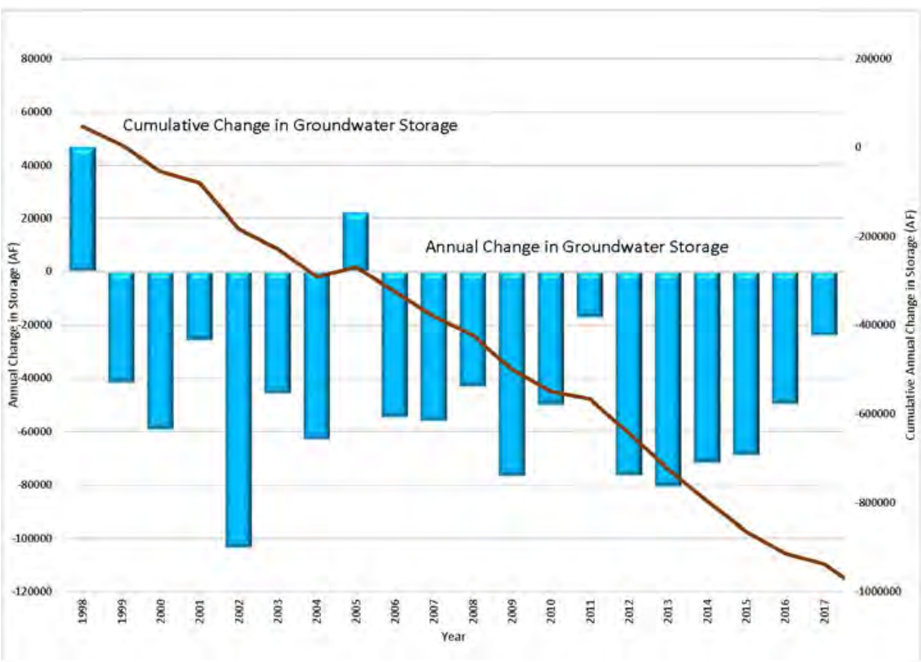

Figure ES-5: Annual and Cumulative Changes in Groundwater Storage

The lowering of groundwater levels has corresponded with degradation of groundwater quality, and particularly in elevated levels of TDS. Additionally, lowering of groundwater levels has contributed to some subsidence in the central portion of the Basin (i.e., about 1 foot over the past 20 years), and has contributed to depletions in interconnections of surface and groundwater systems.

Sustainability

SGMA introduces several terms to measure sustainability, including the following:

- **Sustainability Goals** – These goals are the culmination of conditions resulting in an absence of undesirable results within 20 years.
- **Undesirable Results** – Undesirable results are the significant and unreasonable occurrence of conditions that adversely affect groundwater use in the Basin.
- **Sustainability Indicators** – Sustainability indicators refer to any of the adverse effects caused by groundwater conditions occurring throughout the Basin that, when significant and unreasonable, cause undesirable results, including the following:
  - Lowering groundwater levels
  - Reduction of groundwater storage
  - Seawater intrusion (does not apply in the Basin)
  - Degraded water quality
  - Land subsidence
  - Depletion of interconnected surface water
- **Minimum Thresholds** – Minimum thresholds are a numeric value for each sustainability indicator and are used to define when undesirable results occur, including if minimum thresholds are exceeded in a percentage of sites in the Basin's monitoring network.
- **Measurable Objectives** – Measurable objectives are a specific set of quantifiable goals for the maintenance or improvement of groundwater conditions. They will be included in the adopted GSP, and will help the CBGSA achieve their sustainability goal for the Basin.

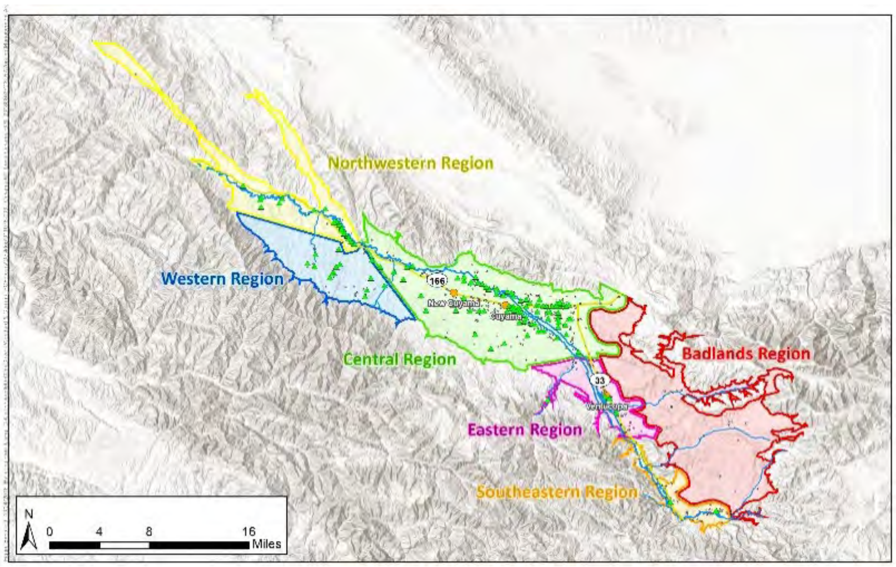

Figure ES-6: Threshold Regions

The method prescribed by SGMA to measure undesirable results involves setting minimum thresholds and measurable objectives for a series of representative wells. Geologic conditions and land use vary across the Basin. These varying conditions also cause groundwater conditions to vary across the Basin. The CBGSA Board of Directors concluded that one set of minimum thresholds for the entire Basin may not provide the appropriate degree of refinement needed to effectively manage Basin-wide sustainability. As a result, threshold regions were created to establish the appropriate sustainability criteria for separate regions of the Basin. The threshold regions are shown above in Figure ES-6.

Representative wells were identified in the Basin to provide a basis for measuring groundwater conditions without having to measure each existing well, which would have been cost prohibitive. Representative wells were selected based on availability, their history of recorded groundwater levels, and their potential to effectively represent groundwater conditions near the identified well. During GSP implementation, well owners will have to consent to the use of their wells for monitoring.

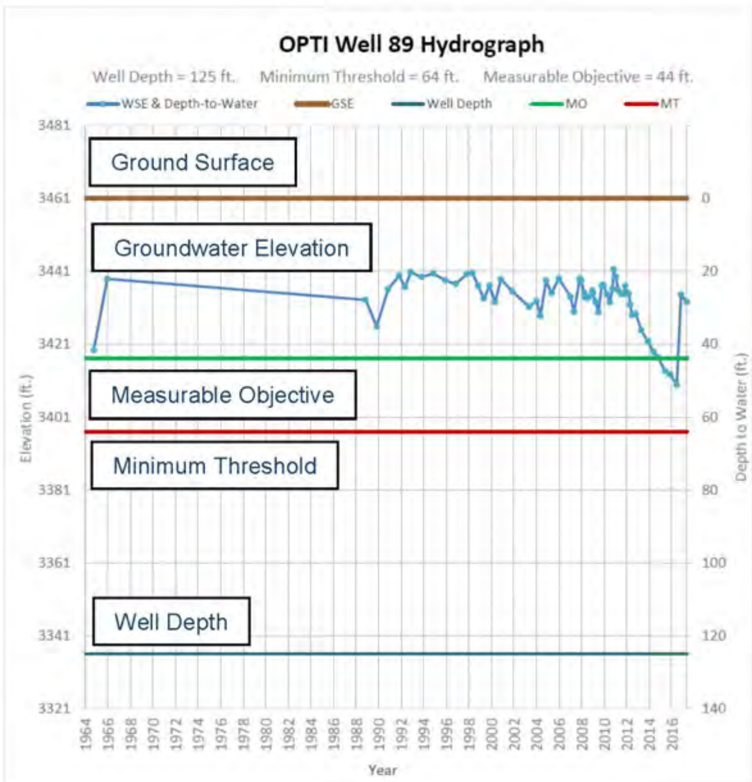

Figure ES-7: Sample Relationship Between Minimum Threshold and Measurable Objective

A total of 60 representative wells have been identified for measurement of groundwater levels in the Basin, and 64 representative wells have been identified for groundwater quality monitoring. There are also five selected ground surface subsidence monitoring stations. Using groundwater level data as the basis for measuring change in groundwater storage, these representative wells and subsidence monitoring stations provide the basis for measuring the five potential undesirable results across the Basin.

Minimum thresholds and measurable objectives were developed for each of the identified representative wells. Figure ES-7 shows a typical relatonship of the minimum thresholds, measurable objectives, and other data for a sample well.

Thresholds were developed with reference to 2015 groundwater levels. In general, measurable objectives were established based on providing a 5-year drought buffer above the minimum threshold. The opposite approach was taken in the southeastern region, where the measurable objective was established based on 2015 groundwater levels and the minimum threshold was determined by providing a 5-year drought buffer below the established measurable objective based on changes in groundwater levels during the recent extended drought.

A table summarizing minimum thresholds and measurable objectives is included in the Draft GSP. Graphs showing the minimum threshold and measurable objective for each representative well are in an appendix to the Draft GSP.

Water Budgets

The Basin has been in an overdraft condition for many years. Overdraft conditions in the Basin were first documented in the 1950s. Since then, groundwater pumping has increased in response to increased levels of agricultural production, leading to increased levels of groundwater overdraft.

The current analysis was prepared using the best available information and through development of a new groundwater modeling tool. Although the Basin has been studied for many years, the available data are not as robust in areas outside the center of the Basin as compared to many other basins, thus leading to some level of uncertainty in the analyses. A data collection program has been designed to augment existing information, and is included in this Draft GSP. It is anticipated that as additional information becomes available, the new model can be updated, and more refined estimates of annual pumping and overdraft can be developed.

The groundwater evaluations conducted as a part of Draft GSP development provided estimates of historical, current and future groundwater budget conditions.

These analyses show that at current groundwater pumping levels, the average annual overdraft is estimated to be approximately 26,000 acre-feet, and the reduction in groundwater pumping required to achieve sustainability is approximately 40,000 acre-feet per year. Future groundwater conditions in the Basin will continue to show decreased groundwater levels based on projections of current land and water uses. Assuming no projected changes in land use or population in the Basin, the projected annual decline in groundwater storage is estimated to be the same as under current conditions.

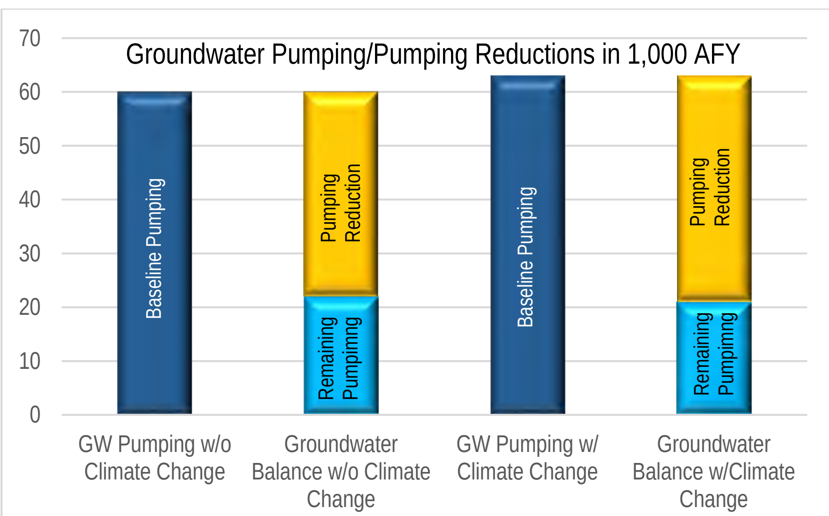

Figure ES-8: Basin-Wide Groundwater Pumping and Reductions Required to Achieve Sustainability

The projected Basin water budget was also evaluated under climate change conditions. Under the intermediate climate change scenario prescribed by DWR, the annual groundwater overdraft is projected to increase to approximately 27,000 acre-feet, requiring an approximate 42,000 acre-feet per year reduction in groundwater pumping to achieve sustainability. These changes are shown in Figure ES-8.

Analysis of the Basin as a whole shows that much of the Basin is in hydrologic balance. Existing and projected groundwater levels in the western portions of the Basin, along with the southeastern region, show those areas to be sustainable under current and projected conditions. However, the model results project significant groundwater level reductions in the central portion of the Basin.

Monitoring Networks

> **Five Sustainability Indicators Applicable to the Cuyama Groundwater Basin**
> - Chronic lowering of groundwater levels
> - Reduction in groundwater storage
> - Degraded water quality
> - Land subsidence
> - Depletions of interconnected surface water

This Draft GSP outlines the monitoring networks for the five sustainability indicators that apply to the Basin. The objective of these monitoring networks is to monitor conditions across the Basin and to detect trends toward undesirable results. Specifically, the monitoring network was developed to do the following:

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

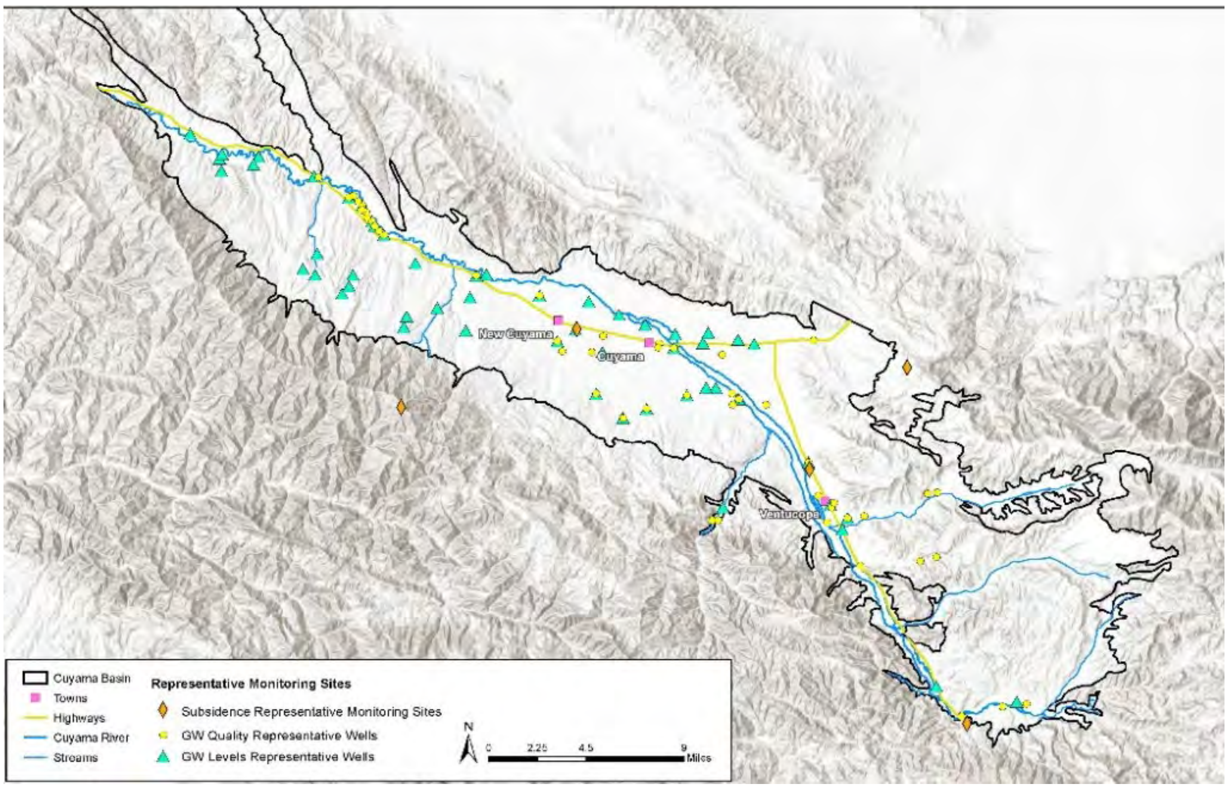

Figure ES-9: Groundwater Monitoring Wells

The monitoring networks were designed by evaluating data sources provided by DWR, including the California Statewide Groundwater Elevation Monitoring (CASGEM) Program, the USGS, participating counties, and private landowners. The proposed monitoring network consists of wells that are already being used for monitoring in the Basin, but there are also current spatial data gaps in the Basin monitoring network. Additional wells are being added, and there is the potential for installing new dedicated monitoring wells through funding provided by DWR's Technical Support Services program. Most wells in the monitoring network are measured on either a semi-annual or annual schedule. Historical measurements have been entered into the Basin Data Management System (DMS), and future data will also be stored in the Basin DMS.

A summary of monitoring wells included in the groudwater levels monitoring network is shown below.

Monitoring Data Maintaining Entity	Number of Wells Selected for Monitoring Network
CASGEM	28
USGS	43
Santa Barbara County Water Agency	36
San Luis Obispo County Flood Control & Water Conservation District	2
Ventura County Watershed Protection District	5
Cuyama Community Services District	1
Private Landowner	48
Total	**101**
Note: Total does not equal sum of rows due to duplicate entries in multiple databases	

Data Management System

The Basin DMS was built on a flexible, open software platform that uses familiar Google maps and charting tools. Typical views generated by the Basin DMS are shown in Figure ES-10 and ES-11. The Basin DMS serves as a data-sharing portal that enables use of the same data and tools for visualization and analysis. These tools support sustainable groundwater management and create transparent reporting about collected data and analysis results.

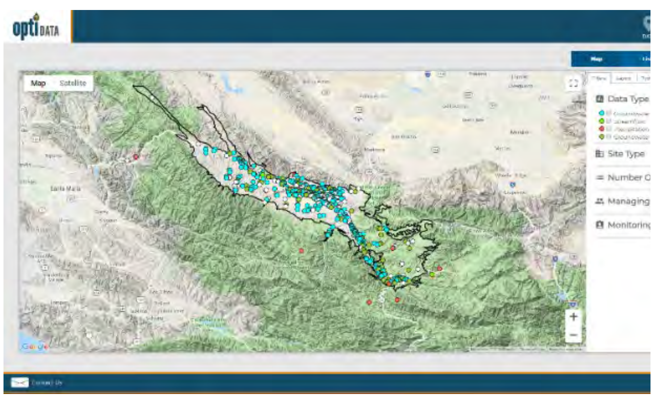

Figure ES-10: Opti DMS Screenshot

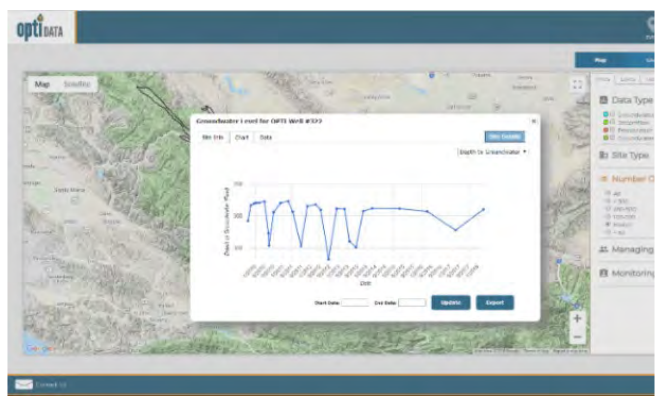

Figure ES-11: Typical DMS Data Display

The Basin DMS is web-based; the public can easily access this portal using common web browsers such as Google Chrome, Firefox, and Microsoft Edge. The Basin DMS is currently populated with available historical data; additional data will be entered into the system as it is collected.

The Basin DMS portal provides easy access and the ability to query information stored in the system. Groundwater data can be plotted for any of the available data points, providing a pictorial view of historical and current data. The DMS can be accessed at https://opti.woodardcurran.com/cuyama/login.php.

Projects and Management Actions

Achieving sustainability in the Basin requires implementation of management actions and, if demonstrated to be feasible, projects that will increase water supply. One management action, reductions in groundwater pumping, is required to achieve sustainability irrespective of the feasibility of any other water supply projects. The exact amount of required reduction in groundwater pumping will be reevaluated after additional data are collected and analyzed. Based on current information, groundwater pumping in the Basin may have to be reduced by as much as 50 to 67 percent. Additional evaluations of pumping reductions required to achieve sustainability are planned over the next several years. These additional evaluations may lead to modification of levels of pumping reduction associated with the attainment of reliability.

Additional management actions included in this Draft GSP include the following:

- Monitoring and recording groundwater levels, groundwater quality, and subsidence data
- Maintaining and updating the Basin DMS with newly collected data
- Monitoring groundwater use using satellite imagery
- Annual monitoring of progress toward sustainability
- Annual reporting of Basin conditions to DWR as required by SGMA

Several alternative projects to potentially increase water supply availability in the Basin were identified and considered. The initial set of alternatives were reviewed with the CBGSA SAC and Board of Directors, resulting in two potential water supply projects included in this Draft GSP. These projects require further analysis and permitting to determine feasibility and cost effectiveness, and are listed below.

The first project is rainfall enhancement through what is commonly referred to as cloud seeding. Cloud seeding is a type of weather modification with the objective to increase the amount of precipitation that would fall in the Basin watershed. The concept is to introduce silver iodide, or a similar substance, into the clouds to induce greater rainfall. Cloud seeding has been used in numerous areas throughout California and other western states. Preliminary estimates suggest up to approximately 4,000 acre-feet per year of additional water supply could be added to the Basin. The target area for rainfall enhancement is shown in Figure ES-12.

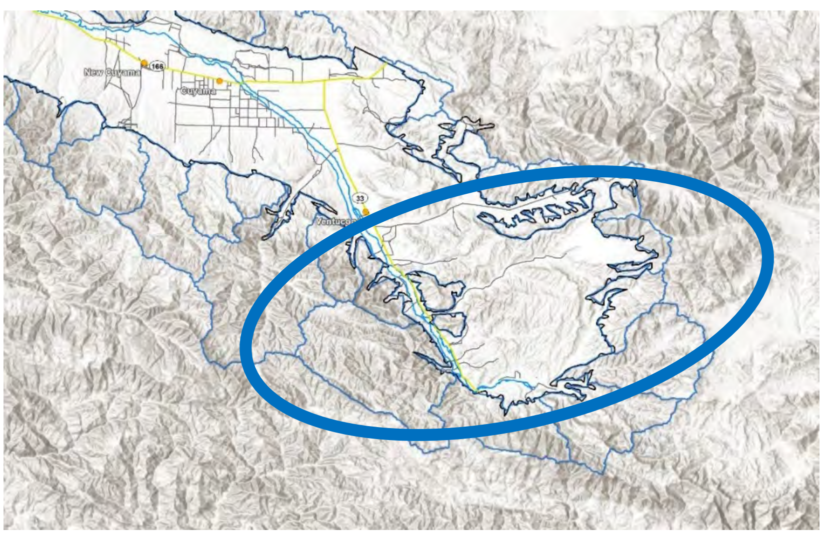

Figure ES-12: Target Area for Potential Rainfall Enhancement

The next step toward implementation of this water supply project is to refine the analysis to better determine the potential increase in precipitation that could be achieved, and to refine the estimated cost of implementation. The project would require completion of an environmental document consistent with the requirements of the California Environmental Quality Act (CEQA).

The second potential project is capture of high stormwater flows in the Cuyama River and diversion into recharge basins that would be sited in the Central region of the Basin. The captured stormwater flows would percolate into the groundwater basin resulting in increased recharge of groundwater. The potential stormwater recharge project has several challenges associated with it, including water rights availability, managing sediment that will be present in any diverted stormwater flows, and obtaining lands for construction of the recharge basins. Preliminary estimates suggest that up to 4,000 acre-feet per year of additional water supply could be added to the Basin. The general location of the potential recharge basins are shown in Figure ES-13.

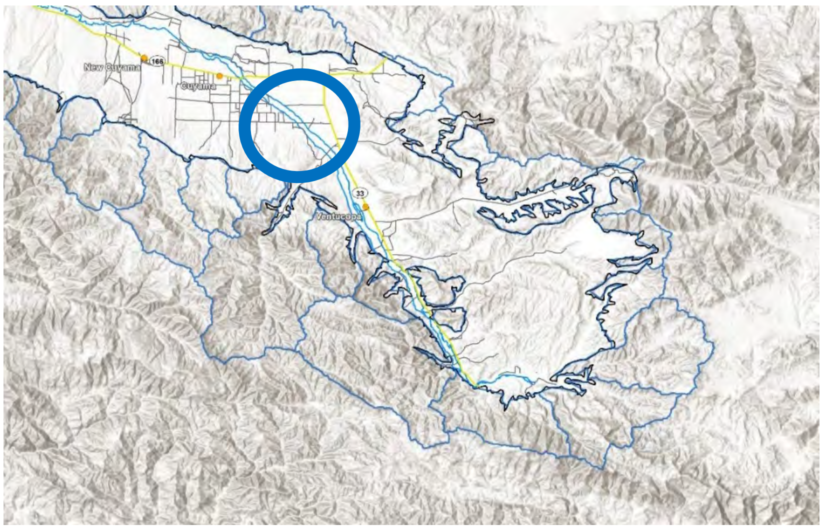

Figure ES-13: General Location of Potential Recharge Basins

The next step toward implementation of this potential project is to evaluate each of these areas of uncertainty and to develop more refined estimates of potential water supply benefit and cost.

This Draft GSP also includes projects specific to the domestic water systems in Ventucopa, Cuyama, and New Cuyama. These projects include installing new wells to secure reliability of water supply to residents of these communities. Implementation of these community well projects would be the responsibility of each of the three communities, as the projects address reliability of available supply for each community.

GSP Implementation

Achieving sustainability in the Basin requires implementation of management actions and, if demonstrated to be feasible, projects that will increase water supply. One management action, which is reductions in groundwater pumping, is required to achieve sustainability irrespective of the feasibility of any other water supply projects. Implementing project and management actions can best be achieved through development of Basin Management Areas to focus necessary activities on the areas of the Basin with projected long-term overdraft.

Two Management Areas have been established in the Basin to aid in administering projects and management actions, as shown in Figure ES-14. The Central and Ventucopa management areas were identified based on the

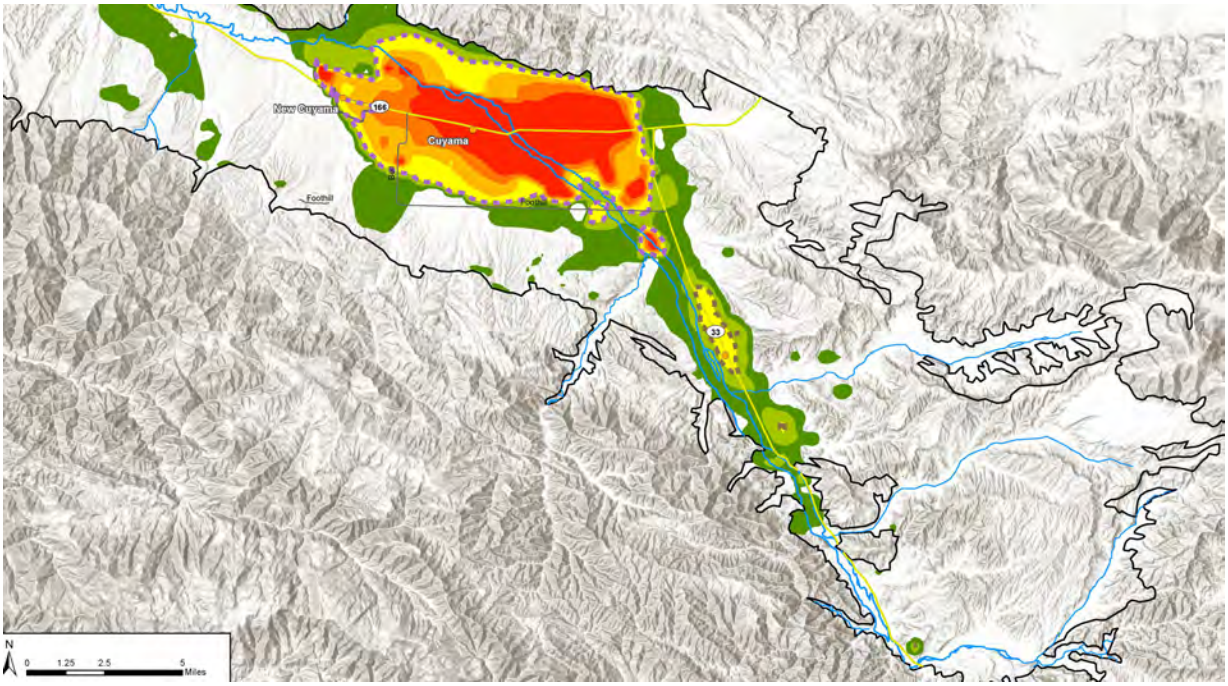

Figure ES-14: Location of Central and Ventucopa Management Areas

model's projection of groundwater levels decreasing at a rate of 2 feet or more per year over over a 50-year hydrologic period.

Figure ES-14 depicts the general boundaries of the proposed Management Areas. The highlighted colors show the projected annual change in groundwater levels, with clear and green indicating no change to less than 2 feet of projected annual decline in groundwater levels, and the yellow, orange and red areas indicating areas of increasing projections of annual declines in groundwater levels, ranging from more than 2 feet per year up to more than 7 feet per year.

Overdraft conditions in the Central Management Area requires reductions in groundwater pumping. The exact amount of required reduction in groundwater pumping will be reevaluated after additional data are collected and analyzed. However, based on current information, total Basin-wide groundwater pumping may have to be reduced by as much as 50 to 67 percent, with the major proportion or reduction required in the Central Management Area.

Both Management Areas will be administered by the CBGSA. However, the CBGSA may elect to delegate administrative responsibility to another party.

Implementing the GSP will require numerous management activities that will be undertaken by the CBGSA, including the following:

- Preparing annual reports summarizing the conditions of the Basin and progress towards sustainability and submitting them to DWR
- Monitoring groundwater conditions for all five sustainability indicators twice each year
- Entering updated groundwater data into the Basin DMS
- Monitoring basin-wide groundwater use using satellite imagery
- Updating the GSP once every five years and submitting to DWR

The CBGSA Board adopted a preliminary schedule for reduction of groundwater pumping in the Central Management Area.

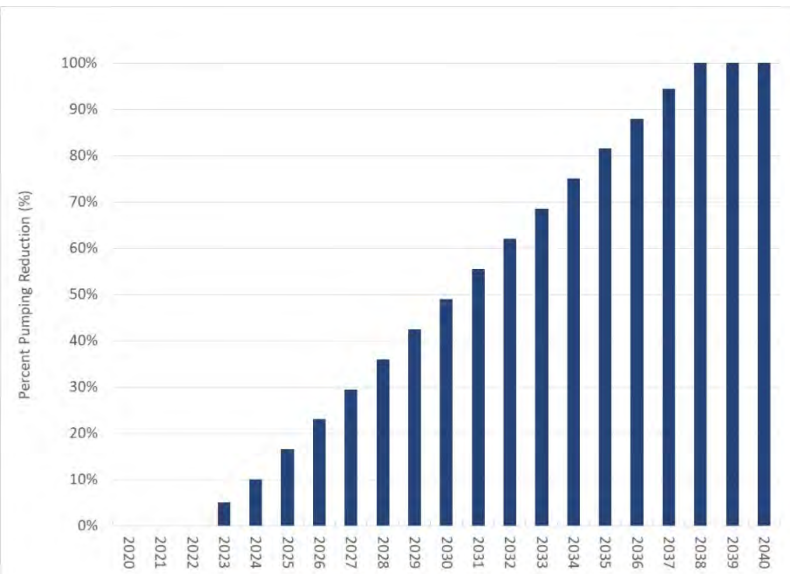

Figure ES-15: Schedule for Proposed Reductions in Groundwater Pumping

For the Central Management Area, pumping reductions are scheduled to begin in 2023 with full implementation by 2038, as shown in Figure ES-15. This approach provides adequate time to put into place methods necessary to monitor groundwater use and reductions. The specific methods for monitoring and reporting will be developed beginning in 2021, with the target of methods being in place by the end of 2022 to allow effective monitoring and pumping reductions to begin in 2023. Monitoring in 2023 will demonstrate achievement of the proposed levels of pumping reduction by the end of that year.

Pumping reductions are not currently recommended for the Ventucopa Area. The recommendation is to perform additional monitoring, incorporate new monitoring wells, and further evaluate groundwater conditions in the area over the next two to five years. Once additional data are obtained and evaluated, the need for any reductions in pumping will be determined.

Evaluation and possible implementation of the two identified projects will also be initiated between 2020 and 2025. Further evaluation of the two projects is necessary to determine technical, economic, and institutional feasibility. A critical aspect of feasibility for the stormwater diversion project will be confirmation of water rights availability. Downstream water right holders will have to be maintained whole for the project to be feasible and will require an in-depth analysis of water flows and availability. As a result, the first step in determining feasibility will be to evaluate the potential for obtaining a right for diversion from the Cuyama River.

The table below presents an overall schedule of GSP activities spanning the next 20 years.

Time Range	2020 to 2024	2025 to 2029	2030 to 2034	2035 to 2040
Phase	Set up and initiate monitoring and pumping allocation programs	Project implementation and GSP evaluation/update	Project implementation and GSP evaluation/update	Achieve Basin sustainability
Tasks	• Establish monitoring network and initiate monitoring and reporting • Evaluate/refine thresholds and monitoring network • Install new wells • Develop pumping monitoring program* • Set up and initiate pumping allocation program* • Project analysis and feasibility • Public outreach	• CBGSA conducts five-year evaluations/update • Monitoring and reporting continues • Evaluate/refine thresholds and monitoring network • Refine water budget • Pumping monitoring program continues* • Continue implementation of pumping allocation program* • Plan/design/construct small- to medium-sized projects* • Public outreach continues	• CBGSA conducts five-year evaluations/update • Monitoring and reporting continues • Evaluate/refine thresholds and monitoring network • Refine water budget • Pumping monitoring program continues* • Continue implementation of pumping allocation program* • Plan/design/construct larger projects* • Public outreach continues	• CBGSA conducts five-year evaluations/update • Monitoring and reporting continues • Evaluate/refine thresholds and monitoring network • Refine water budget • Pumping monitoring program continues* • Pumping allocation program fully implemented* • Project implementation completed* • Public outreach continues
*Represents activities that will take place in CBGSA-designated management areas				

Funding

Implementation of the GSP requires funding. To the degree they become available, outside grants will be sought to help reduce the cost of implementation. However, funds will need to be collected to support implementation, and costs associated with Basin-wide management and GSP implementation will likely be borne by residents and landowners across the Basin. These costs include the following:

- CBGSA administration
- Groundwater level monitoring and reporting
- Groundwater quality monitoring and reporting
- Ground surface subsidence monitoring and reporting
- Water use estimation
- Data management
- Stakeholder engagement
- Annual report preparation and submittal to DWR
- Funding mechanism development and implementation
- Grant applications
- GSP updates and submittal to DWR (every five years)

For budgetary purposes, the estimated initial cost of these activities ranges from $800,000 to $1.3 million per year. The CBGSA Board of Directors will evaluate options for securing needed funding. Options for funding include instituting fees based on groundwater pumping, acreage, or combinations of these, and pursuit of any available grant funds.

Activities associated with the two Management Areas will be borne by the landowners and water users within the two Management Areas.

For the Ventucopa Management Area, costs include monitoring of groundwater level data, evaluating the need for additional or new representative wells, and evaluting the need for pumping allocations. The estimated initial cost of these activities ranges from $40,000 to $80,000 per year.

For the Central Management Area, costs include the following:

- Developing and implementing a system for pumping allocations, tracking, and management
- Developing and implementing a funding mechanism
- Evaluating and implementing water supply projects

The estimated initial cost of these activities range from $200,000 to $500,000 per year, plus costs associated with evaluating and implementing either of the two potential water supply projects. Depending on feasibility, annual costs of the rainfall enhancement project would be on the order of $150,000 per year. The stormwater water capture project cost is estimated to cost from $3 to $4 million per year to amortize project capital costs and to provide funds for annual operations and maintenance.

The CBGSA Board of Directors will evaluate options for securing the needed funding. Similar to the funding options for the CBGSA basin-wide activities, options for funding management area costs include fees based on groundwater pumping, acreage, or combinations of these, and pursuit of any available grant funds.

Funding for new community wells or well improvements is the responsibility of the three Basin communities. There are potential opportunities for securing grant funds, depending on timing and State and federal grant funding availability.

1. AGENCY INFORMATION, PLAN AREA, AND COMMUNICATION

1.1 Introduction and Agency Information

This section describes the Cuyama Basin Groundwater Sustainability Agency (CBGSA), its authority in relation to the Sustainable Groundwater Management Act (SGMA), and the purpose of this Groundwater Sustainability Plan (GSP).

This GSP meets regulatory requirements established by the California Department of Water Resources (DWR) as shown in the completed *Preparation Checklist for GSP Submittal* (Appendix A). The CBGSA's Notification of Intent to Develop a Groundwater Sustainable Plan is in Appendix B.

On June 6, 2016, Santa Barbara County Water Agency (SBCWA) sent DWR a notice of intent to form a Groundwater Sustainability Agency (GSA). Following this submittal, the CBGSA Board of Directors was organized, and now includes the following individuals:

- Derek Yurosek – Chairperson, Cuyama Basin Water District (CBWD)
- Lynn Compton – Vice Chairperson, County of San Luis Obispo
- Byron Albano – CBWD
- Cory Bantilan – SBCWA
- Tom Bracken – CBWD
- George Cappello – CBWD
- Paul Chounet – Cuyama Community Services District (CCSD)
- Zack Scrivner – County of Kern
- Glenn Shephard – County of Ventura
- Das Williams – SBCWA
- Jane Wooster – CBWD

In addition, the following individuals serve as alternatives to regular CBGSA Board members:

- Darcel Elliott – SBCWA
- Steve Lavagnino – SBCWA
- Louise Draucker – CCSD
- Brad DeBranch – CBWD
- Matt Klinchuch – CBWD
- Arne Anselm – County of Ventura
- Debbie Arnold – County of San Luis Obispo
- Alan Christensen – County of Kern

During development of this GSP, board meetings were held on the first Wednesday of every month at 4 pm in the Cuyama Family Resource Center, at 4689 California State Route 166, in New Cuyama, California.

The CBGSA's established boundary corresponds to DWR's *California's Groundwater Bulletin 118 – Update 2003* (Bulletin 118) groundwater basin boundary for the Cuyama Valley Groundwater Basin (Basin) (DWR, 2003). No additional areas were incorporated.

1.1.1 Contact Information

Contact information for the CBGSA is shown below.

- Cuyama Basin General Manager/CBGSA Director: Jim Beck
- Phone Number: (661) 447-3385
- Email: tblakslee@hgcpm.com
- Physical and Mailing Address: 4900 California Avenue, Tower B, 2nd Floor, Bakersfield, CA. 93309
- Website: http://cuyamabasin.org/index.html

1.1.2 Management Structure

The CBGSA is governed by an 11-member Board of Directors that meets monthly. The General Manager manages day-to-day operations of the CBWD, while Board Members vote on actions of the CBGSA; the Board is the CBGSA's decision-making body.

During GSP development, a Standing Advisory Committee (SAC) was formed to act in an advisory capacity to the CBGSA Board of Directors. The SAC includes the following individuals:

- Roberta Jaffe – Chairperson
- Brenton Kelly – Vice Chairperson
- Brad DeBranch
- Louise Draucker
- Jake Furstenfeld
- Joe Haslett
- Mike Post
- Hilda Leticia Valenzuela

The ninth position on the SAC, which would be filled by a person representing the Hispanic community, is currently vacant. The CBGSA is currently in the process of identifying a person to fill this position.

1.1.3 Legal Authority

Per Section 10723.8(a) of the California Water Code, SBCWA gave notice to DWR on behalf of the CBGSA of its decision to form a GSA, which is Basin 3-013, per DWR's Bulletin 118 (Appendix C).

1.2 Plan Area

This section describes the Basin, including major streams and creeks, institutional entities, agricultural and urban land uses locations of groundwater production wells, locations of state lands and geographic boundaries of surface water runoff areas. This section also describes existing surface water and groundwater monitoring programs, existing water management programs, and general plans in the Basin. The information contained in this section reflects information from publicly available sources, and may not reflect all information that will be used for GSP technical analysis.

This section of the GSP satisfies Section 354.8 of the SGMA regulations.

1.2.1 Plan Area Definition

The Basin is in California's Central Coast Hydrologic Region. It is beneath the Cuyama Valley, which is bounded by the Caliente Range to the northwest and the Sierra Madre Mountains to the southeast. The Basin was initially defined in Bulletin 118. The boundaries of the Cuyama Basin were delineated by DWR because they were the boundary between permeable sedimentary materials and impermeable bedrock. DWR defines this boundary as "impermeable bedrock with lower water yielding capacity. These include consolidated rocks of continental and marine origin and crystalline/or metamorphic rock."

1.2.2 Plan Area Setting

Figure 1-1 shows the Basin and its key geographic features. The Basin encompasses an area of about 378 square miles and includes the communities of New Cuyama and Cuyama, which are located along State Route (SR) 166 and Ventucopa, which is located along SR 33. The Basin encompasses an approximately 55-mile stretch of the Cuyama River, which runs through the Basin for much of its extent before leaving the Basin to the northwest and flowing towards the Pacific Ocean. The Basin also encompasses stretches of Wells Creek in its north-central area, Santa Barbara Creek in the south-central area, the Quatal Canyon drainage and Cuyama Creek in the southern area of the Basin. Most of the agriculture in the Basin occurs in the central portion east of New Cuyama, and along the Cuyama River near SR 33 through Ventucopa.

Figure 1-2 shows the CBGSA boundary. The CBGSA boundary covers all of Cuyama Basin. The CBGSA was created by a Joint Exercise of Powers Agreement among the following agencies:

- Counties of Kern, San Luis Obispo, and Ventura
- SBCWA, representing the County of Santa Barbara
- CBWD
- CCSD

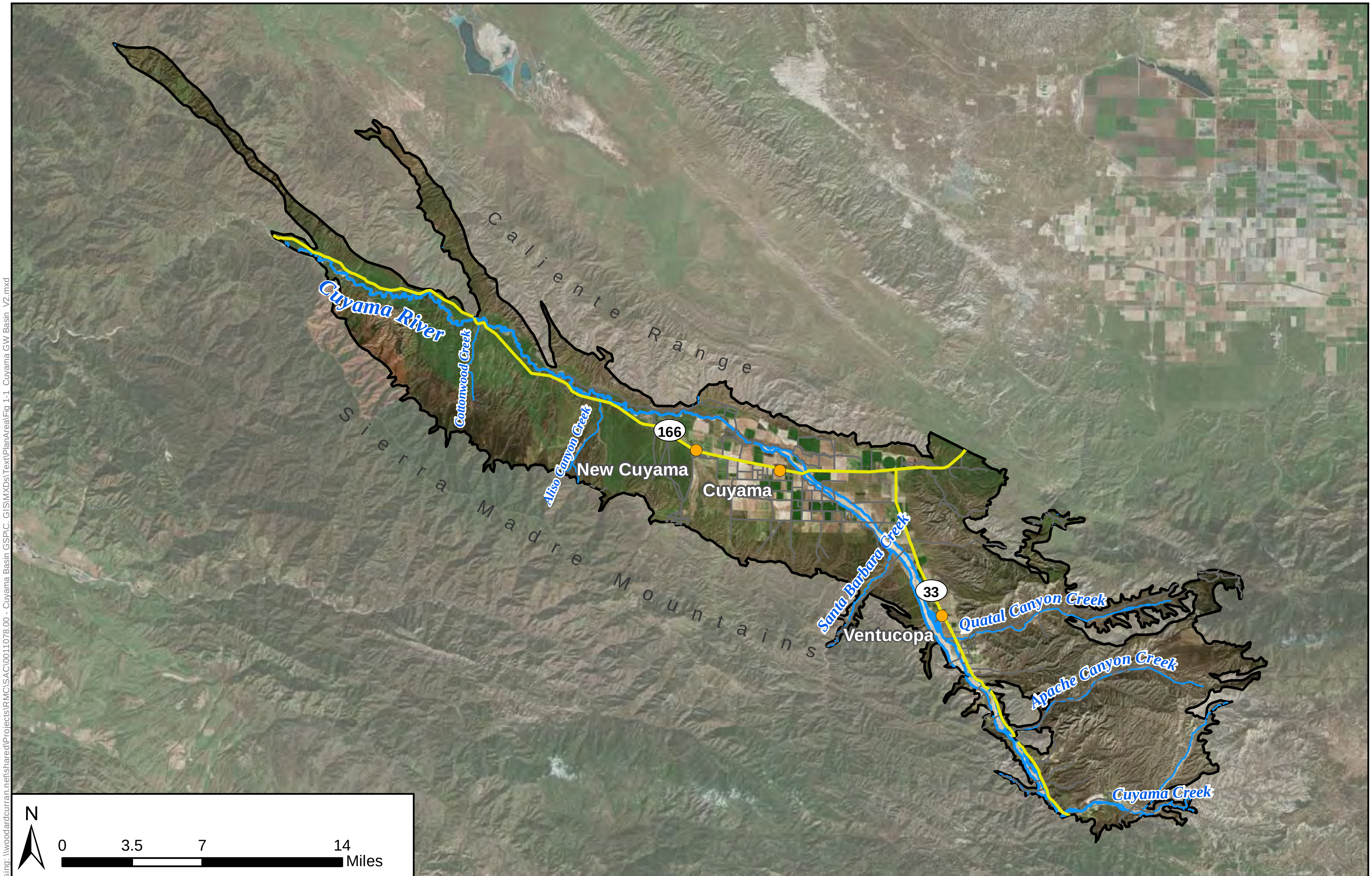

Figure 1-1 - Cuyama Valley Groundwater Basin

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

December 2019

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Legend

- Towns
- Cuyama Basin
- Highways
- Local Roads
- Cuyama River
- Streams/Creeks

Figure Exported: 7/9/2018 By: mwicks Using: \\woodardcurran.net\shared\Projects\RMC\SAC\0011078.00 - Cuyama Basin GSP\C. GIS\MXDs\TextPlanArea\Fig 1-1 Cuyama GW Basin V2.mxd

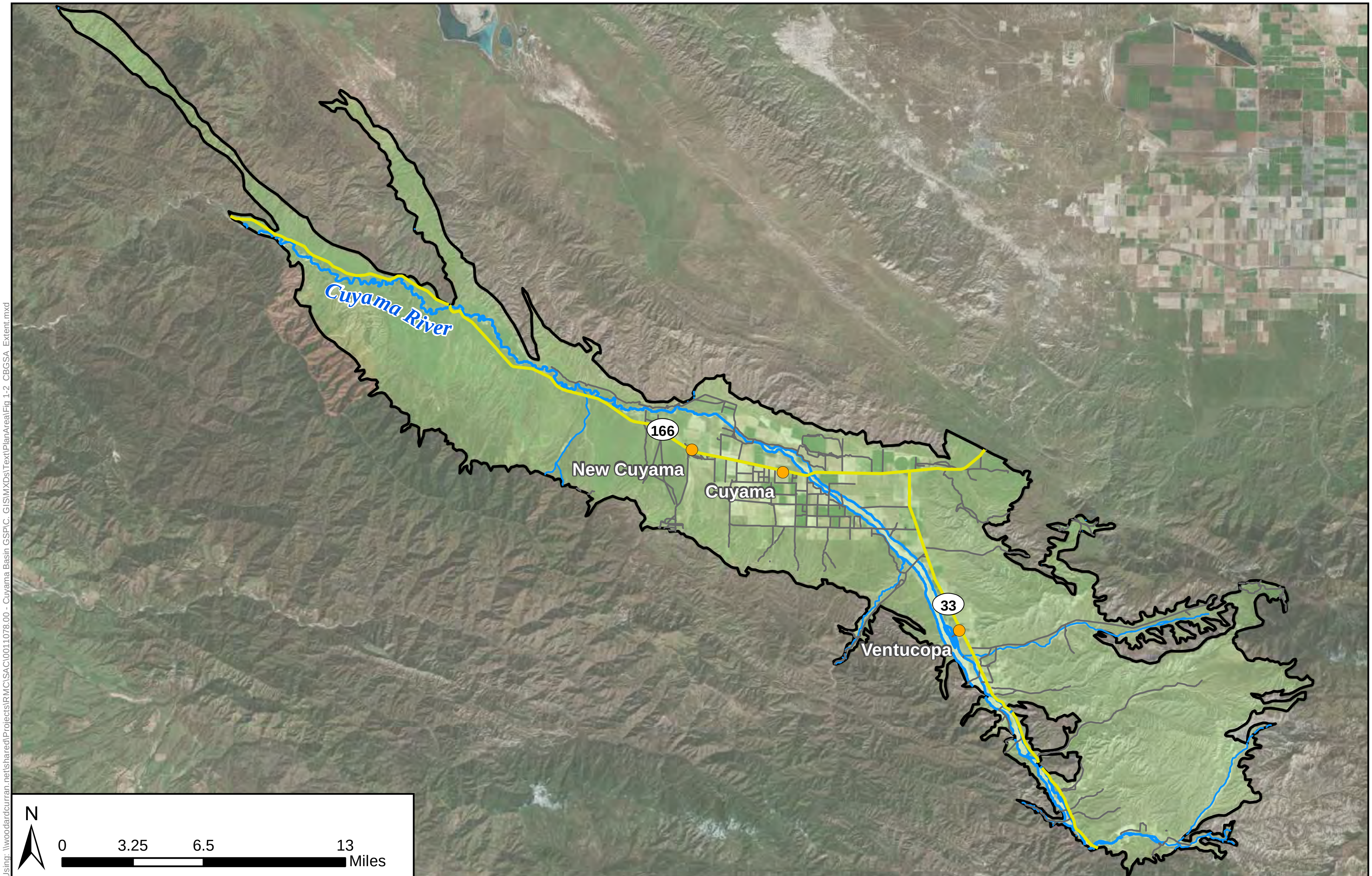

Figure 1-2 - Cuyama Valley Groundwater Sustainability Agency Boundary

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

December 2019

WOODARD & CURRAN

Legend

- Towns
- Cuyama Basin GSA
- Highways
- Local Roads
- Cuyama River
- Streams/Creeks

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Figure 1-3 shows the Basin and neighboring groundwater basins. The Carrizo Plain Basin is located immediately northeast of the Cuyama Basin and they share a boundary at a location about 5 miles east of the intersection of SR 166 and SR 133. The San Joaquin Valley Basin is located just east of the Carrizo Plain Basin. The Basin also shares a boundary with the Mil Potrero Area Basin, which is located just east of one of the Basin's southeastern tips, and the Lockwood Valley Basin is located close to the Basin's southern area but does not share a boundary with it. To the southwest, and more distant from the Basin, are the Santa Maria, San Antonio Creek Valley and Santa Ynez River Valley basins, which are located about 30 to 40 miles southwest of the Cuyama Basin.

Figure 1-4 depicts the Basin's extent relative to the boundaries of the various counties that overlie the Basin. Santa Barbara County has jurisdiction over the largest portion of the Basin (168 square miles), covering most of the area south of the Cuyama River, as well as Ventucopa and a small area to the north of that community. San Luis Obispo County has jurisdiction over areas north of the Cuyama River (covering 77 square miles). The Cuyama River marks the boundary between San Luis Obispo County and Santa Barbara County. Kern County has jurisdiction over the smallest extent of Cuyama Basin area compared to the other counties (13 square miles). Its jurisdictional coverage is located just east of the SR 166 and SR 33 intersection, as well as tips of the Basin in the Quatal Canyon area. Ventura County has jurisdiction over the southeastern area of the Basin (covering 120 square miles), including the area east of Ventucopa.

Figure 1-5 shows the non-county jurisdictional boundaries in the Basin. The CBWD was formed in 2016 and covers a large area of the Basin (about 130 square miles), from a location about 5 miles west of Wells Creek to 2 miles east of the intersection of SR 166 and SR 33, and south of Ventucopa along SR 33. The CCSD was formed in 1977 and covers a small area of the Basin (about 0.5 square miles) located along SR 166 in the community of New Cuyama.

Figures 1-6 through 1-13 show the agricultural and urban land uses in the Cuyama Basin for the years 1996, 2000, 2003, 2006, 2009, 2012, 2014 and 2016, respectively. The 1996 land use data are from historical DWR county land use surveys[1] while the 2014 and 2016 land use data were developed for DWR using remote sensing data.[2] Data for the remaining years were developed by the CBGSA using the same remote sensing method that DWR used for 2014 and 2016. Agricultural land is located primarily in the New Cuyama and Ventucopa areas, and along the SR 166 and SR 33 corridors between those communities. There is a regular rotation of crops with between 9,000 and 15,000 acres of agricultural area left idle each year between 2000 and 2016 (the 1996 dataset does not include records of idle land). Areas that are in active agricultural use primarily produce miscellaneous truck crops, carrots, potatoes and sweet potatoes, miscellaneous grains and hay, and grapes. Various other crop types are produced in the Basin as well, such as fruit and nut trees, though at smaller production scales.

[1] https://www.water.ca.gov/Programs/Water-Use-And-Efficiency/Land-And-Water-Use/Land-Use-Surveys

[2] https://gis.water.ca.gov/app/CADWRLandUseViewer/

In addition to the crop types shown on the maps, much of the land area in the Basin, particularly in the western and eastern areas, consists of non-irrigated pasture. These are not present on the map because they are not detected by the remote sensing approach. Some recently planted crops are also not shown on the maps because they were either not detected by the remote sensing approach or were planted subsequent to the most recently mapped year of 2016. These include a new vineyard along SR 166 in the western part of the Basin (which the remote sensing approach identifies as "idle" in 2016) and new olive orchards along SR 33. These additional land uses will be accounted for in the numerical modeling used to develop water budgets for the GSP.

Figure 1-14 shows 2016 land use by water source in the Basin. Almost all of the water use in the Basin is served by groundwater. There are 37 surface water rights permits in the Basin that allow up to 116 acre-feet (AF) per year. Much of the surface water use is for stockwatering of pasture land, which may not be included in the land use dataset shown in the figure.

Figure 1-15 shows the number of domestic wells per square mile and the average depth of domestic wells in each square mile in the Basin. Figure 1-15 shows a grid pattern where each block on the grid is a section that covers 1 square mile of land. The number in each square represents the average depth of the well(s) in the section. Most of the sections in the Basin that have domestic wells contain only one well, while twelve sections contain two wells each, three sections contain three wells each, four sections contain four wells each, and one section contains six wells. Wells range in depth broadly across the Basin, from as shallow as 120 feet below ground surface in the southeast portion of the Basin to 1,000 feet below ground surface in the central portion of the Basin.

Figure 1-16 shows the density and average depth of production wells in the Basin per square mile. There is a wide distribution of production well density in the Basin (between 1 and 11 wells per square mile). Depths of production wells range from 50 feet below ground surface (bgs) on the outer edges of the Basin, to over 1,200 feet bgs in the central portion of the Basin.

Figure 1-17 shows the density and average depth of public wells in the Cuyama Basin. The Basin contains three public wells, one just south of New Cuyama, one east of Ventucopa and one at the southern tip of the Basin. These wells have depths of 855, 280 and 800 feet, respectively.

Information presented in Figures 1-15 through 1-17 reflect information contained in DWR's well completion report database, which contains information about the majority of wells drilled after 1947. However, some wells may not have been reported to DWR (potentially up to 30 percent of the total), and therefore are not included in the database or in these figures. Furthermore, designations of each well as a domestic, production, or public well were developed by DWR based on information contained in the well completion reports and have not been modified for this document.

Figure 1-18 shows the public lands in and around the Basin. Some portions of the land that overlies the Cuyama Basin, and most of the areas immediately surrounding the Basin, have a federal or State jurisdictional designation. The Los Padres National Forest covers most of the Basin's northwestern arm, then runs just outside the Basin's western boundary until the Forest boundary turns east at about Ventucopa where it covers the southern part of the Basin. The balance of the northwestern arm consists of private holdings and the state-owned Carrizo Plains Ecological Reserve which extends into the Basin to the Santa Barbara County-San Luis Obispo County line at the Cuyama River. A portion of the Basin north of Ventucopa, as well as an area nearby that is immediately outside the Basin, is designated as the Bitter Creek National Wildlife Refuge. The Bureau of Land Management has jurisdiction over a large area outside the Basin, and along the Basin's northern boundary, including small parts of the Basin north of the Cuyama River. Most of the northeastern arm of the Basin is designated as State Lands.

Figure 1-19 shows that the Basin is located within the Cuyama Watershed, which lies within the larger Santa Maria watershed, with the Basin occupying roughly the entirety of the Santa Maria Basin's eastern contributing watershed, and a small part of the Cuyama Basin's northeastern arm that flows into the Estrella River Basin due to the topography present in this area. Figure 1-19 illustrates the Cuyama Watershed's location in the Santa Maria Basin, as well as the larger Basin's major receiving water bodies, which include the Santa Maria River, the Cuyama River, Aliso Canyon Creek, Cottonwood Creek, Apache Canyon Creek, Santa Barbara Creek, the Quatal Canyon drainage, and Cuyama Creek.

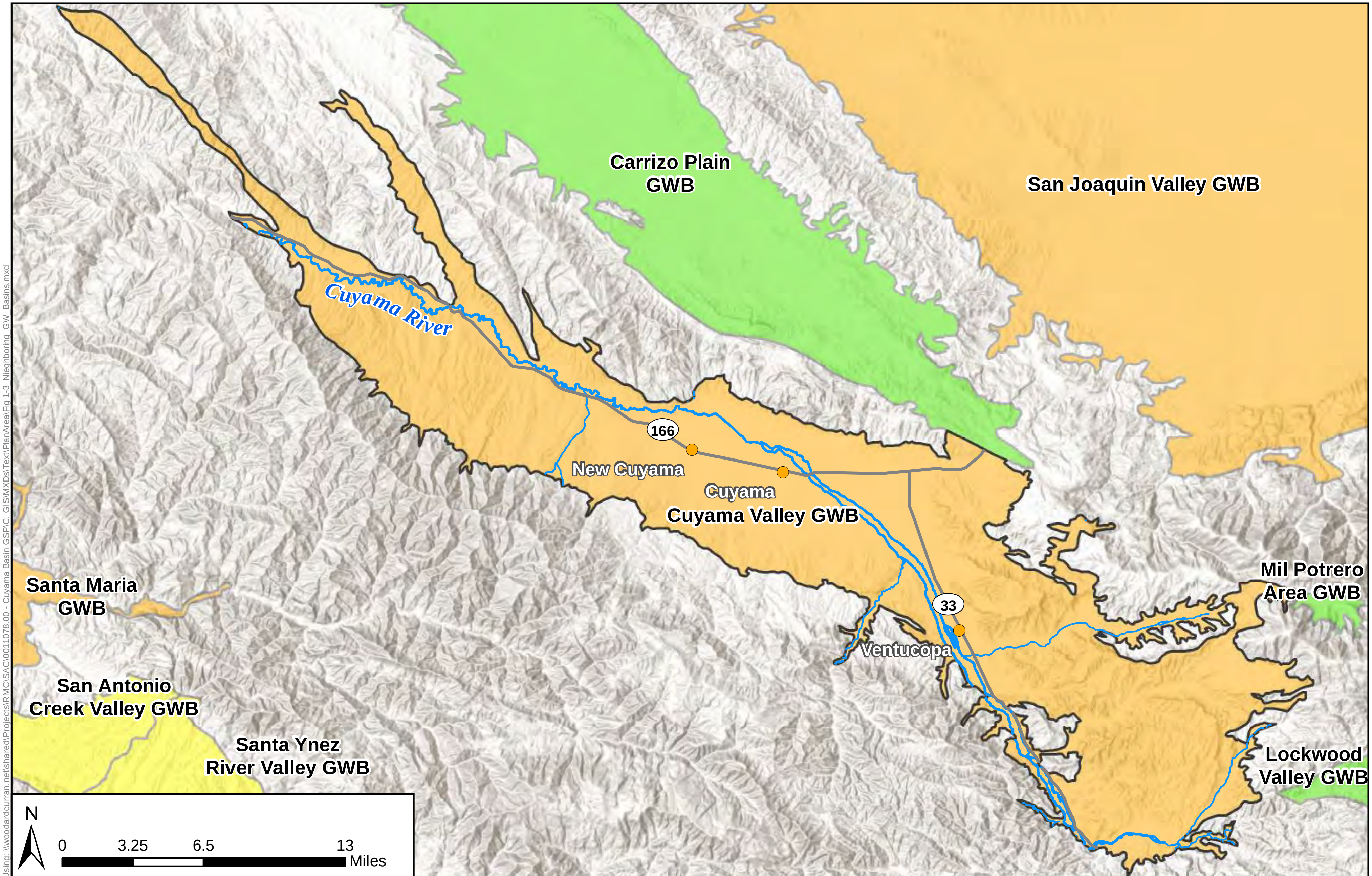

Figure 1-3 - Neighboring Groundwater Basins

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

December 2019

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Legend

- Towns
- Cuyama Basin
- Highways
- Cuyama River
- Streams/Creeks

Basin Priority

- High Priority
- Medium Priority
- Low Priority
- Very Low Priority

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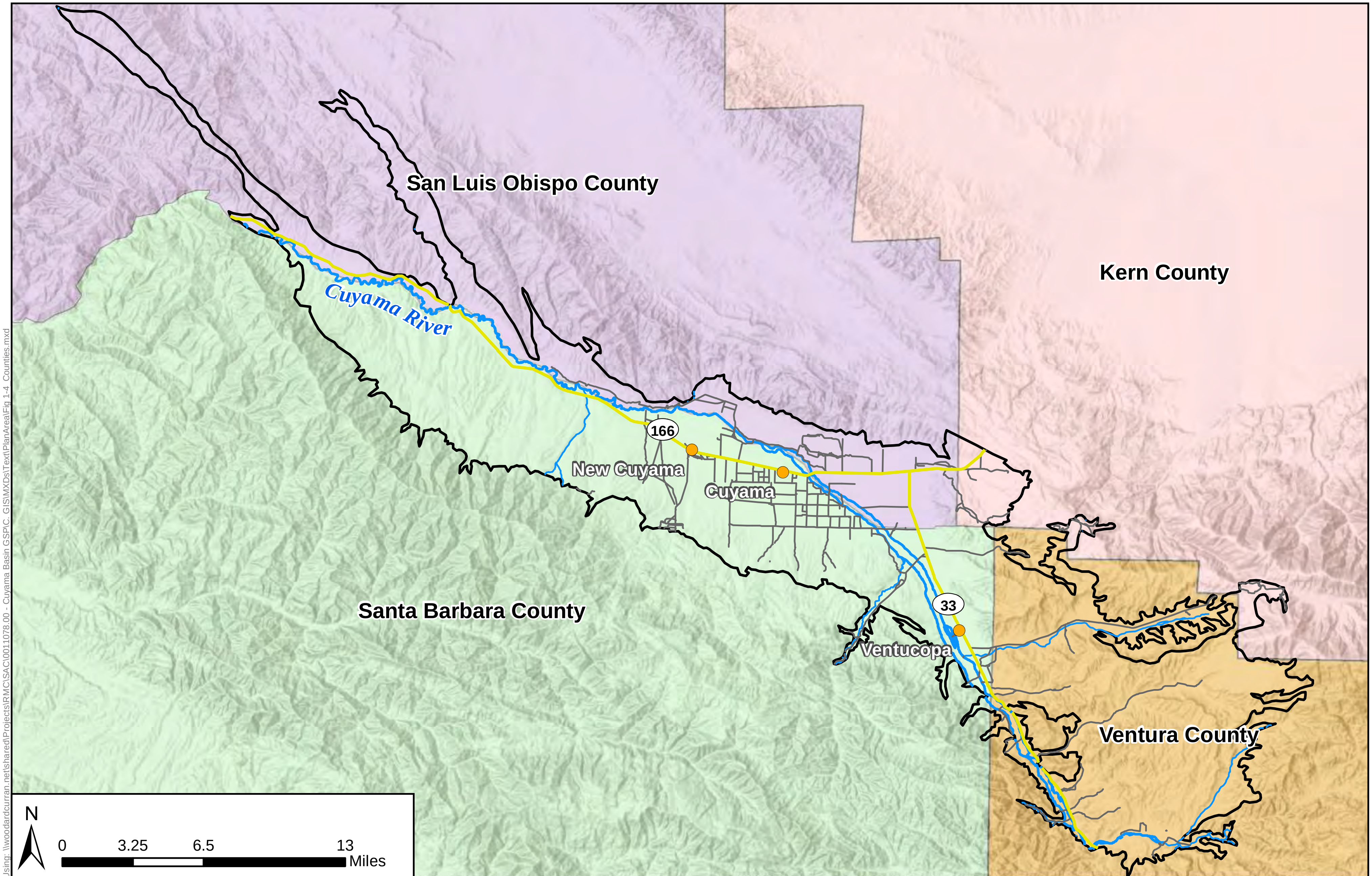

Figure 1-4 - Counties Overlying Cuyama Basin

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

December 2019

Legend

- Towns
- Cuyama Basin
- Highways
- Local Roads
- Cuyama River
- Streams/Creeks

County

- Kern County
- San Luis Obispo County
- Santa Barbara County
- Ventura County

Figure Exported: 6/19/2018 By: mwicks Using: \\woodardcurran.net\shared\Projects\RMC\SAC\0011078.00 - Cuyama Basin GSP\C GIS\MXDs\Text\PlanArea\Fig 1-4 Counties.mxd

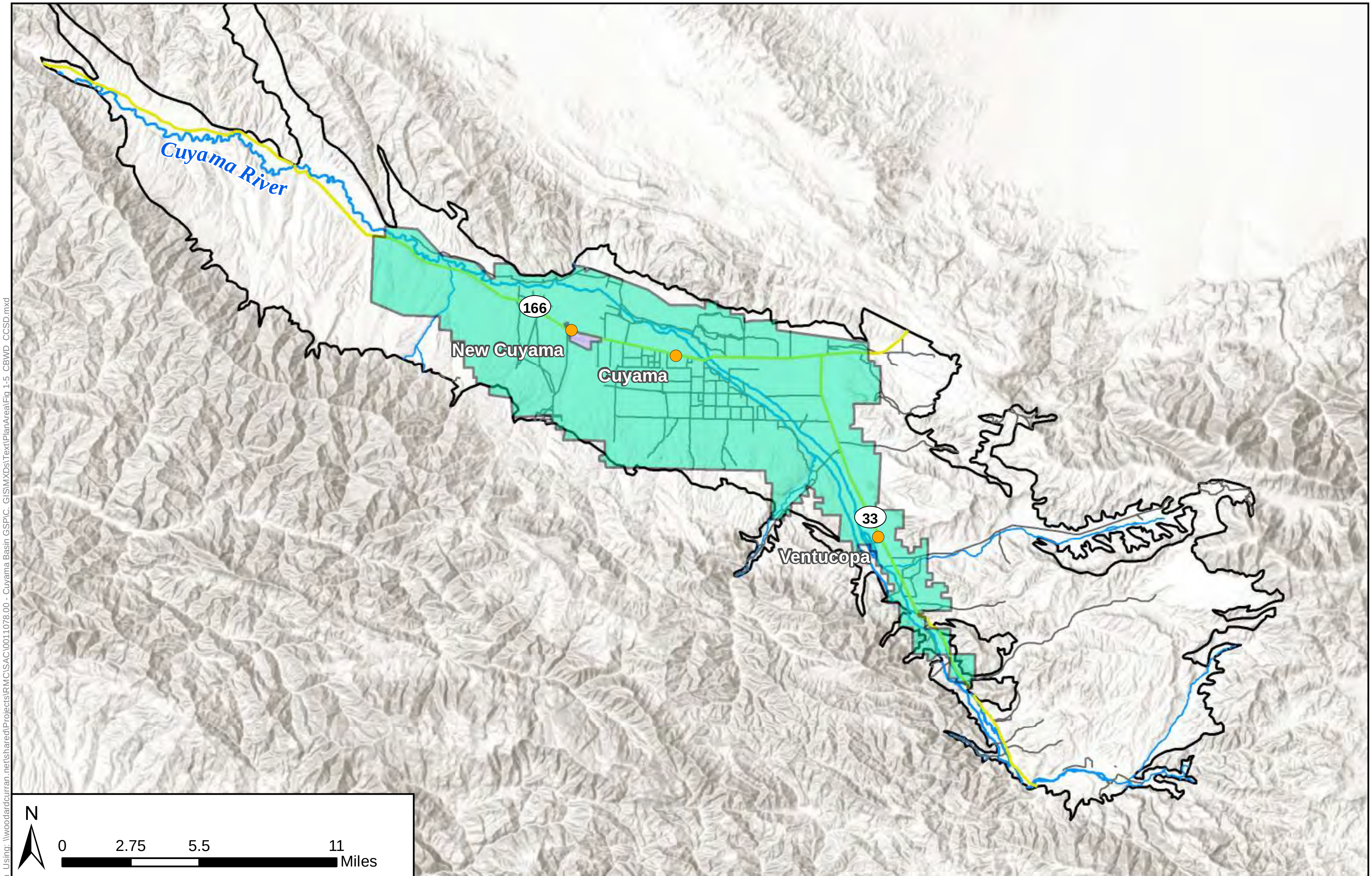

Figure 1-5 - Non-County Jurisdictional Boundaries

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

December 2019

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Legend

- Cuyama Basin
- Towns
- Cuyama Community Service District
- Cuyama Basin Water District
- Highways
- Local Roads
- Cuyama River
- Streams/Creeks

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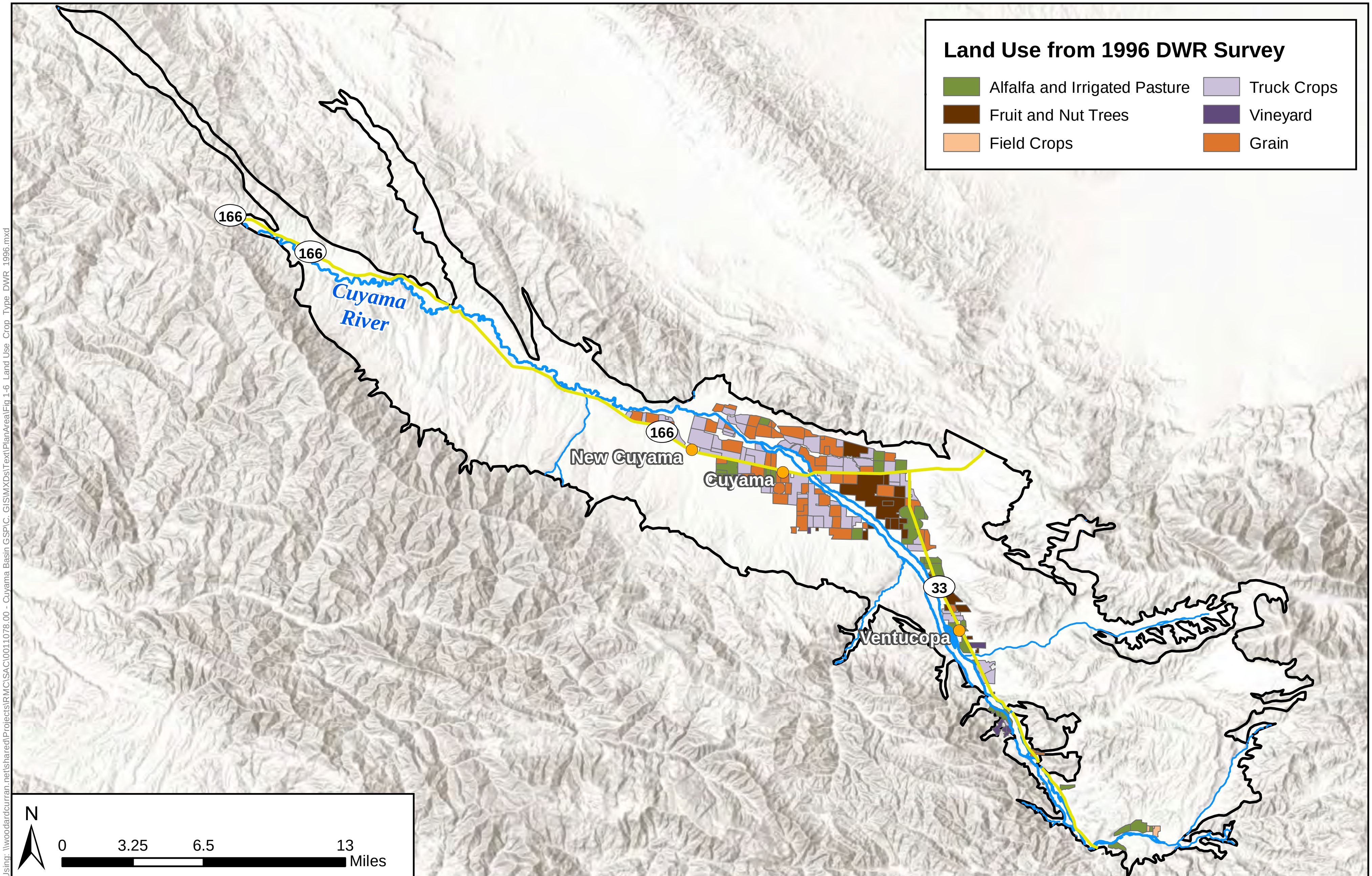

Figure 1-6 - 1996 Land Use

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

December 2019

Legend

- Cuyama Basin
- Towns
- Highways
- Cuyama River
- Streams/Creeks

Source: California Department of Water Resources County Land Use Surveys, 1996 dataset.
https://www.water.ca.gov/Programs/Water-Use-And-Efficiency/Land-And-Water-Use/Land-Use-Surveys

Figure Exported: 6/19/2018 By: mwicks Using: \\woodardcurran.net\shared\Projects\RMC\SAC\0011078.00 - Cuyama Basin GSP\C_GIS\MXDs\Text\PlanArea\Fig 1-6 Land Use Crop Type DWR 1996.mxd

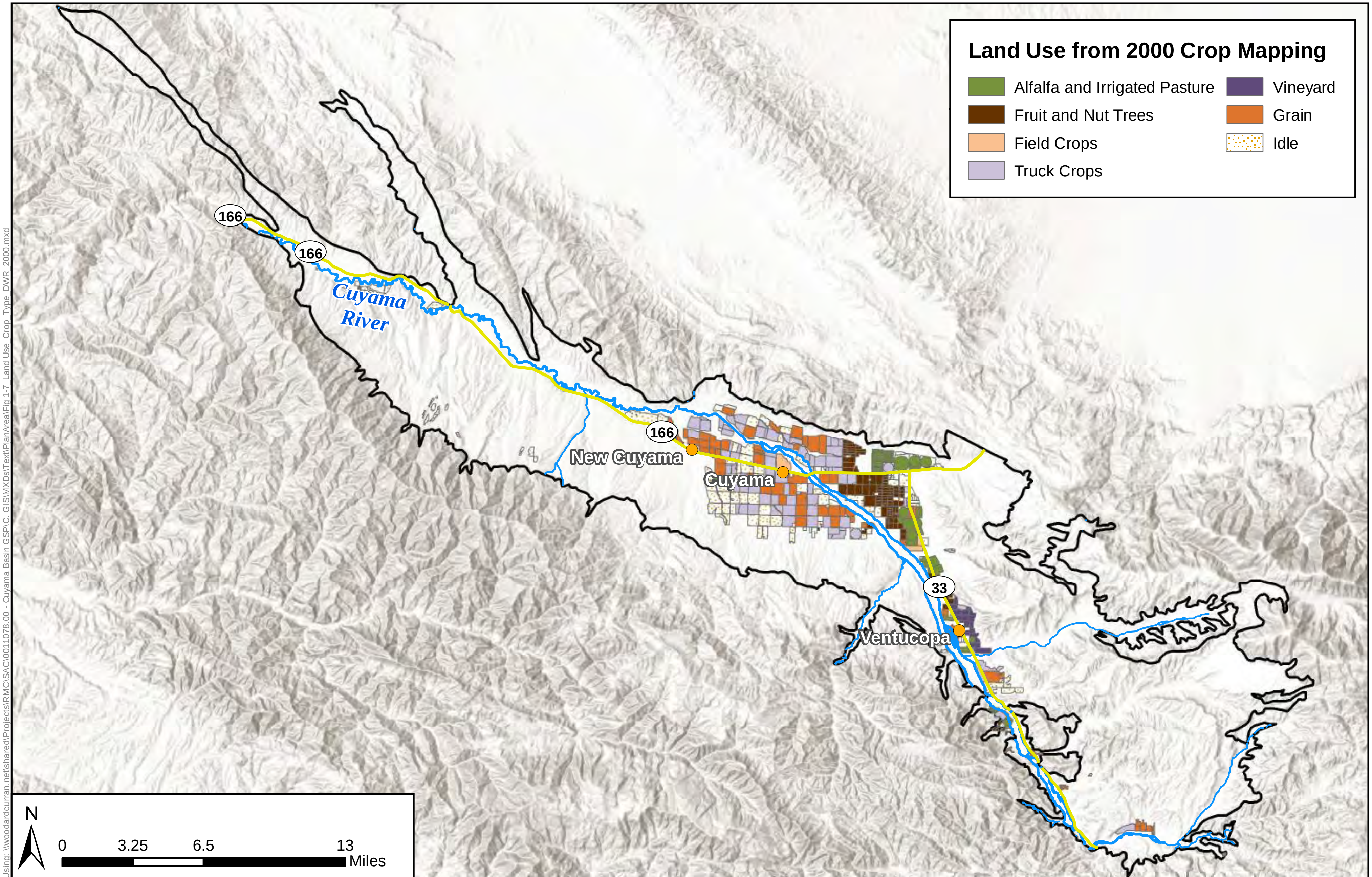

Figure 1-7 - 2000 Land Use

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

December 2019

Legend

Cuyama Basin
Towns
Highways
Cuyama River
Streams/Creeks

Source: Crop Mapping developed by LandIQ for the Cuyama Basin GSA, 2000 dataset

Figure Exported: 6/19/2018 By: mwicks Using: \\woodardcurran.net\shared\Projects\RMC\SAC\0011078.00 - Cuyama Basin GSP\C. GIS\MXDs\Text\PlanArea\Fig 1-7_Land Use_Crop_Type_DWR_2000.mxd

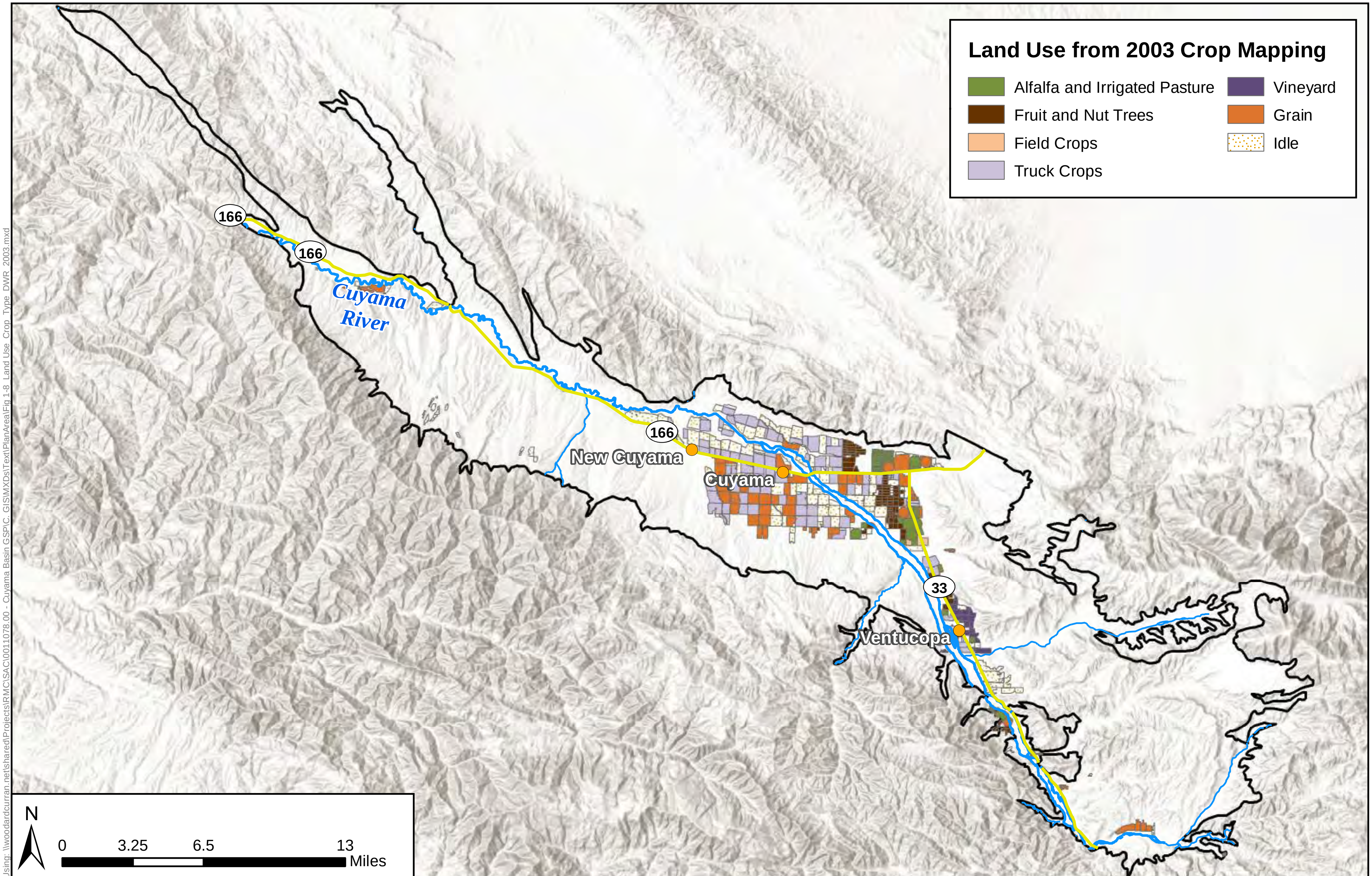

Figure 1-8 - 2003 Land Use

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

December 2019

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Legend

Cuyama Basin
Towns
Highways
Cuyama River
Streams/Creeks

Source: Crop Mapping developed by LandIQ for the Cuyama Basin GSA, 2003 dataset.

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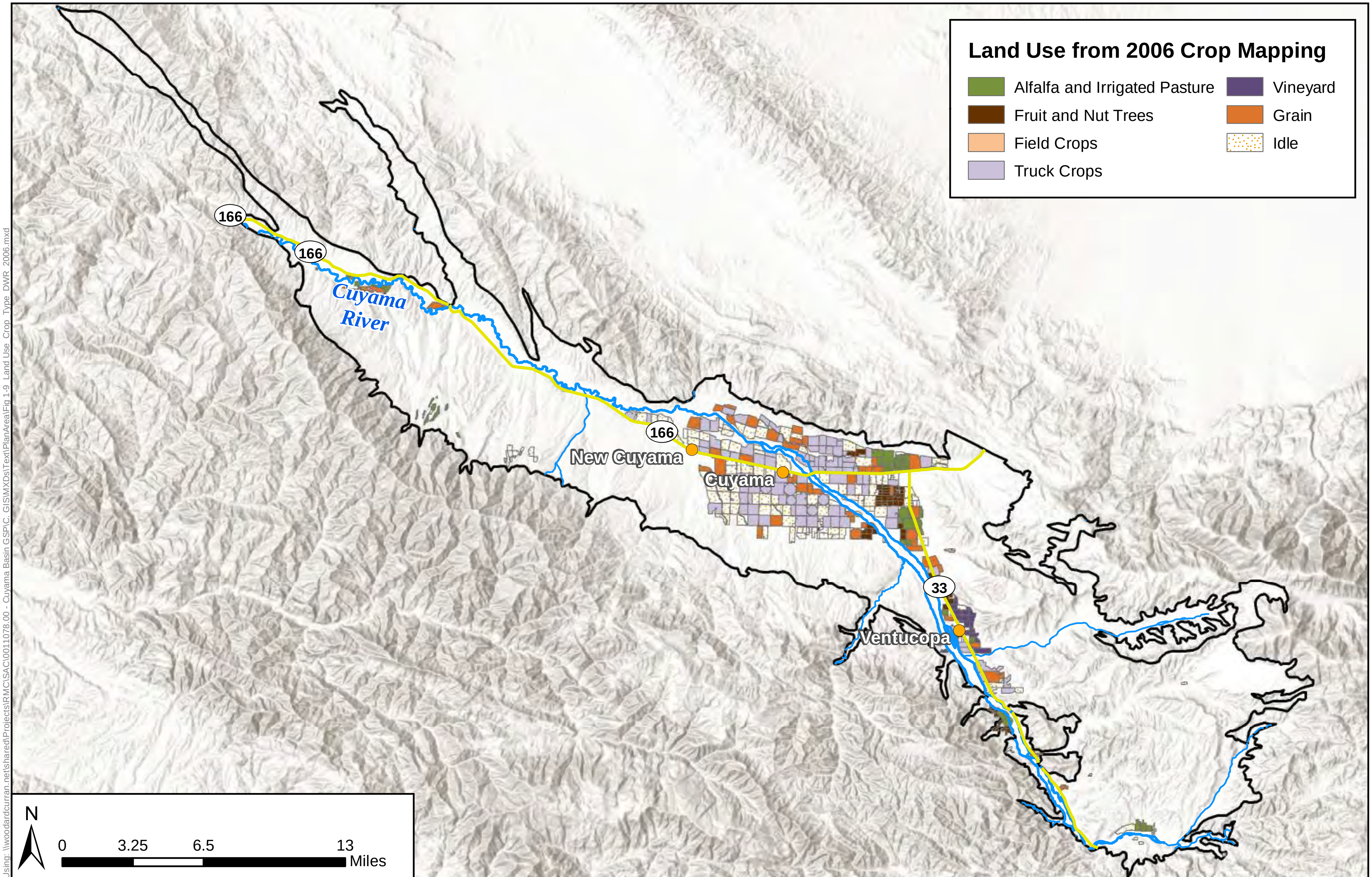

Figure 1-9 - 2006 Land Use

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

December 2019

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Legend

- Cuyama Basin
- Towns
- Highways
- Cuyama River
- Streams/Creeks

Source: Crop Mapping developed by LandIQ for the Cuyama Basin GSA, 2006 dataset.

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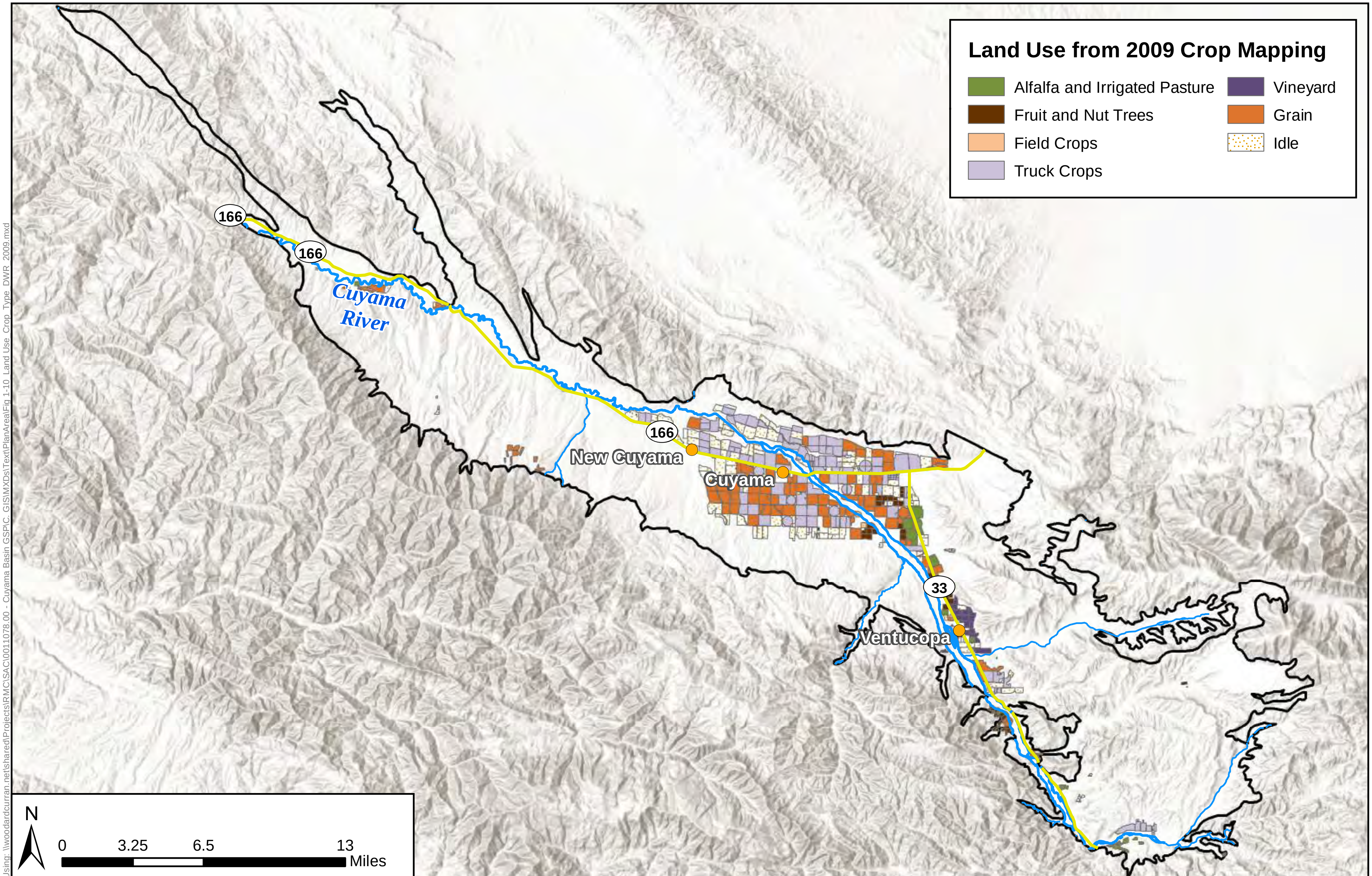

Figure 1-10 - 2009 Land Use

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

December 2019

Legend

Cuyama Basin
Towns
Highways
Cuyama River
Streams/Creeks

Source: Crop Mapping developed by LandIQ for the Cuyama Basin GSA, 2009 dataset.

Figure Exported: 6/19/2018 By: mwicks Using: \\woodardcurran.net\shared\Projects\RMC\SAC\0011078.00 - Cuyama Basin GSP\C_GIS\MXDs\Text\PlanArea\Fig 1-10_Land_Use_Crop_Type_DWR_2009.mxd

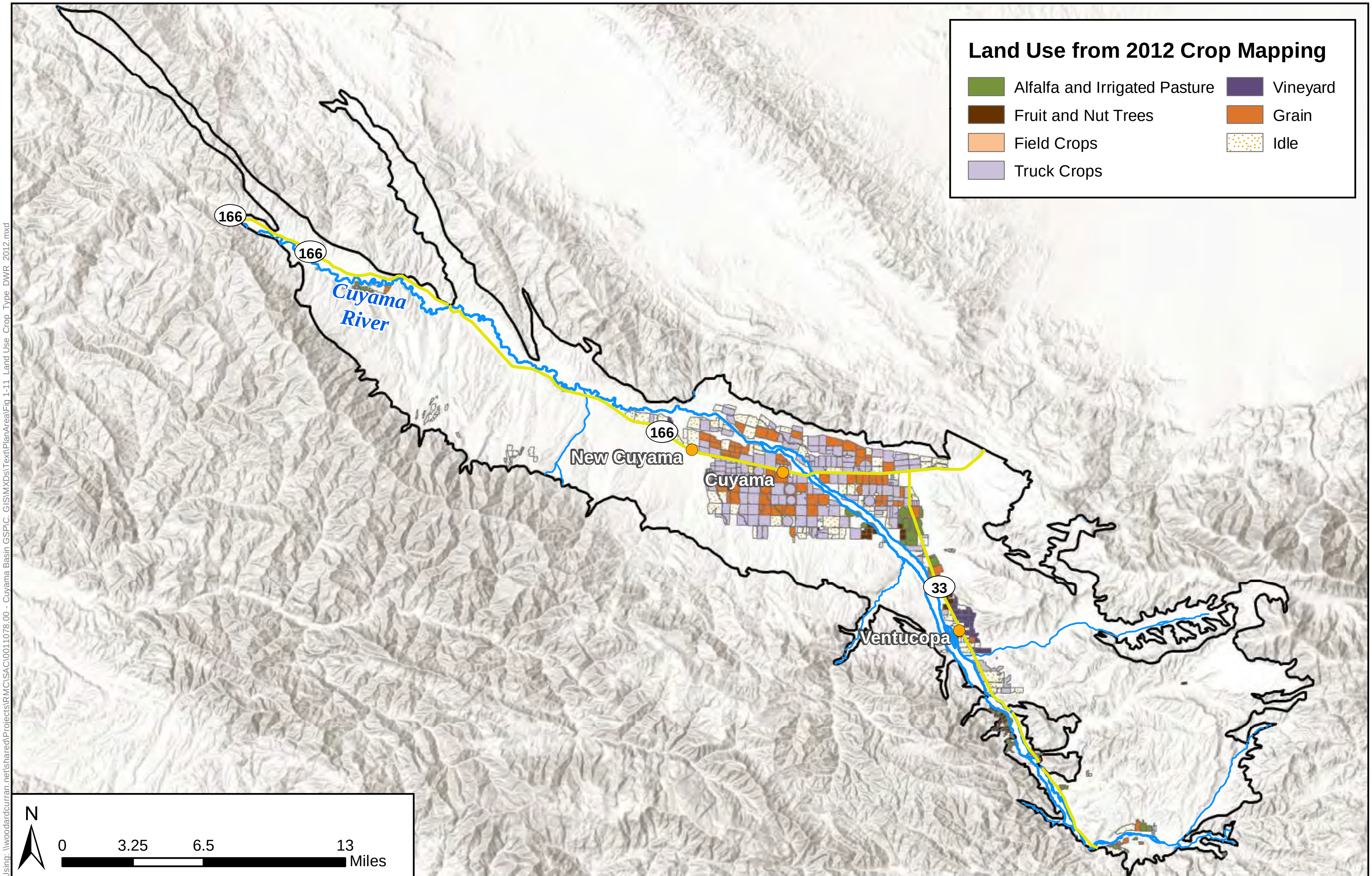

Figure 1-11 - 2012 Land Use

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

December 2019

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Source: Crop Mapping developed by LandIQ for the Cuyama Basin GSA, 2012 dataset.

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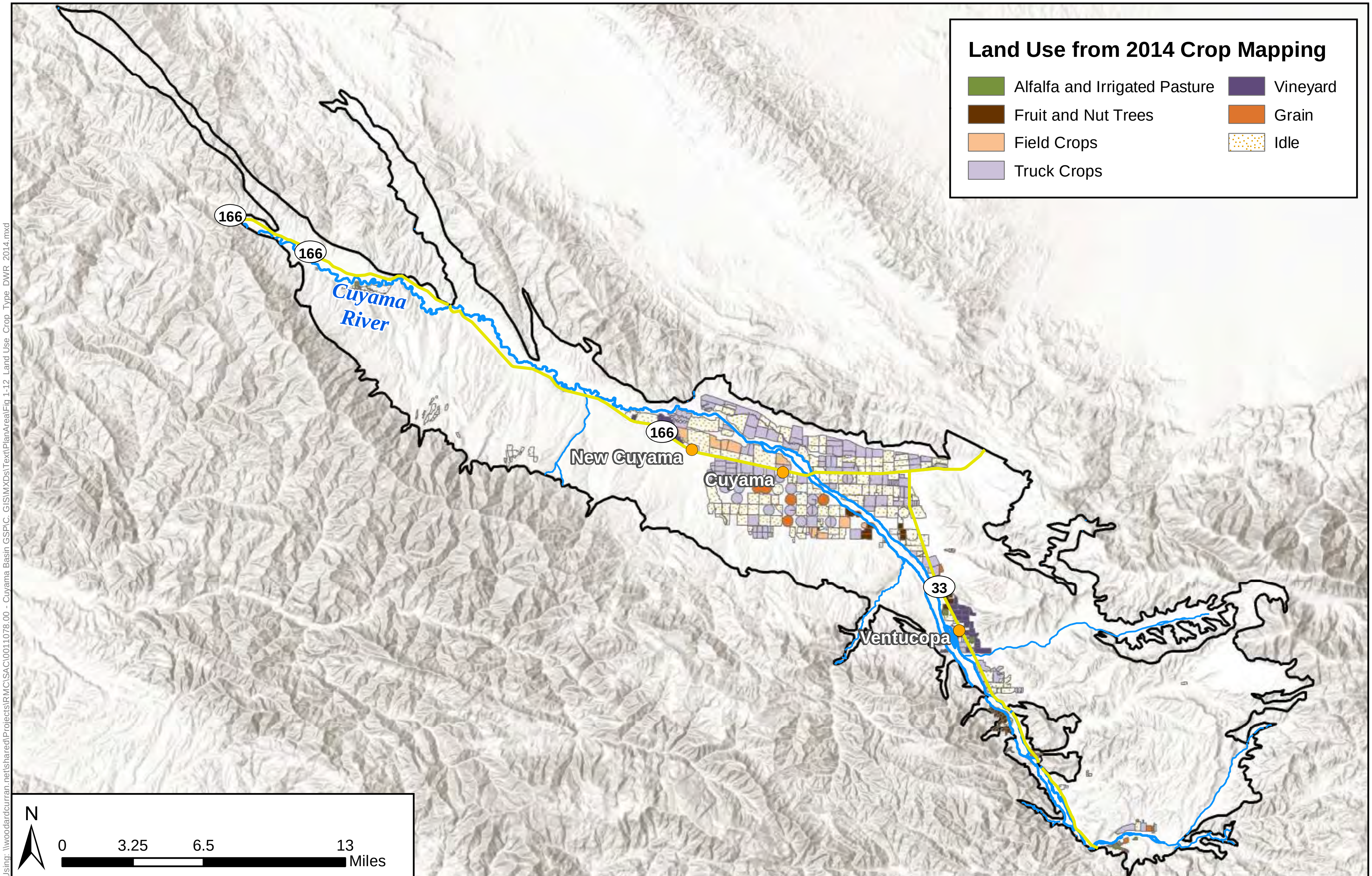

Figure 1-12 - 2014 Land Use

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

December 2019

Legend

Cuyama Basin
Towns
Highways
Cuyama River
Streams/Creeks

Source: California Department of Water Resources County Land Use Surveys, 2014 dataset.
https://gis.water.ca.gov/app/CADWRLandUseViewer/

Figure Exported: 6/19/2018 By: mwicks Using: \\woodardcurran.net\shared\Projects\RMC\SAC\0011078.00 - Cuyama Basin GSP\C. GIS\MXDs\Text\PlanArea\Fig 1-12 Land Use Crop Type DWR 2014.mxd

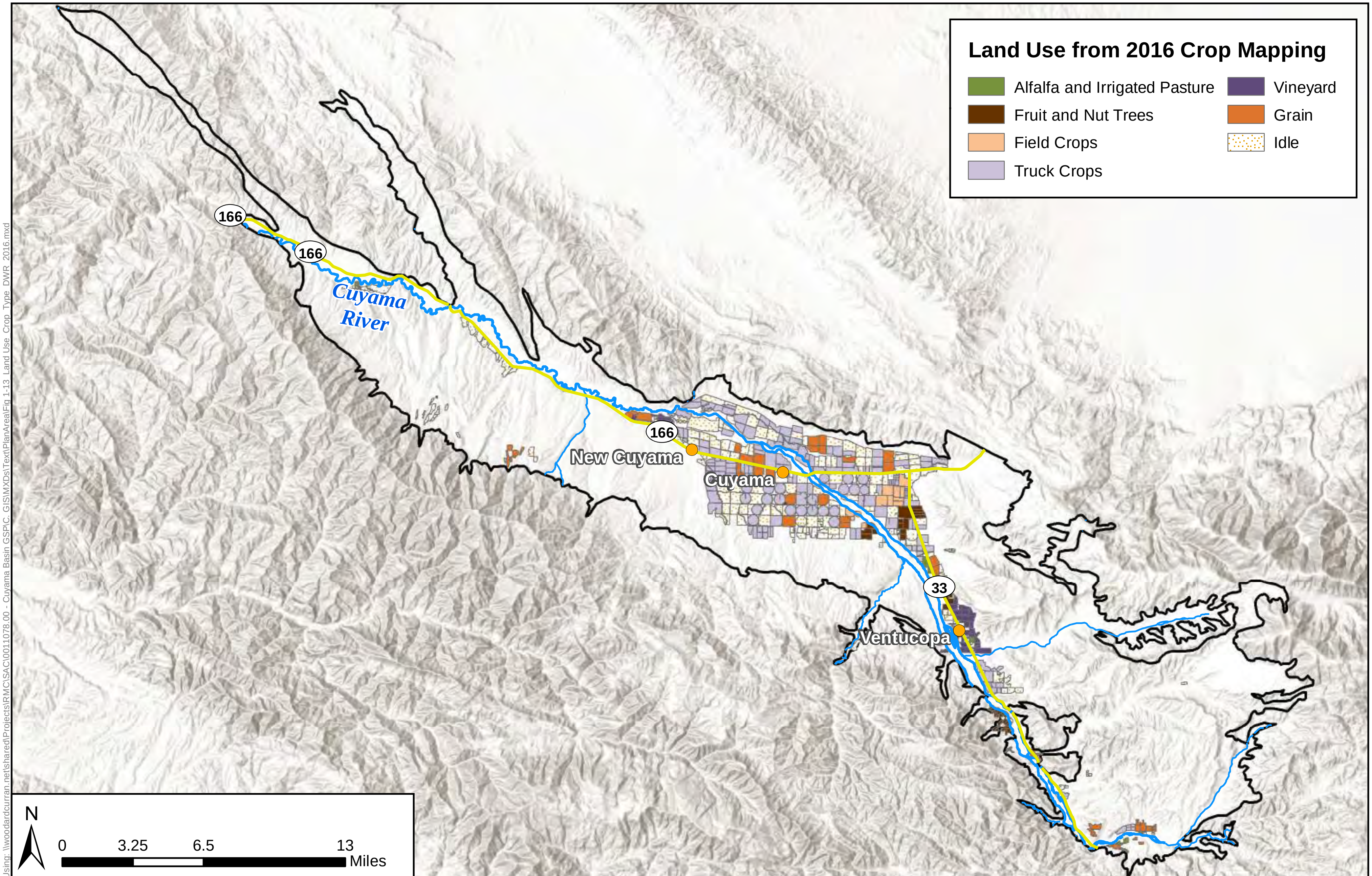

Figure 1-13 - 2016 Land Use

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

December 2019

WOODARD & CURRAN

Legend

- Cuyama Basin
- Towns
- Highways
- Cuyama River
- Streams/Creeks

Source: California Department of Water Resources County Land Use Surveys, 2016 dataset. https://gis.water.ca.gov/app/CADWRLandUseViewer/

Figure Exported: 6/19/2018 By: mwicks Using: \\woodardcurran.net\shared\Projects\RMC\SAC\0011078.00 - Cuyama Basin GSP\C_GIS\MXDs\TextPlanArea\Fig 1-13_Land Use_Crop_Type_DWR_2016.mxd

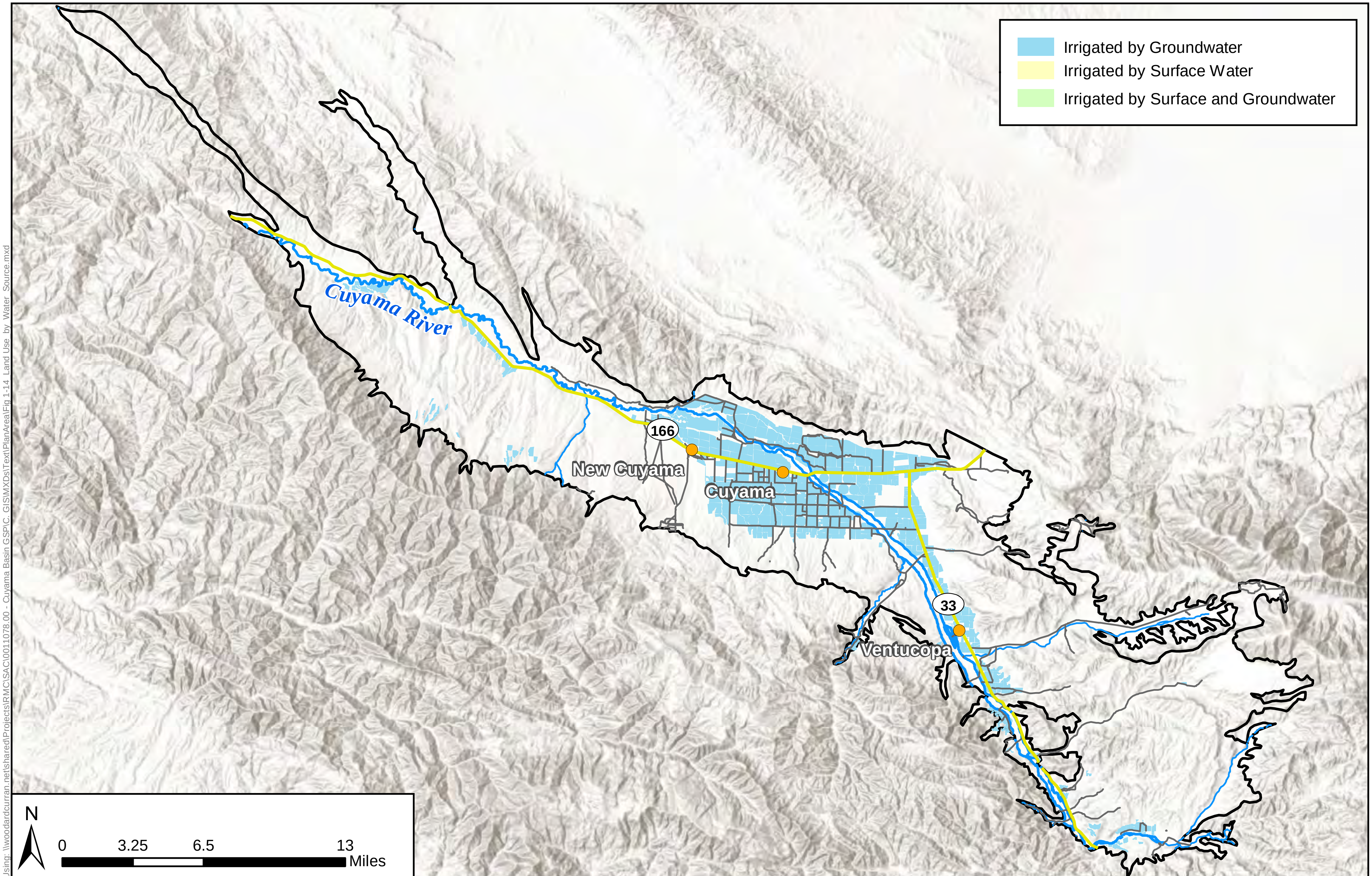

Figure 1-14 - Land Use by Water Source

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

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Legend

Cuyama Basin
Towns
Highways
Local Roads
Cuyama River
Streams/Creeks

Source: California Department of Water Resources Statewide Crop Mapping, 2016 dataset.
https://gis.water.ca.gov/app/CADWRLandUseViewer/

Figure Exported: 6/19/2018 By: mwicks Using: \\woodardcurran.net\shared\Projects\RMC\SAC\0011078.00 - Cuyama Basin GSP\C. GIS\MXDs\Text\PlanArea\Fig 1-14_Land Use_by_Water_Source.mxd

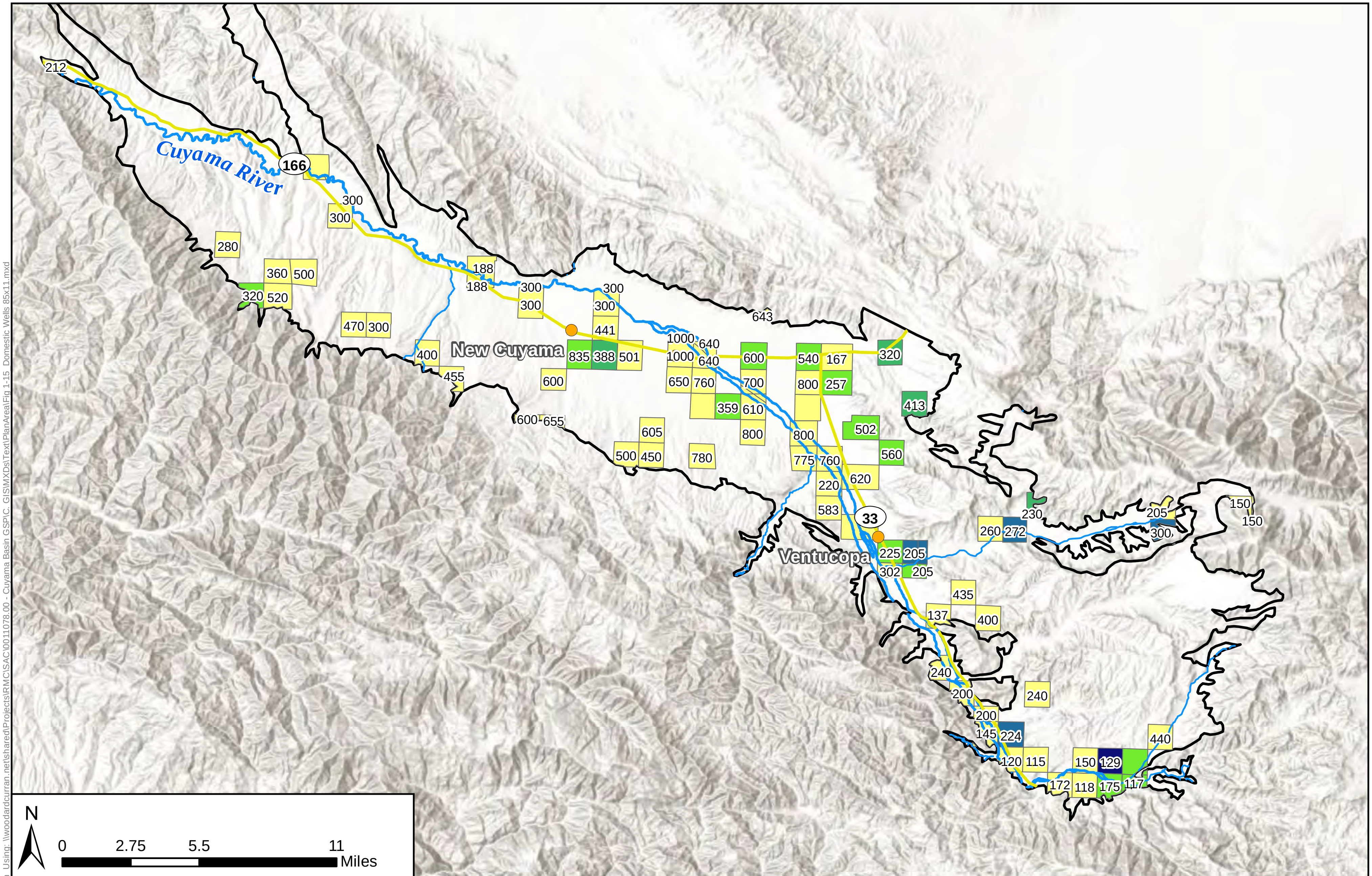

Figure 1-15 - Domestic Well Density and Average Depths

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

December 2019

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Legend

- Cuyama Basin
- Towns
- Highways
- Cuyama River
- Streams/Creeks

Number of Domestic Wells by Township & Range

- 1 Well
- 2 Wells
- 3 Wells
- 4 Wells
- 6 Wells

Numbers in the township and range grid correspond to the average depth of the wells within that grid. Grids with no number have no associated well depth data. Average well depth is given in feet below the ground surface.

Source: Department of Water Resources, Well Completion Report Map Application. Downloaded on February 6, 2018. <https://dwr.maps.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37>

Figure Exported: 6/14/2018 By: cegleton Using: \\woodardcurran.net\shared\Projects\RMC\SAC\0011078.00 - Cuyama Basin GSP\C_GIS\MXD\Text\PlanArea\Fig 1-15_Domestic Wells 85x11.mxd

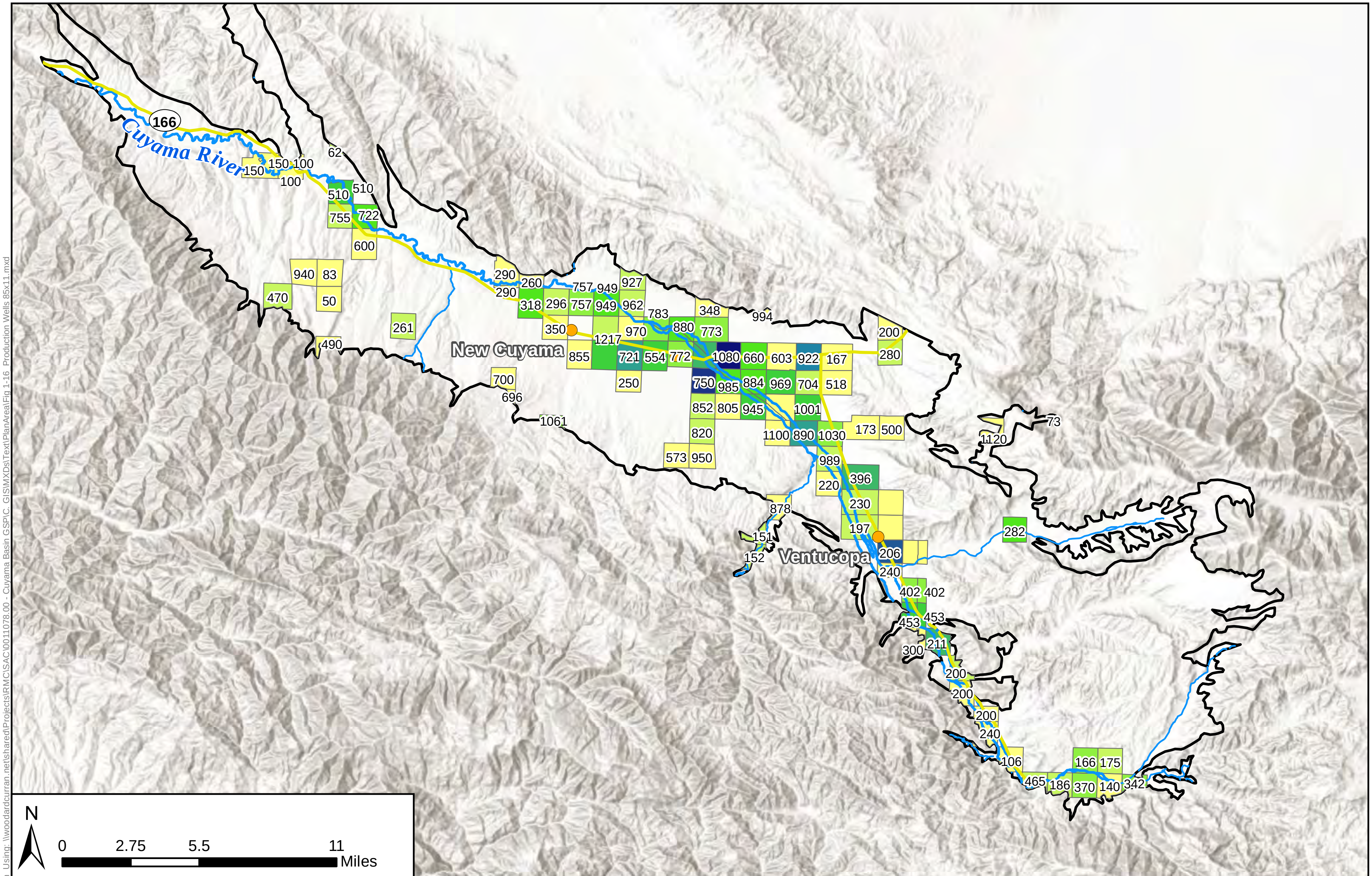

Figure 1-16 - Production Well Density and Average Depths

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

December 2019

WOODARD & CURRAN

Legend

- Cuyama Basin
- Towns
- Highways
- Cuyama River
- Streams/Creeks

Number of Production Wells by Township & Range

1 Well	5 Wells	9 Wells
2 Wells	6 Wells	10 Wells
3 Wells	7 Wells	11 Wells
4 Wells	8 Wells	

Numbers in the township and range grid correspond to the average depth of the wells within that grid. Grids with no number have no associated well depth data. Average well depth is given in feet below the ground surface.

Source: Department of Water Resources, Well Completion Report Map Application. Downloaded on February 6, 2018. <https://dwr.maps.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37>

Figure Exported: 6/14/2018 By: ceggleton Using: \\woodardcurran.net\shared\Projects\RMC\SAC\0011078.00 - Cuyama Basin GSP\C_GIS\MXDs\Text\PlanArea\Fig 1-16_Production Wells 85x11.mxd

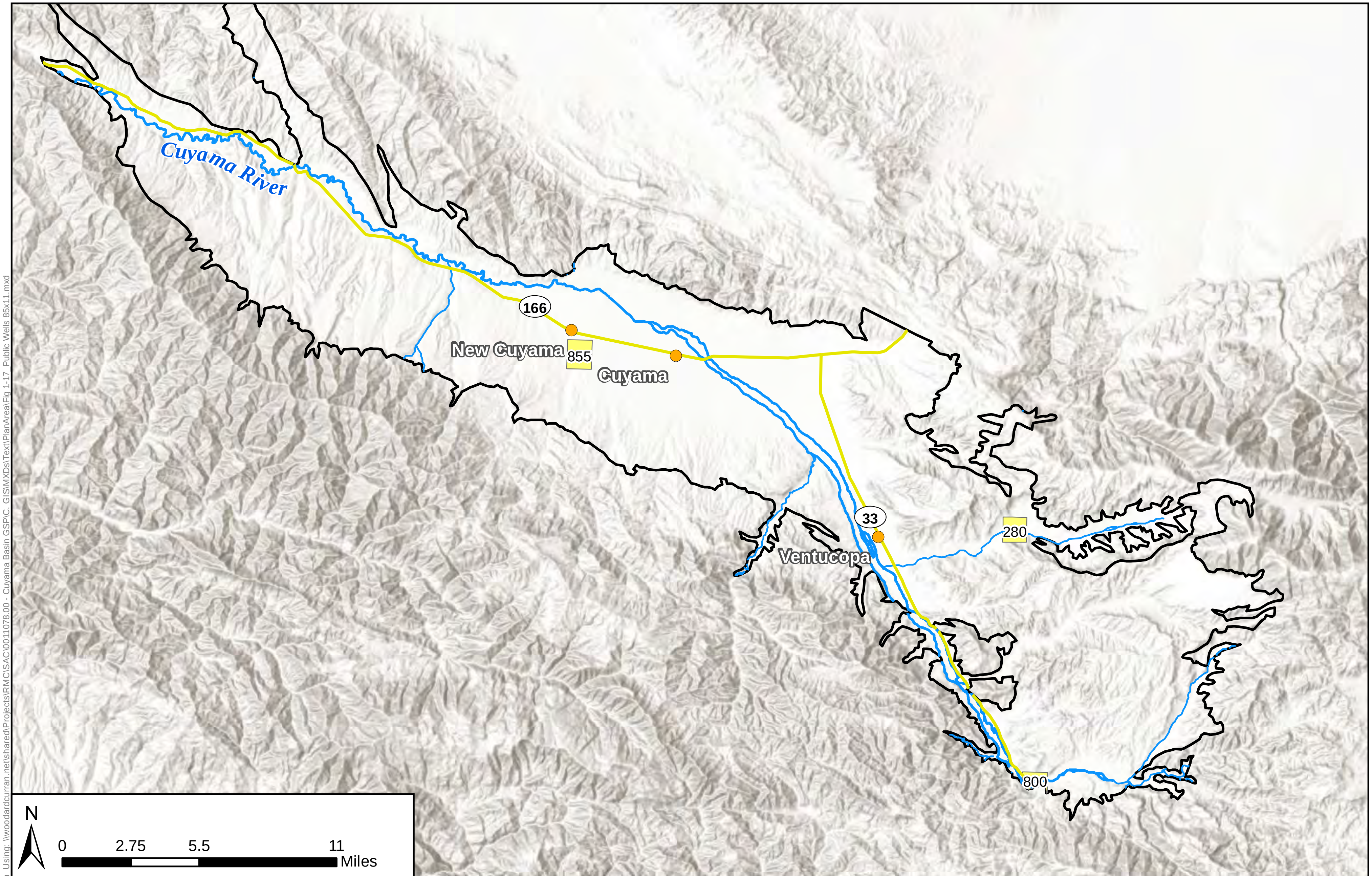

Figure 1-17 - Public Well Density and Average Depths

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

December 2019

WOODARD & CURRAN

Legend

Cuyama Basin

Towns

Highways

Cuyama River

Streams/Creeks

Number of Public Wells by Township & Range

1 Well

Numbers in the township and range grid correspond to the average depth of the wells within that grid. Grids with no number have no associated well depth data. Average well depth is given in feet below the ground surface.

Source: Department of Water Resources, Well Completion Report Map Application. Downloaded on February 6, 2018. <https://dwr.maps.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37>

Figure Exported: 6/14/2018 By: ceggleton Using: \\woodardcurran.net\shared\Projects\RMC\SAC\0011078.00 - Cuyama Basin GSP\C. GIS\MXDs\Text\PlanArea\Fig 1-17 Public Wells 85x11.mxd

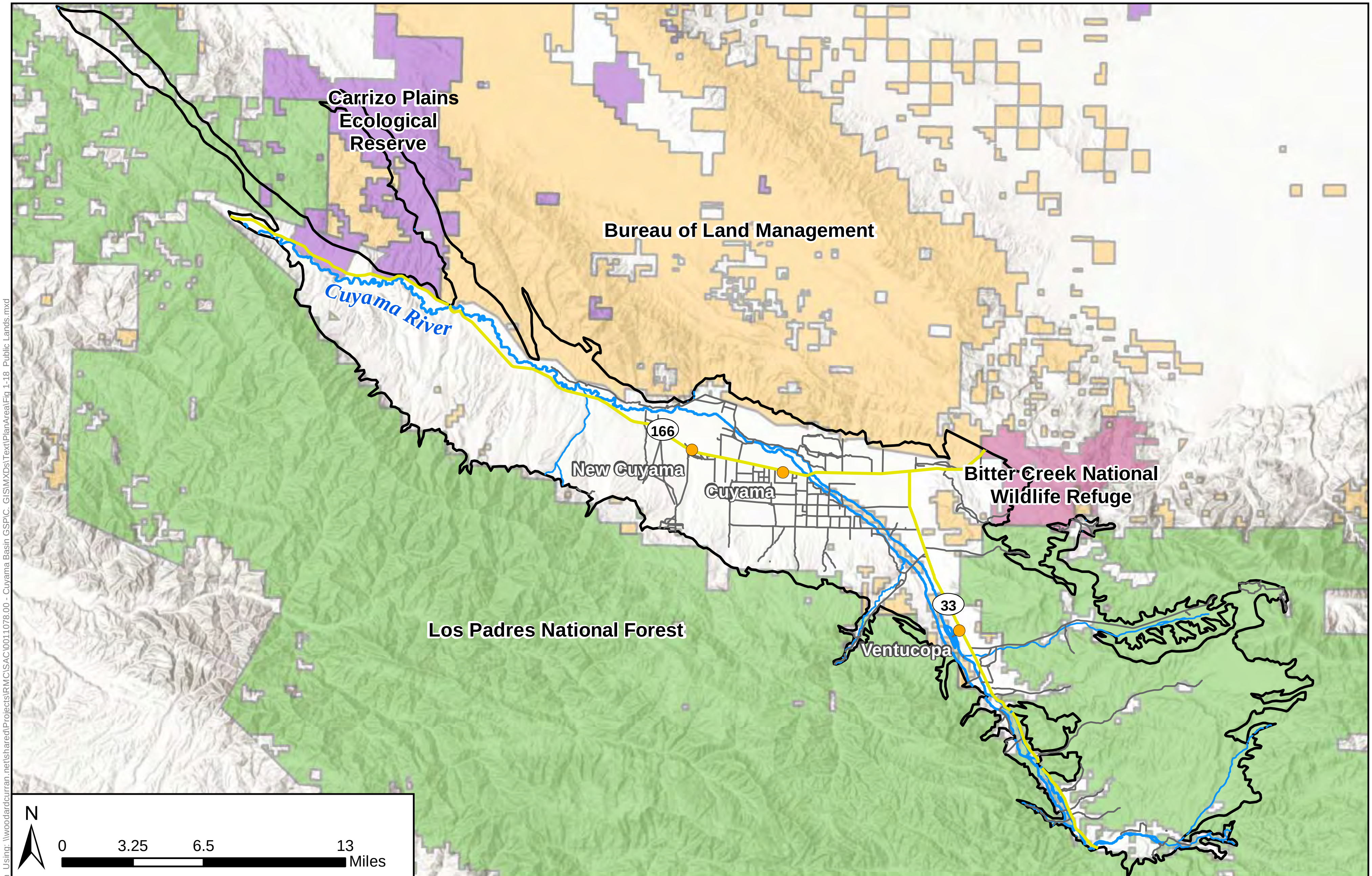

Figure 1-18 - Federal and State Lands

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

December 2019

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Legend

- Cuyama Basin
- Towns
- Highways
- Local Roads
- Cuyama River
- Streams/Creeks
- Bureau of Land Management
- US Forest Service
- US Fish and Wildlife
- State Lands

Figure Exported: 6/19/2018 By: ceggleton Using: \\woodardcurran.net\shared\Projects\RMC\SAC\0011078.00 - Cuyama Basin GSP\GIS\MXDs\Text\PlanArea\Fig 1-18 Public Lands.mxd

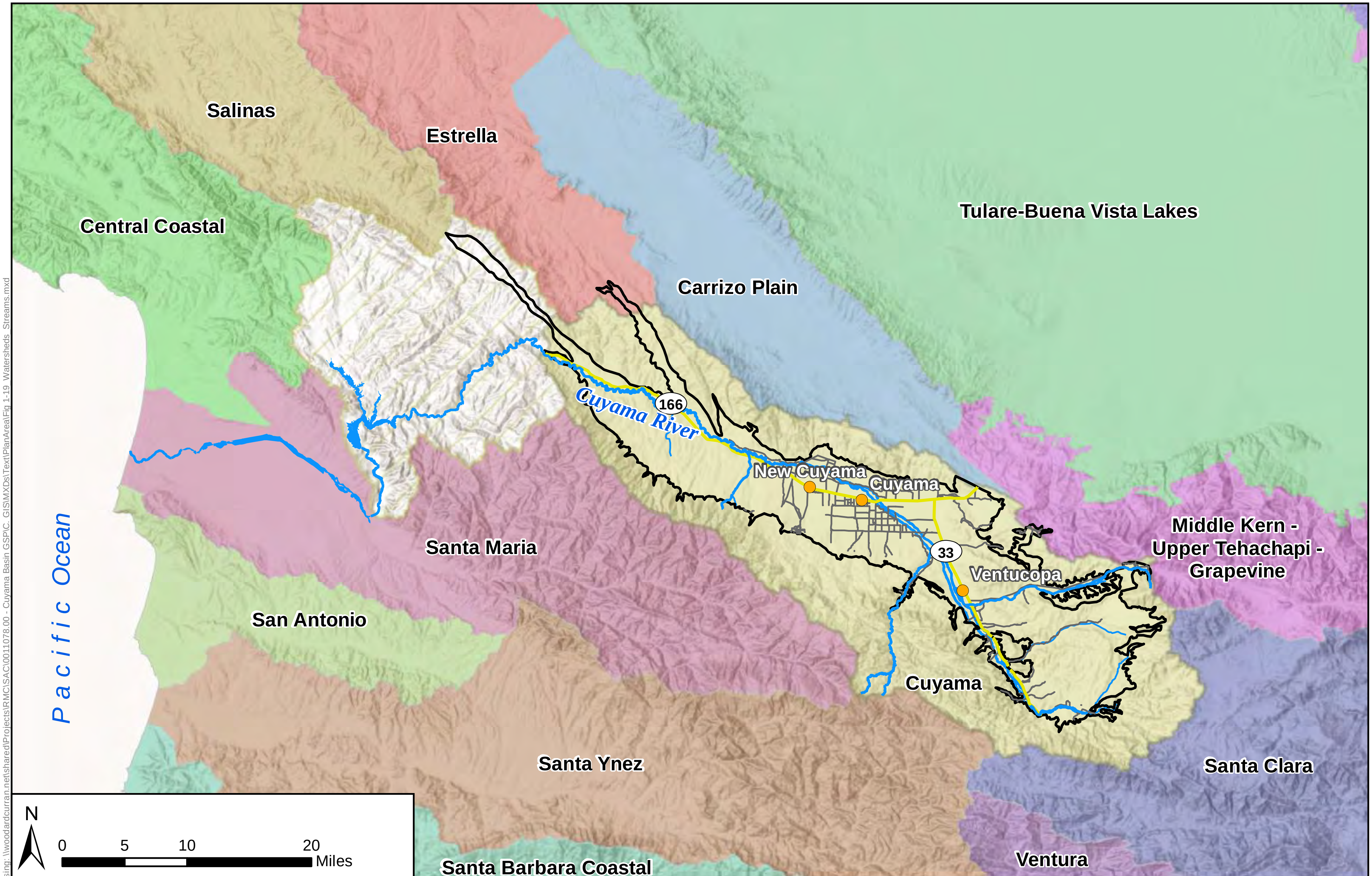

Figure 1-19 - Regional Watersheds

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

December 2019

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Watershed Data Source: USGS TNM Hydrography (WBD), U.S. Geological Survey - National Geospatial Program
Watersheds are 8-digit Hydrologic Units

1.2.3 Existing Surface Water Monitoring Programs

Existing surface water monitoring in the Cuyama Basin is extremely limited. Surface water monitoring in the Basin is limited to DWR’s California Data Exchange Center program, and monitoring performed by the United States Geological Survey (USGS). The only California Data Exchange Center gage in the Cuyama River watershed is at Lake Twitchell, which is downstream of the Cuyama Basin. The USGS has two active gages that capture flows in the Cuyama River watershed upstream of Lake Twitchell, as well as four deactivated gages (Figure 1-20). Table 1-1 lists the active and deactivated gages in the Basin.

Table 1-1: USGS Surface Flow Gages in the Cuyama Basin

Gage Number	Location	Status	Years of Record
11136800	Cuyama River below Buckhorn Canyon near Santa Maria	Active	1959-2017
11136650	Aliso Canyon Creek near New Cuyama	Deactivated	1963-1972
11136600	Santa Barbara Canyon Creek near Ventucopa	Active	2009-2017
11136500	Cuyama River near Ventucopa	Deactivated	1945-1958; 2009-2014
11136480	Reyes Creek near Ventucopa	Deactivated	1972-1978
11136400	Wagon Road Creek near Stauffer	Deactivated	1972-1978

The two active gages include one gage on the Cuyama River downstream of the Basin (identification number [ID] 11136800), which is located just upstream of Lake Twitchell. This gage has 58 recorded years of streamflow measurements from 1959 to 2017. The other active gage is south of the city of Ventucopa along Santa Barbara Canyon Creek (ID 11136600) and has seven recorded years of streamflow measurements ranging from 2010 to 2017. Although neither of these stream gages provide a comprehensive picture of surface water flows in the Cuyama Basin, they provide some information about the inflow and outflow of surface water through the Basin.

The need for surface water gages to measure flow on the Cuyama River is recognized as a data gap for this GSP. The CBGSA is working to identify optimal locations for new gages; new gages installations will be funded by the current SGMA Category 1 grant from DWR, or may be funded by the DWR Technical Support Services program.

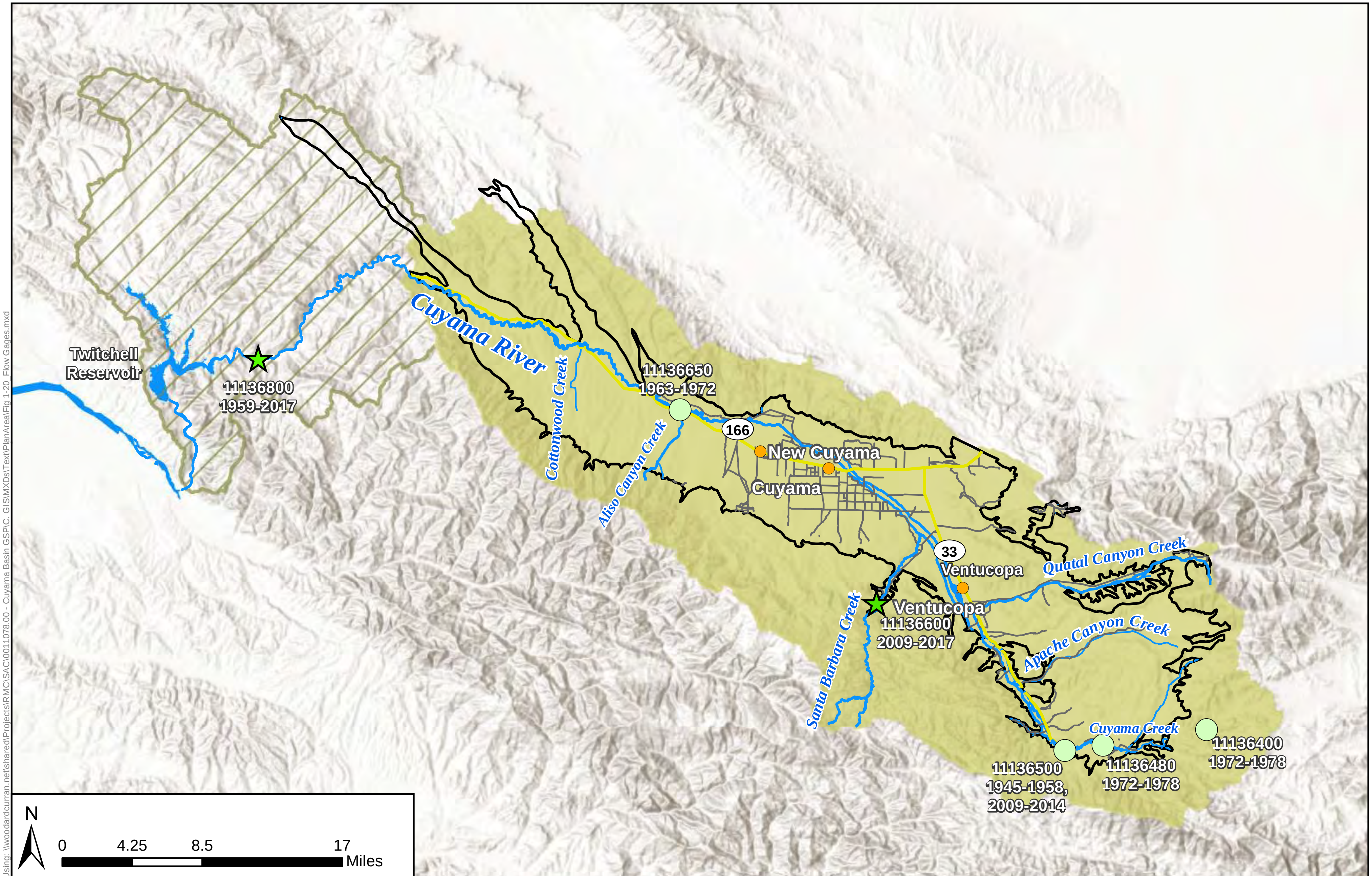

Figure 1-20 - Surface Stream Flow Gages

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

December 2019

WOODARD & CURRAN

Legend

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

Cuyama Watershed

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

1.2.4 Existing Groundwater Monitoring Programs

Existing groundwater monitoring programs in the Basin are primarily operated by regional, state and federal agencies. Existing groundwater monitoring programs in the Basin collect data on groundwater elevation, groundwater quality and subsidence at varying temporal frequencies. Each groundwater monitoring program in the Basin is described below, and additional information is provided in Chapter 4.

Groundwater Elevation Monitoring

DWR Water Data Library

DWR's Water Data Library (WDL) is a database that stores groundwater elevation measurements from wells in the Basin measured from 1946 through the present. Data contained in the WDL are from several different monitoring entities, including the Ventura County Watershed Protection District (VCWPD), SBCWA, Santa Barbara County Flood Control and Water Conservation District, and San Luis Obispo County Flood Control and Water Conservation District (SLOCFC&WCD).

USGS – National Water Information System

The USGS's National Water Information System contains extensive water data, including manual measurements of depth to water in wells throughout California. Wells are monitored by the USGS in the Santa Barbara County Flood Control and Water Conservation District's jurisdictional area. Most of the wells that were monitored in 2017 have been monitored since 2008, although a few have measurements dating back to 1983. Groundwater level measurements at these wells are taken approximately once per quarter.

California Statewide Groundwater Elevation Monitoring Program

The California Statewide Groundwater Elevation Monitoring (CASGEM) Program monitors seasonal and long-term groundwater elevation trends in dedicated groundwater basins throughout California. Monitoring entities establish CASGEM Program-dedicated monitoring wells and report seasonal groundwater levels to the CASGEM Program's database. The information below describes sources where CASGEM Program data can be retrieved.

DWR Groundwater Information Center Interactive Map

DWR's Groundwater Information Center Interactive Map Application is a database that collects and stores groundwater elevations and depth-to-water measurements. Groundwater elevations are measured biannually in the spring and fall by local monitoring agencies. Depth-to-water and groundwater elevation data are submitted to the Groundwater Information Center Interactive Map Application by the various monitoring entities including the SLOCFC&WCD, SBCWA, and VCWPD.

SBCWA CASGEM Program Monitoring Plan

The SBCWA's CASGEM Program Monitoring Plan discusses the SBCWA's 19-well monitoring network, which includes 16 actively monitored wells and three inactive wells no longer monitored due to accessibility and permission issues. Initially, SBCWA was the sole monitoring entity for the entire Basin, but in 2014 SBCWA reapplied to the CASGEM Program as a partial monitoring entity to reduce their monitoring activities and grant permission for neighboring counties (San Luis Obispo and Ventura) to monitor their portions of the Basin.

Of the 16 active wells in SBCWA's monitoring network, three are CASGEM Program-dedicated monitoring wells and 13 are voluntary. Wells are monitored by either SBCWA staff or USGS staff. The three CASGEM Program-dedicated monitoring wells are measured biannually in April and October, whereas the 13 voluntary wells are measured annually. All wells are single completion. CASGEM Program-dedicated wells have known Well Completion Reports and perforated intervals.

SLOCFC&WCD CASGEM Monitoring Plan

The SLOCFC&WCD's CASGEM Program Monitoring Plan identifies two wells in their CASGEM Program monitoring network. Upon recognition as a CASGEM monitoring entity in 2014, San Luis Obispo County Department of Public Works staff monitored these wells biannually. Static water level measurements are obtained biannually in April and October (corresponding to seasonal highs and low groundwater elevations).

VCWPD CASGEM Program Monitoring Plan

The VCWPD CASGEM Program Monitoring Plan identifies the two wells in their CASGEM Program monitoring network. Upon recognition as a CASGEM Program monitoring entity in 2014, VCWPD staff have monitored the two wells biannually. Static water level measurements are obtained biannually, due to the remoteness of the area, in April and October (corresponding to seasonal highs and low groundwater elevations). The two wells are in the southernmost portion of the Basin.

VCWPD does not have information beyond location and water elevation measurements for the two wells. There are no well completion reports for either well, and the perforation intervals are unknown. VCWPD identifies the southeastern portion of the Basin as a spatial data gap, given that the area contains no monitoring wells.

Groundwater Quality Monitoring

DWR WDL

DWR's WDL monitors groundwater quality data. Samples are collected from a variety of well types including irrigation, stock, domestic, and some public supply wells. Wells are not regularly sampled, and most wells have only one- or two-days' worth of sampling measurements and large temporal gaps between the results. Constituents most frequently monitored include dissolved chloride, sodium, calcium, boron, magnesium, and sulfate. Measurements taken include conductance, pH, total alkalinity and hardness (more than 1,000 total samples per parameter). Additional dissolved nutrients, metals, and total dissolved solids (TDS) are also sampled but have fewer sample results available (one to 1,000 samples per parameter).

GeoTracker Groundwater Ambient Monitoring and Assessment Program

Established in 2000, the Groundwater Ambient Monitoring and Assessment (GAMA) Program monitors groundwater quality throughout the state of California. The GAMA Program will create a comprehensive groundwater monitoring program throughout California and increase public availability and access to groundwater quality and contamination information. The GAMA Program receives data from a variety of monitoring entities including DWR, USGS, and the State Water Resources Control Board. In the Basin, three agencies submit data from monitoring wells for a suite of constituents including TDS, nitrates and nitrites, arsenic, and manganese.

National Water Information System

The USGS's National Water Information System monitors groundwater for chemical, physical, and biological properties in water supply wells throughout the Basin and data are updated to GeoTracker on a quarterly basis. The majority of wells with groundwater quality data were monitored prior to 2015.

Irrigated Lands Regulatory Program

The Irrigated Lands Regulatory Program, established in 2003, regulates discharges from irrigated agriculture to surface and ground waters and establishes waste discharge orders for selected regions. The Irrigated Lands Regulatory Program focuses on priority water quality issues, such as pesticides and toxicity, nutrients, and sediments. Wells are sampled biannually, once between March and June, and once between September and December.

Division of Drinking Water

The State Water Resources Control Board's Division of Drinking Water, (formerly the Department of Health Services) monitors public water system wells per the requirements of Title 22 of the California Code of Regulations relative to levels of organic and inorganic compounds such as metals, microbial compounds and radiological analytes. Data are available for active and inactive drinking water sources, for water systems that serve the public, and wells defined as serving 15 or more connections, or more than 25 people per day. In the Basin, Division of Drinking Water wells were monitored for Title 22 requirements, including pH, alkalinity, bicarbonate, calcium, magnesium, potassium, sulfate, barium, copper, iron, zinc, and nitrate.

Subsidence Monitoring

In the Basin, subsidence monitoring is performed using continuous global positioning system (CGPS) stations monitored by the University NAVSTAR Consortium's (UNAVCO) Plate Boundary Observatory (PBO) program. There are no known extensometers in the Basin.

UNAVCO PBO

The UNAVCO PBO network consists of a network of about 1,100 CGPS and meteorology stations in the western United States used to monitor multiple pieces of information, including subsidence. There are two stations in the Cuyama Basin: CUHS, located near the city of New Cuyama, and VCST, located south of the city of Ventucopa. The CUHS station has subsidence data from 2000 through 2017, and the VCST station has subsidence data from 2001 through 2017.

1.2.5 Existing Water Management Programs

Santa Barbara County Integrated Regional Water Management Plan 2013

The *Santa Barbara County Integrated Regional Water Management Plan 2013* (IRWM Plan 2013) is the main integrated regional water management (IRWM) planning document for the Santa Barbara County IRWM Region (County of Santa Barbara, 2013). IRWM Plan 2013 emphasizes multi-agency collaboration, stakeholder involvement and collaboration, regional approaches to water management, water management involvement in land use decisions, and project monitoring to evaluate results of current practices. IRWM Plan 2013 identifies regionally and locally focused projects that help achieve regional objectives and targets while working to address water-related challenges in the region.

The following IRWM Plan 2013 objectives related to groundwater use would potentially influence implementation of the GSP:

- Protect, conserve, and augment water supplies
- Protect, manage, and increase groundwater supplies
- Practice balanced natural resource stewardship
- Protect and improve water quality
- Maintain and enhance water and wastewater infrastructure efficiency and reliability

IRWM Plan 2013 provides valuable resources related to potential concepts, projects and monitoring strategies that can be incorporated into the CBGSA GSP.

San Luis Obispo County 2014 IRWM Plan

The San Luis Obispo 2014 IRWM Plan presents a comprehensive water resources management approach to managing the region's water resources, focusing on strategies to improve the sustainability of current and future needs of San Luis Obispo County (County of San Luis Obispo, 2014). Much of the IRWM Plan was based on the San Luis Obispo County Water Master Report (SLOCFC&WCD, 2012)

The following 2014 IRWM Plan goals related to groundwater use would potentially influence implementation of the GSP:

- **Water Supply Goal:** Maintain or improve water supply quantity and quality for potable water, fire protection, ecosystem health, and agricultural production needs; as well as to cooperatively address limitations, vulnerabilities, conjunctive-use, and water-use efficiency.
- **Ecosystem and Watershed Goal:** Maintain or improve the health of the Region's watersheds, ecosystems, and natural resources through collaborative and cooperative actions, with a focus on assessment, protection, and restoration/enhancement of ecosystem and resource needs and vulnerabilities.
- **Groundwater Monitoring and Management (Groundwater) Goal:** Achieve sustainable use of the region's water supply in groundwater basins through collaborative and cooperative actions.
- **Water Resources Management and Communications (Water Management) Goal:** Promote open communications and regional cooperation in the protection and management of water resources, including education and outreach related to water resources conditions, conservation/water use efficiency, water rights, water allocations, and other regional water resource management efforts.

The 2014 IRWM Plan provides valuable resources related to potential concepts, projects, and monitoring strategies that can be incorporated into the CBGSA GSP.

Ventura County 2014 IRWM Plan

The Ventura County 2014 IRWM Plan reflects the unique needs of a diverse region in Ventura County, which encompasses three major watersheds, 10 cities, portions of the Los Padres National Forest, a thriving agricultural economy, and is home to more than 823,000 people (County of Ventura, 2014). The 2014 IRWM Plan is a comprehensive document that primarily addresses region-wide water management and related issues.

The following 2014 IRWM Plan goals related to groundwater use would potentially influence implementation of the GSP:

- Reduce dependence on imported water and protect, conserve and augment water supplies
- Protect and improve water quality
- Protect and restore habitat and ecosystems in watersheds

The 2014 IRWM Plan provides valuable resources related to potential concepts, projects and monitoring strategies that can be incorporated into the CBGSA GSP.

Kern County 2011 IRWM Plan

The Kern County 2011 IRWM Plan covers most of Kern County but does not include the portion of the county that includes the Cuyama Basin (Kern County Water Agency, 2011). Therefore, the IRWM Plan is not relevant to the Cuyama GSP and is not addressed here.

1.2.6 General Plans in Plan Area

As illustrated in Figure 1-4, the Cuyama Basin is located within the geographic boundaries of four counties, including Kern, San Luis Obispo, Santa Barbara and Ventura. Each of these counties have an existing process for permitting new or replacement groundwater wells, which would continue after implementation of this GSP. In addition, implementation of the CBGSA GSP would be affected by the policies and regulations outlined in the General Plans of these counties, given that the Cuyama Basin, and long-term land use planning decisions that would affect the Basin, are under the jurisdiction of these counties.

This section describes how implementation of the various General Plans may change water demands in the Basin, for example due to population growth and development of the built environment, how the General Plans may influence the GSP's ability to achieve sustainable groundwater use, and how the GSP may affect implementation of General Plan land use policies.

Santa Barbara County Comprehensive Plan

The Santa Barbara County Comprehensive Plan is a means by which more orderly development and consistent decision making in the county can be accomplished. The Plan involves a continuing process of research, analysis, goal-setting and citizen participation, the major purpose of which is to enable the County Board of Supervisors and Planning Commission to more effectively determine matters of priority in the allocation of resources, and to achieve the physical, social and economic goals of the communities in the county (County of Santa Barbara, 2016).

Relevant Santa Barbara County Comprehensive Plan Principles and Policies

The following Santa Barbara County Comprehensive Plan Land Use Element policies related to groundwater use would potentially influence implementation of the GSP:

- **Land Use Development Policy 4:** Prior to issuance of a development permit, the County shall make the finding, based on information provided by environmental documents, staff analysis, and the applicant, that adequate public or private services and resources (i.e., water, sewer, roads, etc.) are available to serve the proposed development.
- **Hillside and Watershed Protection Policy 7:** Degradation of the water quality of groundwater basins, nearby streams, or wetlands shall not result from development of the site. Pollutants, such as chemicals, fuels, lubricants, raw sewage, and other harmful waste, shall not be discharged into or alongside coastal streams or wetlands either during or after construction.

The following Santa Barbara County Comprehensive Plan Conservation Element, Groundwater Resources Section goals and policies related to groundwater use would potentially influence implementation of the GSP:

- **Goal 1:** To ensure adequate quality and quantity of groundwater for present and future county residents, and to eliminate prolonged overdraft of any groundwater basins.
- **Policy 1.1:** The County shall encourage and assist all of the county's water purveyors and other groundwater users in the conservation and management, on a perennial yield basis, of all groundwater resources.
- **Policy 1.2:** The County shall encourage innovative and/or appropriate, voluntary water conservation activities for increasing the efficiency of agricultural water use in the county.
- **Policy 1.3:** The County shall act within its powers and financial abilities to promote and achieve the enhancement of groundwater basin yield.
- **Goal 2:** To improve existing groundwater quality, where feasible, and to preclude further permanent or long-term degradation in groundwater quality.
- **Policy 2.1:** Where feasible, in cooperation with local purveyors and other groundwater users, the County shall act to protect groundwater quality where quality is acceptable, improve quality where degraded, and discourage degradation of quality below acceptable levels.
- **Policy 2.2:** The County shall support the study of adverse groundwater quality effects which may be due to agricultural, domestic, environmental and industrial uses and practices.
- **Goal 3:** To coordinate County land use planning decisions and water resources planning and supply availability.
- **Policy 3.1:** The County shall support the efforts of the local water purveyors to adopt and implement groundwater management plans pursuant to the Groundwater Management Act and other applicable law.
- **Policy 3.2:** The County shall conduct its land use planning and permitting activities in a manner which promotes and encourages the cooperative management of groundwater resources by local agencies and other affected parties, consistent with the Groundwater Management Act and other applicable law.
- **Policy 3.3:** The County shall use groundwater management plans, as accepted by the Board of Supervisors, in its land use planning and permitting decisions and other relevant activities.
- **Policy 3.4:** The County's land use planning decisions shall be consistent with the ability of any affected water purveyor(s) to provide adequate services and resources to their existing customers, in coordination with any applicable groundwater management plan.
- **Policy 3.5:** In coordination with any applicable groundwater management plan(s), the County shall not allow, through its land use permitting decisions, any basin to become seriously over drafted on a prolonged basis.
- **Policy 3.6:** The County shall not make land use decisions which would lead to the substantial over commitment of any groundwater basin.

- **Policy 3.7:** New urban development shall maximize the use of effective and appropriate natural and engineered recharge measures in project design, as defined in design guidelines to be prepared by the Santa Barbara County Flood Control and Water Conservation District in cooperation with P&D.
- **Policy 3.8:** Water-conserving plumbing, as well as water-conserving landscaping, shall be incorporated into all new development projects, where appropriate, effective, and consistent with applicable law.
- **Policy 3.9:** The County shall support and encourage private and public efforts to maximize efficiency in the pre-existing consumptive M&I use of groundwater resources.
- **Policy 3.10:** The County, in consultation with the cities, affected water purveyors, and other interested parties, shall promote the use of consistent "significance thresholds" by all appropriate agencies with regard to groundwater resource impact analysis.
- **Goal 4:** To maintain accurate and current information on groundwater conditions throughout the county.
- **Policy 4.1:** The County shall act within its powers and financial abilities to collect, update, refine, and disseminate information on local groundwater conditions.

The following Santa Barbara County Comprehensive Plan Agricultural Element goal and policy related to groundwater use would potentially influence implementation of the GSP:

- **Goal 1:** Santa Barbara County shall assure and enhance the continuation of agriculture as a major viable production industry in Santa Barbara Country. Agriculture shall be encouraged. Where conditions allow, (taking into account environmental impacts) expansion and intensification shall be supported.
- **Policy 1F:** The quality and availability of water, air, and soil resources shall be protected through provisions including but not limited to, the stability of Urban/Rural Boundary Lines, maintenance of buffer areas around agricultural areas, and the promotion of conservation practices.

Santa Barbara County Comprehensive Plan's Influence on Water Demand and Groundwater Sustainability Plan's Goals

Review of relevant *Santa Barbara County Comprehensive Plan* goals and policies reveals that the County's goals and policies relative to future land use development and conservation complement the use and conservation of groundwater resources goals anticipated to be included in the CBGSA GSP. The Comprehensive Plan explicitly states as a goal ensuring that adequate quality and quantity of groundwater will be available for present and future county residents, as well as the elimination of prolonged overdraft of any groundwater basins through land use planning decisions and water resources planning.

The county is expected to grow from 428,600 to 520,000 residents between 2015 and 2040 (Santa Barbara County Association of Governments, 2012). These growth estimates are County-wide, and the General Plan does not specify how much growth, if any, is expected to occur within the Basin. Ensuring sustainable management of the Basin through implementation of the GSP will be critical in terms of supporting projected population growth in the county while maintaining sustainable groundwater levels in the Basin.

GSP's Influence on Santa Barbara County Comprehensive Plan's Goals and Policies

Successful implementation of the GSP will help to ensure that the Cuyama Basin's groundwater supply is managed in a sustainable manner. Given the amount of population growth projected in the county in the coming years, it is possible that changes in groundwater management by the GSP will result in changes to the pace, location and type of development that will occur in the county in the future. It is anticipated that GSP implementation will be consistent with the Comprehensive Plan's goals related to sustainable land use development in the county.

San Luis Obispo County General Plan

The *San Luis Obispo County General Plan* describes official County policy on the location of land uses and their orderly growth and development. It is the foundation upon which all land use decisions are based, guides action the County takes to assure a vital economy, ensures a sufficient and adequate housing supply, and protects agricultural and natural resources (County of San Luis Obispo, 2015).

Relevant San Luis Obispo General Plan Principles and Policies

The following San Luis Obispo General Plan Land Use Element principles and policies related to groundwater use would potentially influence implementation of the GSP:

- **Principle 1:** Preserve open space, scenic natural beauty and natural resources. Conserve energy resources. Protect agricultural land and resources.
- **Policy 1.2:** Keep the amount, location and rate of growth allowed by the Land Use Element within the sustainable capacity of resources, public services and facilities.
- **Policy 1.3:** Preserve and sustain important water resources, watersheds and riparian habitats.

The following San Luis Obispo General Plan Conservation and Open Space Element goals and policies related to groundwater use would potentially influence implementation of the GSP:

- **Goal WR 1:** The county will have a reliable and secure regional water supply.
- **Policy WR 1.2:** Conserve Water Resources. Water conservation is acknowledged to be the primary method to serve the county's increasing population. Water conservation programs should be implemented countywide before more expensive and environmentally costly forms of new water are secured.
- **Policy WR 1.3:** New Water Supply. Development of new water supplies should focus on efficient use of our existing resources. Use of reclaimed water, interagency cooperative projects, desalination of contaminated groundwater supplies, and groundwater recharge projects should be considered prior to using imported sources of water or seawater desalination, or dams and on-stream reservoirs.

- **Policy WR 1.7:** Agricultural Operations. Groundwater management strategies will give priority to agricultural operations. Protect agricultural water supplies from competition by incompatible development through land use controls.
- **Policy WR 1.12:** Impacts of New Development. Accurately assess and mitigate the impacts of new development on water supply. At a minimum, comply with the provisions of Senate Bills 610 and 221.
- **Policy WR 1.14:** Avoid Net Increase in Water Use. Avoid a net increase in non-agricultural water use in groundwater basins that are recommended or certified as Level of Severity II or III for water supply. Place limitations on further land divisions in these areas until plans are in place and funded to ensure that the safe yield will not be exceeded.
- **Goal WR 2:** The County will collaboratively manage groundwater resources to ensure sustainable supplies for all beneficial uses.
- **Policy WR 2.1:** Groundwater quality assessments Prepare groundwater quality assessments, including recommended monitoring, and management measures.
- **Policy WR 2.2:** Groundwater Basin Reporting Programs. Support monitoring and reporting programs for groundwater basins in the region.
- **Policy WR 2.3:** Well Permits. Require all well permits to be consistent with the adopted groundwater management plans.
- **Policy WR 2.4:** Groundwater Recharge. Where conditions are appropriate, promote groundwater recharge with high-quality water.
- **Policy WR 2.5:** Groundwater Banking Programs. Encourage groundwater-banking programs.
- **Goal WR 3:** Excellent water quality will be maintained for the health of the people and natural communities.
- **Policy WR 3.2:** Protect Watersheds. Protect watersheds, groundwater and aquifer recharge areas, and natural drainage systems from potential adverse impacts of development projects.
- **Policy WR 3.3:** Improve Groundwater Quality. Protect and improve groundwater quality from point and non-point source pollution, including nitrate contamination; MTBE and other industrial, agricultural, and commercial sources of contamination; naturally occurring mineralization, boron, radionuclides, geothermal contamination; and seawater intrusion and salts.
- **Policy WR 3.4:** Water Quality Restoration. Pursue opportunities to participate in programs or projects for water quality restoration and remediation with agencies and organizations such as the Regional Water Quality Control Board (RWQCB), California Department of Fish and Wildlife (CDFW), National Marine Fisheries Service (NMFS), and Resource Conservation Districts (RCDs) in areas where water quality is impaired.
- **Goal 4:** Per capita water use in the county will decline by 20% by 2020.
- **Policy WR 4.1:** Reduce Water Use. Employ water conservation programs to achieve an overall 20% reduction in per capita residential and commercial water use in the unincorporated area by 2020. Continue to improve agricultural water use efficiency consistent with Policy AGP 10 in the Agricultural Element.

- **Policy WR 4.2:** Water Pricing Structures. Support water-pricing structures to encourage conservation by individual water users and seek to expand the use of conservation rate structures in areas with Levels of Severity II and III for water supply.
- **Policy WR 4.3:** Water conservation The County will be a leader in water conservation efforts.
- **Policy WR 4.5:** Water for Recharge. Promote the use of supplemental water such as reclaimed sewage effluent and water from existing impoundments to prevent overdraft of groundwater. Consider new ways to recharge underground basins and to expand the use of reclaimed water. Encourage the eventual abandonment of ocean outfalls.
- **Policy WR 4.6:** Graywater. Encourage the use of graywater systems, rainwater catchments, and other water reuse methods in new development and renovation projects, consistent with state and local water quality regulations.
- **Policy WR 4.7:** Low Impact Development. Require Low Impact Development (LID) practices in all discretionary and land division projects and public projects to reduce, treat, infiltrate, and manage urban runoff.
- **Policy WR 4.8:** Efficient Irrigation. Support efforts of the resource conservation districts, California Polytechnic State University, the University of California Cooperative Extension, and others to research, develop, and implement more efficient irrigation techniques.
- **Goal 5:** The best possible tools and methods available will be used to manage water resources.
- **Policy WR 5.1:** Watershed Approach. The County will consider watersheds and groundwater basins in its approach to managing water resources in order to include ecological values and economic factors in water resources development.

The following San Luis Obispo General Plan Agriculture Element goals and policies related to groundwater use would potentially influence implementation of the GSP:

- **Policy AGP10a:** Encourage water conservation through feasible and appropriate “best management practices.” Emphasize efficient water application techniques; the use of properly designed irrigation systems; and the control of runoff from croplands, rangelands, and agricultural roads.
- **Policy AGP10b:** Encourage the U.C. Cooperative Extension to continue its public information and research program describing water conservation techniques that may be appropriate for agricultural practices in this county. Encourage landowners to participate in programs that conserve water.
- **Policy AGP11b:** Do not approve proposed general plan amendments or re-zonings that result in increased residential density or urban expansion if the subsequent development would adversely affect: (1) water supplies and quality, or (2) groundwater recharge capability needed for agricultural use.
- **Policy AGP11c:** Do not approve facilities to move groundwater from areas of overdraft to any other area, as determined by the Resource Management System in the Land Use Element.

San Luis Obispo County General Plan's Influence on Water Demand and Groundwater Sustainability Plan

The semi-arid climate in the county is subject to limited amounts of rainfall and recharge of groundwater basins and surface reservoirs. A focus of the County General Plan is that future development should take place recognizing that the dependable supply of some county groundwater basins is already being exceeded. If mining of groundwater continues in those areas without allowing aquifers to recharge, water supply and water quality problems will eventually result, which may be costly to correct and could become irreversible.

The General Plan explicitly encourages preservation of the county's natural resources, and states that future growth should be accommodated only while ensuring that this growth occurs within the sustainable capacity of these resources.

The county was expected to grow between 0.44 and 1 percent per year from 2013 through 2018, an increase of approximately 12,000 persons over the five-year period and is expected to grow by over 41,000 from 2010 to 2030 (County of San Luis Obispo, 2014). These growth estimates are County-wide and the General Plan does not specify how much growth, if any, is expected to occur within the Basin. Ensuring sustainable management of the Basin through implementation of the GSP will be critical in terms of supporting projected population growth in the county while maintaining sustainable groundwater levels in the Basin.

GSP's Influence on San Luis Obispo County General Plan's Goals and Policies

Successful implementation of the GSP will help to ensure that the Cuyama Basin's groundwater supply is managed in a sustainable manner. Given the amount of population growth projected in the county in the coming years, it is possible that changes in groundwater management by the GSP will impact the location and type of development that will occur in the Basin in the future. It is anticipated that GSP implementation will reinforce the General Plan's goals related to sustainable land use development in the county.

Ventura County General Plan

The Ventura County General Plan consists of the following:

- County-wide Goals, Policies and Programs containing four chapters (Resources, Hazards, Land Use, and Public Facilities and Services)
- Four appendices (Resources, Hazards, Land Use, and Public Facilities and Services), which contain background information and data in support of the Countywide Goals, Policies and Programs
- Several Area Plans which contain specific goals, policies and programs for specific geographical areas of the county

Relevant Ventura County General Plan Principles and Policies

The following Ventura County General Plan (Resources Chapter, Water Resources Section, 1.3.1 Goals, 1.3.2 Policies) goals and policies related to groundwater use would potentially influence implementation of the GSP:

- **Goal 1:** Inventory and monitor the quantity and quality of the county's water resources.
- **Goal 2:** Effectively manage the water resources of the county by adequately planning for the development, conservation and protection of water resources for present and future generations.
- **Goal 3:** Maintain and, where feasible, restore the chemical, physical and biological integrity of surface and groundwater resources.
- **Goal 4:** Ensure that the demand for water does not exceed available water resources.
- **Goal 5:** Protect and, where feasible, enhance watersheds and aquifer recharge areas.
- **Goal 6:** Promote reclamation and reuse of wastewater for recreation, irrigation and to recharge aquifers.
- **Goal 7:** Promote efficient use of water resources through water conservation.
- **Policy 1:** Discretionary development which is inconsistent with the goals and policies of the County's Water Management Plan (WMP) shall be prohibited, unless overriding considerations are cited by the decision-making body.
- **Policy 2:** Discretionary development shall comply with all applicable County and State water regulations.
- **Policy 3:** The installation of on-site septic systems shall meet all applicable State and County regulations.
- **Policy 4:** Discretionary development shall not significantly impact the quantity or quality of water resources in watersheds, groundwater recharge areas or groundwater basins.
- **Policy 5:** Landscape plans for discretionary development shall incorporate water conservation measures as prescribed by the County's Guide to Landscape Plans, including use of low water usage landscape plants and irrigation systems and/or low water usage plumbing fixtures and other measures designed to reduce water usage.
- **Policy 10:** All new golf courses shall be conditioned to prohibit landscape irrigation with water from groundwater basins or inland surface waters identified as Municipal and Domestic Supply or Agricultural Supply in the California Regional Water Quality Control Board's Water Quality Control Plan unless either: a) the existing and planned water supplies for a Hydrologic Area, including interrelated Hydrologic Areas and Subareas, are shown to be adequate to meet the projected demands for existing uses as well as reasonably foreseeable probable future uses in the area, or b) it is demonstrated that the total groundwater extraction/recharge for the golf course will be equal to or less than the historic groundwater extraction/recharge (as defined in the Ventura County Initial Study Assessment Guidelines) for the site. Where feasible, reclaimed water shall be utilized for new golf courses.

The following Ventura County General Plan (Land Use Chapter, 3.1.1 Goals) goal related to groundwater use would potentially influence implementation of the GSP:

- **Goal 1:** Ensure that the county can accommodate anticipated future growth and development while maintaining a safe and healthful environment by preserving valuable natural resources, guiding development away from hazardous areas, and planning for adequate public facilities and services. Promote planned, well-ordered and efficient land use and development patterns.

The following Ventura County General Plan (Public Facilities Chapter, Water Supply Facilities section 4.3.1 Goals and 4.3.2 Policies) goals and policies related to groundwater use would potentially influence implementation of the GSP:

- **Goal 1:** Ensure the provision of water in quantities sufficient to satisfy current and projected demand.
- **Goal 2:** Encourage the employment of water conservation measures in new and existing development.
- **Goal 3:** Encourage the continued cooperation among water suppliers in the county in meeting the water needs of the county as a whole.
- **Policy 1:** Development that requires potable water shall be provided a permanent potable water supply of adequate quantity and quality that complies with applicable County and State water regulations. Water systems operated by or receiving water from Casitas Municipal Water District, the Calleguas Municipal Water District or the United Water Conservation District will be considered permanent supplies unless an Urban Water Management Plan (prepared pursuant to Part 2.6 of Division 6 of the Water Code) or a water supply and demand assessment (prepared pursuant to Part 2.10 of Division 6 of the Water Code) demonstrates that there is insufficient water supply to serve cumulative development in the district's service area. When the proposed water supply is to be drawn exclusively from wells in areas where groundwater supplies have been determined by the Environmental Health Division or the Public Works Agency to be questionable or inadequate, the developer shall be required to demonstrate the availability of a permanent potable water supply for the life of the project.
- **Policy 2:** Discretionary development as defined in section 10912 of the Water Code shall comply with the water supply and demand assessment requirements of Part 2.10 of Division 6 of the Water Code.
- **Policy 3:** Discretionary development shall be conditioned to incorporate water conservation techniques and the use of drought resistant native plants pursuant to the County's Guide to Landscape Plans.

Ventura County Plan's Influence on Water Demand and Groundwater Sustainability Plan's Goals

Review of relevant Ventura County General Plan goals and policies reveals that the County's goals and policies relative to future land use development and conservation complement the use and conservation of groundwater resources goals included in the CBGSA GSP. The General Plan explicitly states as a goal ensuring that adequate quality and quantity of groundwater will be available for present and future county residents, as well as accommodating anticipated future growth and development while maintaining a safe and healthful environment by preserving valuable natural resources, including groundwater.

The county is expected to grow from 865,090 to 969,271 residents between 2018 and 2040 (Caltrans, 2015). These growth estimates are County-wide and the General Plan does not specify how much growth, if any, is expected to occur within the Basin. Ensuring sustainable management of the Basin through implementation of the GSP will be critical in terms of supporting projected population growth in the county while maintaining sustainable groundwater levels in the Basin.

GSP's Influence on Ventura County General Plan's Goals and Policies

Successful implementation of the GSP will help to ensure that the Cuyama Basin's groundwater supply is managed in a sustainable manner. Given the amount of population growth projected in the county in the coming years, it is possible that changes in groundwater management by the GSP will result in changes to the pace, location and type of development that will occur in the county in the future. It is anticipated that GSP implementation will reinforce the General Plan's goals related to sustainable land use development in the county.

Kern County General Plan

Because of the close interrelationship between water supplies, land use, conservation, and open space issues, the Land Use, Conservation, and Open Space Element sections of the Kern County General Plan are the most relevant elements for development of the GSP. These elements provide for a variety of land uses for future economic growth while also assuring the conservation of Kern County's agricultural, natural, and resource attributes (County of Kern, 2009).

Relevant Kern County General Plan Goals and Policies

The following Land Use, Conservation, and Open Space Element goals and policies related to groundwater use would potentially influence implementation of the GSP:

- **Goal 1.4.5:** Ensure that adequate supplies of quality water (appropriate for intended use) are available to residential, industrial, and agricultural users in Kern County.
- **Policy 1.4.2:** The efficient and cost-effective delivery of public services and facilities will be promoted by designating areas for urban development which occur in or adjacent to areas with adequate public service and facility capacity.
- **Policy 1.4.2.a:** Ensure that water quality standards are met for existing users and future development.
- **Goal 1.6.6:** Promote the conservation of water quantity and quality in Kern County.
- **Goal 1.6.7:** Minimize land use conflicts between residential and resource, commercial, and industrial land uses.

- **Policy 1.6.11:** Provide for an orderly outward expansion of new urban development so that it maintains continuity of existing development, allows for the incremental expansion of infrastructure and public service, minimizes impacts on natural environmental resources, and provides a high-quality environment for residents and businesses.
- **Policy 1.9.10:** To encourage effective groundwater resource management for the long-term economic benefit of the county, the following shall be considered:
- **Policy 1.9.10.a:** Promote groundwater recharge activities in various zone districts.
- **Policy 1.9.10.c:** Support the development of groundwater management plans.
- **Policy 1.9.10.d:** Support the development of future sources of additional surface water and groundwater, including conjunctive use, recycled water, conservation, additional storage of surface water and groundwater and desalination.
- **Goal 1.10.1:** Ensure that the county can accommodate anticipated future growth and development while maintaining a safe and healthful environment and a prosperous economy by preserving valuable natural resources, guiding development away from hazardous areas, and assuring the provision of adequate public services.
- **Policy 1.10.6.39:** Encourage the development of the county's groundwater supply to sustain and ensure water quality and quantity for existing users, planned growth, and maintenance of the natural environment.
- **Policy 1.10.6.40:** Encourage utilization of community water systems rather than the reliance on individual wells.
- **Policy 1.10.6.41:** Review development proposals to ensure adequate water is available to accommodate projected growth.

Kern County General Plan's Influence on Water Demand and Groundwater Sustainability Plan's Goals

Review of relevant Kern County General Plan goals and policies reveals that the County's goals and policies relative to future land use development and conservation complement the use and conservation of groundwater resources goals that are anticipated to be included in the CBGSA GSP. The General Plan explicitly encourages development of the county's groundwater supply to ensure that existing users have access to high quality water, and states that future growth should be accommodated only while ensuring that adequate high-quality water supplies are available to existing and future users.

GSP's Influence on Kern County General Plan's Goals and Policies

Successful implementation of the GSP will help to ensure that the Cuyama Basin's groundwater supply is managed in a sustainable manner. Given the small portion of the Cuyama Basin that lies in Kern County, it is anticipated that GSP implementation will have little to no effects on the General Plan's goals related to sustainable land use development in the county.

1.2.7 Plan Elements from CWC Section 10727.4

The plan elements from California Water Code Section 10727.4 require GSPs to address or coordinate the addressing of the components listed in Table 1-1. As noted in the table, several components of California Water Code Section 10727.4 address issues that are not within the CBGSA's authority, and are coordinated with local agencies.

Table 1-2: Plan Elements from CWC Section 10727.4

Element	Location
(a) Control of saline water intrusion	Not applicable
(b) Wellhead protection areas and recharge areas.	To be coordinated with counties
(c) Migration of contaminated groundwater.	Coordinated with RWQCB
(d) A well abandonment and well destruction program.	To be coordinated with counties
(e) Replenishment of groundwater extractions.	Chapter 7, Projects and Management Actions
(f) Activities implementing, opportunities for, and removing impediments to, conjunctive use or underground storage.	Chapter 7, Projects and Management Actions
(g) Well construction policies.	To be coordinated with counties
(h) Measures addressing groundwater contamination cleanup, groundwater recharge, in-lieu use, diversions to storage, conservation, water recycling, conveyance, and extraction projects.	Chapter 7, Projects and Management Actions, and coordinated with RWQCB
(i) Efficient water management practices, as defined in Section 10902, for the delivery of water and water conservation methods to improve the efficiency of water use.	Coordinated with Cuyama Basin Water District
(j) Efforts to develop relationships with state and federal regulatory agencies.	Chapter 8, Plan Implementation
(k) Processes to review land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity.	To be coordinated with counties
(l) Impacts on groundwater dependent ecosystems.	Chapter 2, Basin Settings, Section 2.2. Groundwater Conditions

1.3 Notice and Communication

In accordance with the SGMA regulations in Section 354.10, Notice and Communication, this section provides the following information:

- Description of the beneficial uses and users of groundwater in the Basin, including the land uses and property interests potentially affected by the use of groundwater in the Basin, the types of parties representing those interests, and the nature of consultation with those parties.
- List of public meetings at which the GSP was discussed or considered by the CBGSA.
- Comments regarding the GSP received by the CBGSA and a summary of any responses made by the CBGSA (Appendix D).
- Explanation of the CBGSAs decision-making process.
- Identification of opportunities for public engagement and a discussion of how public input and response will be used.
- Description of how the CBGSA encourages the active involvement of diverse social, cultural, and economic elements of the population within the Basin.
- Methods the CBGSA used to inform the public about progress implementing the GSP, including the status of projects and actions.

1.3.1 Description of Beneficial Uses and Users of Groundwater

Beneficial uses and users of groundwater in the Basin include the following interests (as listed in California Water Code Section 10723.2):

- Holders of overlying groundwater rights, including agricultural users and domestic well owners. There are approximately 475 agricultural and domestic wells identified to date in the Basin.
- Public water systems/municipal well operators are CCSD, the Cuyama Mutual Water Company, and the Ventucopa Water Supply Company.
- Disadvantaged communities; there are three disadvantaged and severely disadvantaged communities in the Cuyama Basin: Cuyama, New Cuyama, and Ventucopa. The census block groups for the Santa Barbara and San Luis Obispo county portions of the Basin are considered disadvantaged.
- Local land use planning agencies are San Luis Obispo, Santa Barbara, Ventura, and Kern counties.
- Entities that monitor and report groundwater elevations are CCSD, San Luis Obispo County, SBCWA, and Ventura County.
- Environmental users of groundwater, including groundwater dependent ecosystems (GDEs)

Potential interests (listed in California Water Code Section 10723.2) that are not present in the Cuyama Basin include the following:

- Surface water users, if there is a hydrologic connection between surface and groundwater bodies
- Federal government, including, the military and managers of federal lands
- California Native American tribes

The types of parties representing Cuyama Basin interests and the nature of consultations with these parties are summarized below.

Standing Advisory Committee

The SAC was established in September 2017 to encourage active involvement from diverse social, cultural, and economic elements of the population within the Basin. The SAC membership reflects this diversity. The members represent large and small landowners and growers from different geographic locations in the Basin, longtime residents of New Cuyama including Hispanic community members, and a manager of an environmentally-centric non-profit organization. SAC's role is described in Section 1.3.4.

Technical Forum

A technical forum was established to allow for technical input from interested parties within the Cuyama Basin. The forum had no decision-making authority. Monthly conference calls were held with representatives from the following organizations to review and seek input on technical matters:

- CBWD and consultants EKI Environment &Water, Inc. (EKI) and Provost & Pritchard Consulting Group (Provist & Pritchard)
- CCSD and consultants Dudek
- Grapevine Capital Partners, North Fork Vineyard and consultants Cleath-Harris Geologists
- San Luis Obispo County
- Santa Barbara Pistachio Company
- SBCWA

Additional Consultations

The GSP team conducted additional consultations regarding GSP matters via email, telephone, or via in-person meetings with representatives from the following groups:

- Bolthouse Farms
- Community representatives from the Family Resource Center and Blue Sky Center
- Duncan Family Farms
- DWR

- Grimmway Farms
- Individual landowners in the Cuyama Basin
- Kern County
- Santa Barbara County Fire Department, New Cuyama Station
- Santa Barbara County Public Works Department
- Santa Barbara IRWM Program
- United States Department of Agriculture's Forest Service Mount Pinos Ranger District, Los Padres National Forest
- University of California at Santa Barbara
- USGS
- Ventura County
- Wellntel Network

The following agencies and organizations were notified by mail about CBGSA-hosted community workshops:

- Cachuma Resource Conservation District in Santa Maria, California
- California Department of Fish and Wildlife, Headquarters in Sacramento, California
- California Natural Resources Agency in Sacramento, California
- California Wildlife Conservation Board in Sacramento, California
- Kern County, Cooperative Extension in Bakersfield, California
- Leadership Council for Justice and Accountability in Bakersfield, California
- Los Padres Forest Watch in Santa Barbara, California
- Morro Coast Audubon Society in Morro Bay, California
- San Luis Obispo County, Cooperative Extension in San Luis Obispo, California
- United States Department of Agriculture's Natural Resource Conservation Service in Fresno, California
- United States Fish and Wildlife Service in Ventura, California
- United States Fish and Wildlife Service, Attention Friends of California Condors Wild and Free in Ventura, California
- United States Forest Service, Bitter Creek National Wildlife Refuge, Refuge Manager, Debora Kirkland in Ventura, California
- United States Forest Service, Los Padres National Forest, Headquarters in Goleta, California
- Ventura County Audubon Society Chapter in Ventura, California
- Ventura County, Cooperative Extension in Ventura, California

The CBGSA developed a stakeholder engagement strategy to ensure that the interests of all beneficial uses and users of groundwater in the Basin were considered. Multi-organization planning processes can be complex. It can be challenging for community members to understand required decision-making steps, and where and how stakeholder issues and concerns are considered. Groundwater management as a practice is also complex. Educating and engaging groundwater stakeholders and the community about complex issues while simultaneously meeting deadlines established by SGMA, required an organized stakeholder engagement strategy.

An additional challenge to the engagement strategy is that the Basin area is rural, and has no news media outlets serving the area. The combined population per the 2010 Census of the three disadvantaged communities is 666 (Ventucopa 92, Cuyama 57, and New Cuyama 517). The engagement strategy relied primarily on mail and email communications about community workshop and CBGSA meetings. Mailings were sent to 675 parcel owners. Additionally, the CBGSA sent 185 emails stakeholders, engaged with counters who distributed notices, and word of mouth.

In January 2018, and to inform development of stakeholder engagement strategy, the CBGSA conducted 22 phone interviews with members of the CBGSA Board of Directors, SAC, CBGSA staff, staff from each of the four counties, and community representatives from the New Cuyama Family Resource Center and the Blue Sky Center, which are both located in New Cuyama. Several common themes emerged, which were used to form the basis for constructive stakeholder engagement and planning for the GSP. The prevailing ideas expressed included the following outreach and planning objectives:

- Provide a fair, balanced, and transparent public process that builds trust and understanding towards the common goal of a GSP that can best benefit everyone in the Basin.
- Provide a public meeting environment that is inclusive of all perspectives and all stakeholders.
- Provide education on a range of topics, at key milestones throughout the planning process, beginning with education about SGMA and what a GSP includes.
- Provide education and outreach specifically inclusive of smaller farmers/ranchers and the Hispanic community.
- Develop a GSP that is fair for all stakeholders in the Basin.

The stakeholder engagement strategy was developed to support the themes listed above, and in March 2018, the strategy was approved by the CBGSA Board. The strategy can be found online at: http://cuyamabasin.org/assets/pdf/CBGSP-Engagement-Strategy_May2018.pdf

1.3.2 List of Public Meetings Where the GSP was Discussed

Below is a list of the public meetings where the GSP was discussed. The following includes the public meetings held from June 2017 through July 2019.

CBGSA Board Meetings

In 2017, meetings were held on June 30, August 2, September 6, September 27, October 4, October 9, November 1, and December 6.

In 2018, meetings were held on January 3, January 10, April 4, May 2, July 11, August 1, September 5, October 3, and November 7.

In 2019, meetings were held on January 9, February 6, April 3, May 1, June 5, and July 10.

Joint Meetings of CBGSA Board and Standing Advisory Committee

In 2018, joint meetings were held on February 7, March 7, June 6, September 5, and December 3.

In 2019, joint meetings were held on March 6 and May 1.

CBGSA Standing Advisory Committee Meetings

In 2017, standing Advisory Committee meetings were held on October 16, and November 30.

In 2018, standing Advisory Committee meetings were held on January 4, February 1, March 1, March 29, April 26, May 31, June 28, July 26, August 30, September 27, November 1, and November 29.

In 2019, standing Advisory Committee meetings were held on January 8, January 31, February 28, and March 28, April 25, May 30 and Jun 27.

Community Workshops

In 2018, community workshops conducted in both English and Spanish were held on March 7, June 6, September 5, and December 3.

In 2019, community workshops were also conducted in English and in Spanish on March 6 and May 1.

1.3.3 Comments Regarding the GSP Received by the CBGSA, Response Summary

Public comments received and CBGSA responses provided are in Appendix D.

1.3.4 GSA Decision Making Process

On June 30, 2017, the CBGSA Board of Directors met for the first time. The 11-member board is the designated decision-making entity for GSP development, and is subject to the Brown Act.[1] According to the requirements of the act, all meetings were noticed 72 hours in advance, were open to the public and included a public comment period. Board membership and meeting agendas, minutes, and materials are available online at http://cuyamabasin.org/cuyama-gsa-board.html. Meeting agendas were also posted at the meeting location, the Family Resource Center, in New Cuyama.

The Board of Director votes are made on the basis of one vote for each Director, with Directors representing CBWD weighted at 6.7 percent and Directors representing other entities weighted at 11.1 percent. A weighted vote total of at least 75 percent is required for approval of the following:

- Annual budget
- GSP for the Basin and any substantive amendment
- Any stipulation to resolve litigation
- Adding new Board members
- Establishing and levying any fee, charge or assessment
- Adopting or amendmending bylaws
- Selecting a consultant to prepare the GSP

A weighted vote total of at least 50 percent is required for approval of all other decisions.

In September 2017, the CBGSA Board appointed the seven-member SAC to provide advice and input to the CBGSA Board on GSP development and implementation, and to assist with stakeholder engagement throughout the Cuyama Basin. In March 2018, the CBGSA Board expanded the SAC membership to nine members, including representatives from the Hispanic community in the Basin. One member resigned in March 2019, and the CBGSA Board of Directors is currently considering a replacement process. According to the requirements of the Brown Act, all SAC meetings were noticed 72 hours in advance and were open to the public. SAC membership, agendas, minutes, and meeting materials are available at http://cuyamabasin.org/standing-advisory-committee.html.

The CBGSA decision-making process included developing agenda for each meeting of the CBGSA Board and for each SAC meeting. The CBGSA Executive Director developed the agendas in concert with the technical team, outreach team, and the respective chairs of the CBGSA Board and SAC. Agenda items were either educational, informational, or required direction or decision. Agenda items were presented to the SAC, and then the SAC chair would provide an overview of SAC discussion and recommendations at

[1] http://ag.ca.gov/publications/2003_Intro_BrownAct.pdf

the subsequent CBGSA Board meeting. Figure 1-21 depicts the overall topics and decision process for developing the GSP.

Figure 1-21: Topics and Decision Process for GSP Development

1.3.5 Opportunities for Public Engagement and How Public Input was Used

Community input was encouraged and received at CBGSA Board meetings, SAC meetings, and community workshops. This GSP was shaped by community input, SAC input, and CBGSA Board direction and decisions.

Opportunities for Public Engagement

Regular opportunities for public engagement were available throughout GSP development. The CBGSA Board, SAC, and CBGSA staff encouraged public input throughout the development of the GSP in the following ways described below.

Meetings and Direct Engagement

- Public meetings and community workshops (detailed in Section 1.3.2)
- Direct contact with CBGSA staff. The public was encouraged to contact the CBGSA staff by phone, email, or mail with questions and comments. CBGSA contact information was distributed at all meetings and is available on the CBGSA website at http://cuyamabasin.org/contact-us.html.

- An informal briefing was hosted by the technical team at The Place, a restaurant in Ventucopa. The technical team met with interested growers and residents to update them and answer questions about the GSP.

GSP Section Review and Comment Periods

When draft sections of the GSP section became available for review and comment, the CBGSA Board, SAC members, stakeholders were notified. A list of the dates drafts were available online are listed below. Draft GSP sections are available online at: http://cuyamabasin.org/resources.html#gsp.

- February 21, 2019: Chapter 5, Sustainability
- February 21, 2019: Chapter 2, Water Budget
- November 28, 2018: Chapter 2, Groundwater Conditions Draft
- November 28, 2018: Chapter 2, Groundwater Conditions Draft: Appendix X Hydrographs
- November 28, 2018: Chapter 2, Groundwater Conditions Draft: Appendix Y – Groundwater Contours
- November 28, 2018: Chapter 2, Groundwater Conditions Draft: Appendix Z – Subsidence White Paper
- November 16, 2018: Chapter 6, Data Management System Chapter Draft
- October 3, 2018: Chapter 2, Updated Hydrogeologic Conceptual Model Draft
- September 24, 2018: Chapter 4, Monitoring Networks Section Draft
- September 24, 2018: Chapter 4, Monitoring Networks Section - Appendices
- September 21, 2018: Chapter 2, Updated Hydrogeologic Conceptual Model Draft
- August 24, 2018: Chapter 2, Groundwater Conditions Draft
- August 24, 2018: Chapter 2, Groundwater Conditions Draft: Appendix X – Hydrographs
- August 24, 2018: Chapter 2, Groundwater Conditions Draft: Appendix Y – Groundwater Contours
- August 24, 2018: Chapter 2, Groundwater Conditions Draft: Appendix Z – Subsidence White Paper
- July 27, 2018: Draft Undesirable Results Narrative
- July 27, 2018: Management Framework Matrix
- June 22, 2018: Draft Hydrogeologic Conceptual Model
- April 20, 2018: Draft Description of Plan Area

How Public Input and Response was Used in the Development of the GSP

Public input was used to help shape the GSP development. The input was also used to develop context and content for CBGSA meetings, SAC meetings, community workshops, CBGSA newsletters, and for content posted to the CBGSA website.

CBGSA-hosted public meetings were designed to encourage input, discussion, and questions from both the CBGSA Board of Directors and SAC members as well as public audience members. The minutes of

CBGSA Board and SAC meetings reflect the questions and comments raised by members and the general public. For each community workshop, public comments were summarized and provided to the CBGSA staff and technical team, the CBGSA Board of Directors, and SAC for further consideration.

Examples of how public input helped shape the GSP are described below.

During the development of the GSP, community input was valuable in identifying and closing groundwater data gaps. Residents and agricultural businesses provided additional data about groundwater levels, historical pumping, and cropping patterns.

During discussion of projects and management actions, several community members and CBGSA Board members expressed concern about unreliable community water supplies in New Cuyama, Cuyama, and Ventucopa. The GSP's list of projects was revised to include construction of new wells for these communities.

Community input also shaped other actions carried forward for further analysis in the GSP. Two projects to improve water resources in the basin came from public input: cloud seeding and rangeland management. The technical team evaluated each approach and discussed benefits and impacts with the CBGSA Board, SAC, and the community. Cloud seeding as a project is included in the GSP for further evaluation. Rangeland management was not carried forward in the GSP due to concerns about the potential impacts of vegetation management, and institutional concerns about coordination with the United States Forest Service.

Appendix D includes a summary of public comments and responses.

1.3.6 How CBGSA Encourages Active Involvement

Establishment of the SAC in September 2017 was a intended to encourage active involvement from diverse social, cultural, and economic elements of the population in the Basin. All meetings of the CGBSA Board and SAC were open to the public and included a public comment period. Community members participated in the public meetings. Community workshops were held in both English and Spanish, provided time for discussion of each topic presented, and provided comment forms for written comments. Workshop materials were also available in English and Spanish. The quarterly CBGSA newsletter was available in English and Spanish and described GSP planning status and opportunities for participation. Notices for community workshops were available in both English and Spanish. Distribution channels included email, hand-delivered postings throughout the Cuyama Valley, and postcard mailings to parcel owners within Basin boundaries. A website (www.cuyamabasin.org) was designed and made available early in the GSP process to assist in keeping stakeholders informed and up to date.

1.3.7 Method of Informing the Public

To inform the public about GSP progress and to seek public input, the following methods were used:

- Notice of public meetings, including CBGSA Board meetings, SAC meetings, and community workshops (in both English and Spanish)
- Website (www.cuyamabasin.org)
- Email distribution via a stakeholder email list was maintained throughout the process and grew to 185 contacts
- Postcards were mailed to 675 parcel owners in the Basin to announce community workshops and provide a link to the website to follow the progress of GSP development
- A quarterly, four-page CBGSA newsletter was mailed to all New Cuyama, CA post office box holders as a part of the Cuyama Recreation District Newsletter. The newsletter was also distributed via the stakeholder email list.
- Volunteers at the Family Resource Center distributed community workshop notices to locations throughout the Cuyama Basin.
- A member of the SAC posted community workshop notices in some of the finger areas in the west part of the Cuyama Basin.

The development of the mailing list and email list was informed by SGMA Section 10723.2, which calls for consideration of interests for all beneficial uses and users of groundwater. The initial email list of approximately 80 stakeholders grew to 185 stakeholders by March 2019. Additionally, a conventional mailing list was used that included 675 parcel owners in the Cuyama Basin identified by each of the four counties and the 17 agencies and organizations listed above in Section 1.3.1.

1.4 References

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2. BASIN SETTINGS: OVERVIEW

This Basin Settings chapter contains three main sections as follows:

- **Hydrogeologic Conceptual Model (HCM)** – The HCM section (Section 2.1) provides the geologic information needed to understand the framework that water moves through in the Basin. It focuses on geologic formations, aquifers, structural features, and topography.
- **Groundwater Conditions** – The Groundwater Conditions section (Section 2.2) describes and presents groundwater trends, levels, hydrographs and level contour maps, estimates changes in groundwater storage, identifies groundwater quality issues, addresses subsidence, and addresses surface water interconnection.
- **Water Budget –** The Water Budget section (Section 2.3) describes the data used to develop the water budget. Additionally, this section discusses how the budget was calculated, provides water budget estimates for historical conditions, and current conditions and projected conditions.

2.1 Basin Settings: HCM

This section of Chapter 2 describes the HCM for the Basin. Additionally, this HCM section satisfies Section 354.8 of the SGMA regulations. As defined in the regulations promulgated by DWR, the HCM:

1. "Provides an understanding of the general physical characteristics related to regional hydrology, land use, geology geologic structure, water quality, *principal aquifers*, and principal aquitards of the *basin setting;*
2. Provides the context to develop water budgets, mathematical (analytical or numerical) models, and monitoring networks, and
3. Provides a tool for stakeholder outreach and communication."

This HCM was developed to understand and then convey information about the physical conditions by which water moves through the Basin. This information is also used to support development of water budgets (Section 2.3).

2.1.1 Useful Terms

This chapter includes descriptions of geologic formations and structures, aquifers, and properties of geology related to groundwater, among other related components.

A glossary of technical terms is below. The terms listed here are intended as a guide for readers, and are not a definitive definition of any term.

- **Formation –** A formation, or geologic formation, is a unit of rock of similar properties, such as grain size, mineral composition, or depositional environmental. Geologic formations are distinct from surrounding rock types and are large enough to be mapped regionally. If the formation contains a dominant rock type, such as sandstone, it may be included in the name of the formation.
- **Basement rocks –** Basement rocks are the oldest and deepest rocks in the subsurface. Basement rocks are typically crystalline and metamorphic or igneous in origin, and groundwater generally only moves through fractures in the rock instead of pore spaces like in sedimentary rocks. No sedimentary layers are found below the basement rocks.
- **Water bearing formation –** A water bearing formation is a rock formation that is saturated and contains water within the pores or fractures of the unit. One or more water bearing formations compose an aquifer.
- **Aquifer –** An aquifer is an underground reservoir of water stored within the pores and fractures of rocks and sediments.
- **Unconfined aquifer –** An unconfined aquifer is an aquifer that does not have an impermeable layer above it (such as a clay layer). With an unconfined aquifer, the upper water surface is defined as the water table and is at atmospheric pressure. Water seeps from the ground surface directly into the aquifer, as there are not impermeable layers to prevent the water from entering the aquifer.
- **Cross section –** A cross section is a diagram that identifies subsurface layers located beneath a surficial trend. Stratigraphic cross sections depict geologic formations in the subsurface in relation to elevation. Cross sections are useful tools to interpret geology in the subsurface and visualize the relative thickness and distribution of geologic formations. Cross sections are often presented with an accompanying map that acts as a reference to spatially locate the trend of the cross section at the surface. To read cross sections, use the location and trend of the surficial lines on the location map as a key. For instance, where A-A' is marked on the map represents where the cross section named A-A' is located spatially
- **Hydraulic conductivity** – Hydraulic conductivity is defined as the "measure of a rock or sediment's ability to transmit water," typically measured in feet or meters per unit of time (day, hour, minute) (DWR, 2003). Rocks and sediments with high values of conductivity, such as gravels or coarse sands, are able to sustain groundwater flow better than rocks and sediments with low values of conductivity. Rocks and sediments with near zero values of hydraulic conductivity, such as very fine-grained sandstones, shale, or granites, do not transmit groundwater and are barriers to flow. Values of conductivity are used in the groundwater model to determine how quickly formations transmit groundwater and where barriers to groundwater flow (i.e., formations with very low values of conductivity) exist.
- **Hydrogeology** – The study of groundwater and aquifers.

- **Primary aquifer –** According to SGMA regulations, primary aquifers must be identified. In the Draft GSP, aquifers requiring specific monitoring and management must also be identified. Primary aquifers are regionally extensive and are sources of groundwater used for beneficial uses.
- **Aquitard –** An aquitard is a layer of strata that has a low conductivity that groundwater flows very slowly through. Aquitards can be regional, such as the Corcoran Clay in the Cuyama Valley, where it prevents flow from upper strata to lower strata across the western side of the valley, or it can be localized, which is common in most alluvial settings. Localized aquitards restrict vertical flows in a small region of an aquifer, and water will generally move laterally around localized aquitards as it flows by gravity toward the bottom of the aquifer.
- **Piper diagrams** – A Piper diagram is used to characterize the chemical quality of a water sample, and involves plotting the relative proportions of major ions. Piper diagrams show the relative abundance of major cations (e.g., sodium, potassium, calcium, magnesium) and anions (e.g., bicarbonate, carbonate, sulfate, chloride, fluoride) commonly found in water on a charge equivalent basis, as a percentage of the total ion content of the water. Piper diagrams are useful for understanding what kind of salts make up the total dissolve solids (TDS) in a location.

2.1.2 Regional Geologic and Structural Setting

The Basin is located at the southeastern end of the California Coast Ranges and north of the Western Transverse Ranges (Figure 2-1), and is in an area of high tectonic activity. The Basin is bounded on the north and south by faults, and is located near major fault zones such as the San Andreas and Santa Maria River fault zones. Because the Basin is located in a mountainous region with high tectonic activity, it has a number of structural features generated by this activity. The Basin has been deformed by this tectonic activity, and is generally a synclinal basin, with multiple synclines that are oriented to the northwest and a number of faults that cross the Basin.

Tectonic activity from the northwest movement of the San Andreas Fault system has led to the development of a fold and thrust belt, which has driven the deformation of the Cuyama Valley for the past four million years (United States Geological Survey [USGS], 2013c). The Cuyama Valley was formed by a downfaulted block of the earth’s crust called a graben. This block is bordered on the north by the Morales and Whiterock faults and on the south by the South Cuyama and Ozena faults. Along these borders the faults have thrust older rocks of pre-Pliocene age over the rocks of Pliocene age and younger. In the eastern part of the valley the north-bordering faults approach the San Andreas Fault zone and the south-bordering faults approach the Big Pine Fault. (Singer and Swarzenski, 1970)

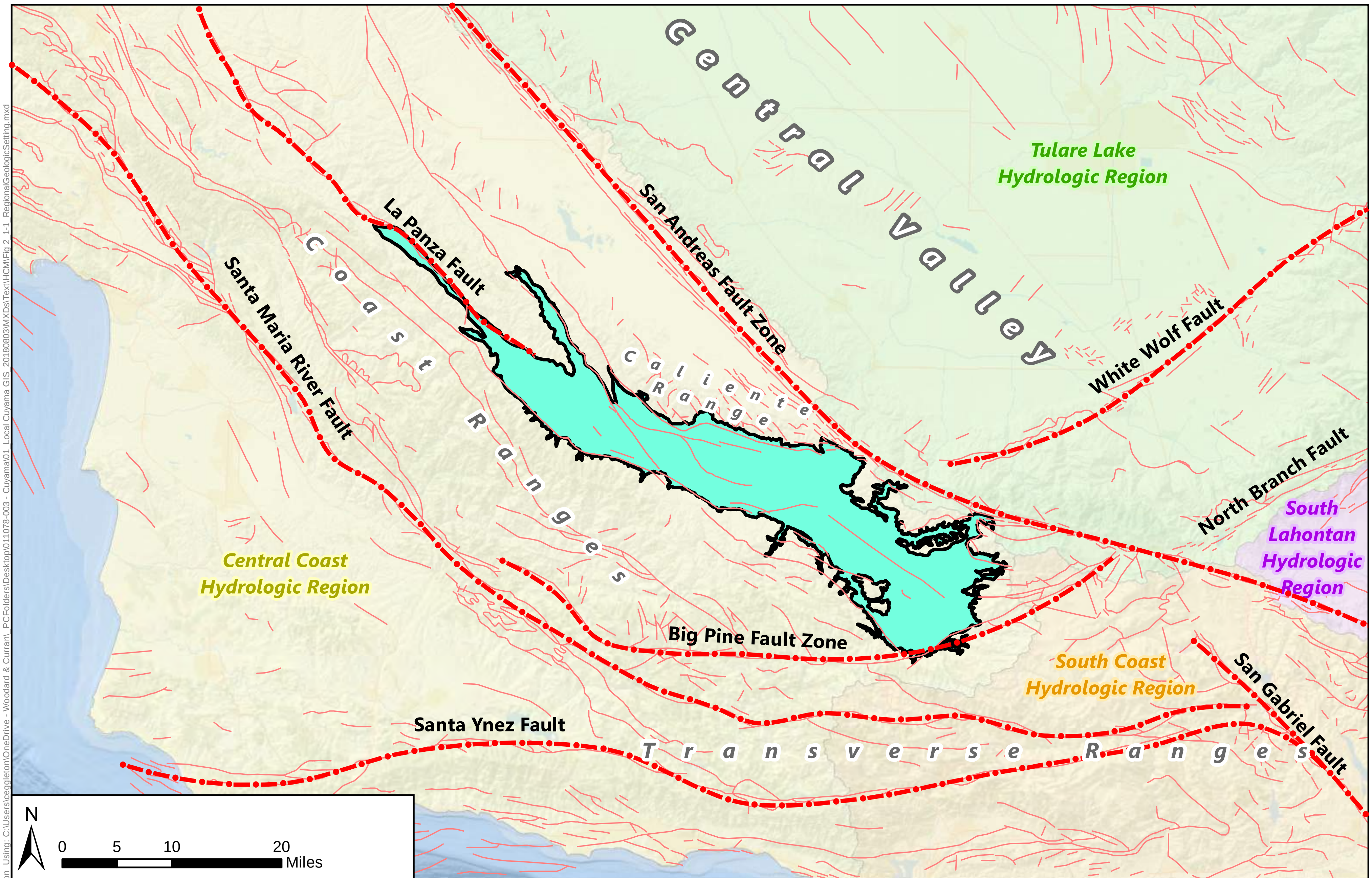

Figure 2-1: Regional Geologic Setting

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

December 2019

WOODARD &CURRAN

Legend

Cuyama Basin

Faults

Fault Data Sources:
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California Geologic Map Data from United States Geologic Survey. Retrieved 2/8/2018.
<https://mrdata.usgs.gov/geology/state/state.php?state=CA>

2.1.3 Geologic History

The Basin has a long history of deformation and deposition, most of this influenced by tectonic activity and cycles of marine transgression and regression. Formations in the Basin reflect variable depositional environments, from the middle bathyal shales and siltstones to the nonmarine sandstone, conglomerate, and mudstones. Marine rocks are dominant in the western part of the Basin and interfinger to the east with nonmarine rocks (Ellis, 1994).

A major late Eocene/early Oligocene (38 to 28 million years [Ma]) unconformity affected all regions south of the San Andreas Fault, shown in the geologic record by nonmarine Oligocene (23 Ma) rocks overlying a thick section (i.e., several kilometers) of upper Eocene (56 Ma) marine rocks (Kellogg et al., 2008; Ellis, 1994). This unconformity is a result of the Ynezian orogeny (around 30 Ma) during which pre-Oligocene marine rocks were folded and uplifted above younger, Oligocene-age sediments (Kellogg et al., 2008).

Following a period of orogeny, deformation changed to extension from the late Oligocene and early Miocene (around 23 Ma) and the Basin became a major extensional basin (Ellis, 1994). This period also correlated with two transgressive-regressive cycles, where the sea advanced and retreated over geologic time over the sediments now in the Basin due to tectonic subsidence (Bazeley, 1988). Sediments deposited during this period reflect the cyclical nature of sea-level rise and are generally categorized by marine strata in the west and nonmarine strata to the east. Formations deposited during ocean transgression are thick marine sediments, including the Vaqueros Formation, Monterey Formation, Branch Canyon Sandstone, and Santa Margarita Sandstone (Kellogg et al., 2008; Lagoe, 1981). Many of the marine units interfinger with terrestrial units and eventually pinch out to zero thickness in the east. During the late Miocene (8 Ma), the sea regressed from the western part of the region, evident in the geologic record where the nonmarine Caliente Formation interfingers with the similarly aged marine Santa Margarita Sandstone and unconformably overlies the Branch Canyon Sandstone (Kellogg et al., 2008). By the middle Miocene (15 Ma), the eastern Cuyama Valley area was characterized by a shelf and nonmarine deposition. Deformation by the middle Miocene changed from extension to right-lateral strike slip motion, resulting in the development of the Russell fault.

Deformation from Oligocene extension and Miocene strike-slip faulting regimes was buried by the folding, uplift, and thrust faulting during the Pliocene through Pleistocene compression (beginning around 4 Ma) (Ellis, 1994). Compression led to the uplift of the Coast and Transverse mountain ranges surrounding the current topographic valley and the converging thrust faults that surround the present day topographic basin, including the Whiterock, Morales, and South Cuyama faults (USGS, 2013b). The transition to a predominantly compressional system led to the development of a thrust system across the older extensional basin and began thrusting older sediments above younger sediments through the Cuyama Valley (Davis et al., 1988). Older, inactive faults and rocks were buried by the deposition of the younger Morales Formation, Older Alluvium, and Younger Alluvium. Thrust and compression continued into the Quaternary (3 to 2.5 Ma) and uplifted the Caliente Range and thrusted Miocene-aged rocks of the Caliente Range southward over Quaternary alluvium on the Morales fault (USGS, 2013b; Ellis, 1994). The Morales Formation and Older Alluvium are folded into synclines along the north and south margins of the valley near the bounding thrust faults (USGS, 2013b). The end of the Pliocene (around 2 Ma) marks the complete withdrawal of the sea from the area and the final sea regression marks the change in deposition of marine sediments to the continental clay, silt, sand, and gravel of the Morales Formation and alluvium (Singer and Swarzenski, 1970; Ellis, 1994). Fluvial deposits of claystone, sandstone, and conglomerate became the primary forms of sedimentation.

2.1.4 Geologic Formations/Stratigraphy

The Basin is composed of a sequence of unconsolidated to partly consolidated nonmarine deposits of Pliocene to Pleistocene age unconformably overly consolidated marine and nonmarine sedimentary rocks of late Cretaceous to middle Cenozoic age on top of Mesozoic crystalline granitic and gneissic bedrock (Davis et al., 1988). The unconsolidated to partly consolidated nonmarine deposits are the primary water-bearing units in the Basin and are described in further detail in Section 2.1.7. Individual geologic units found in the Basin are described in detail below, in order of youngest to oldest in deposition. Geologic units mapped at the surface are shown in Figure 2-2. A generalized stratigraphic column of the Cuyama Valley is shown in Figure 2-3.

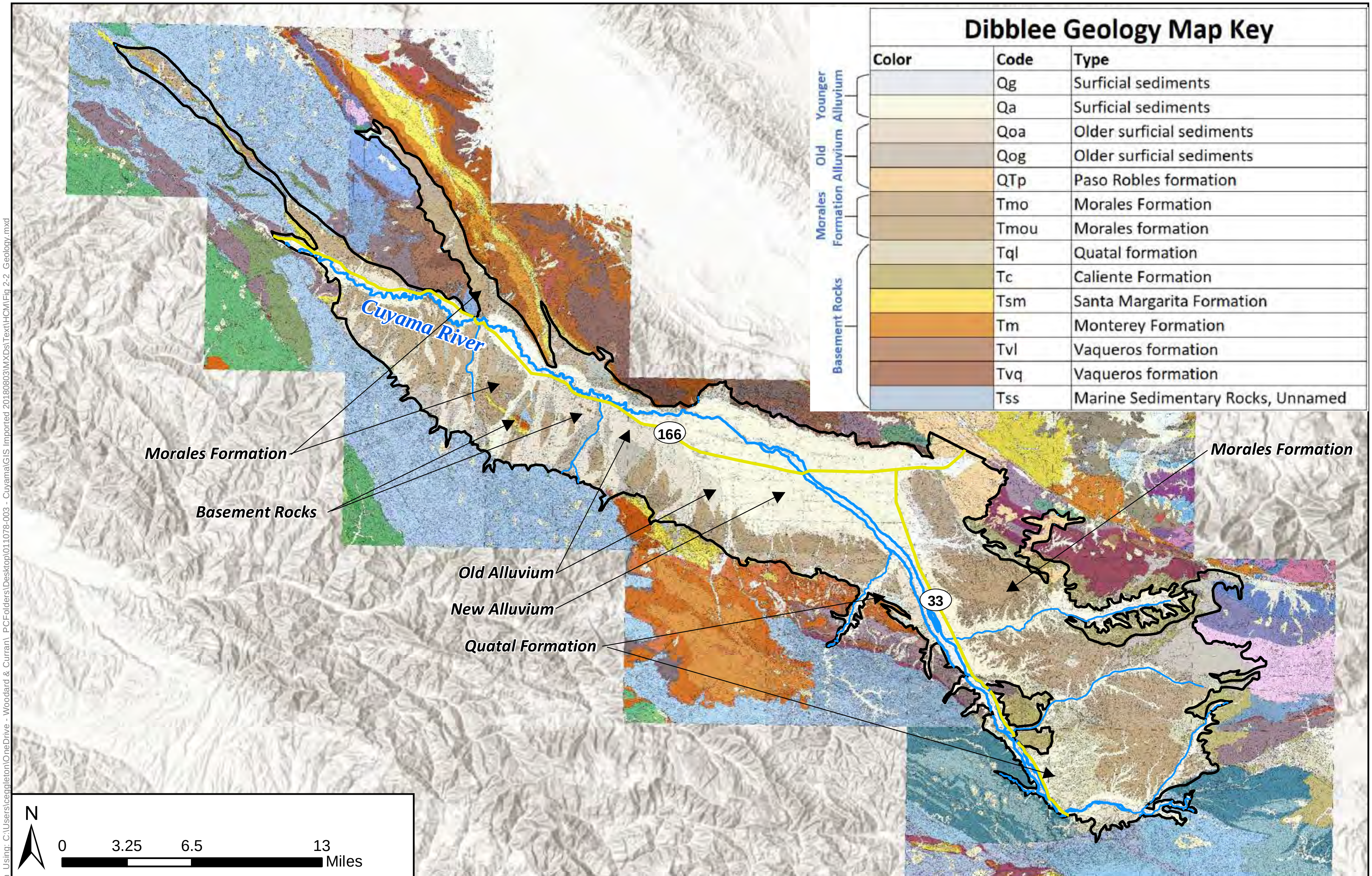

Figure 2-2: Geologic Map

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

December 2019

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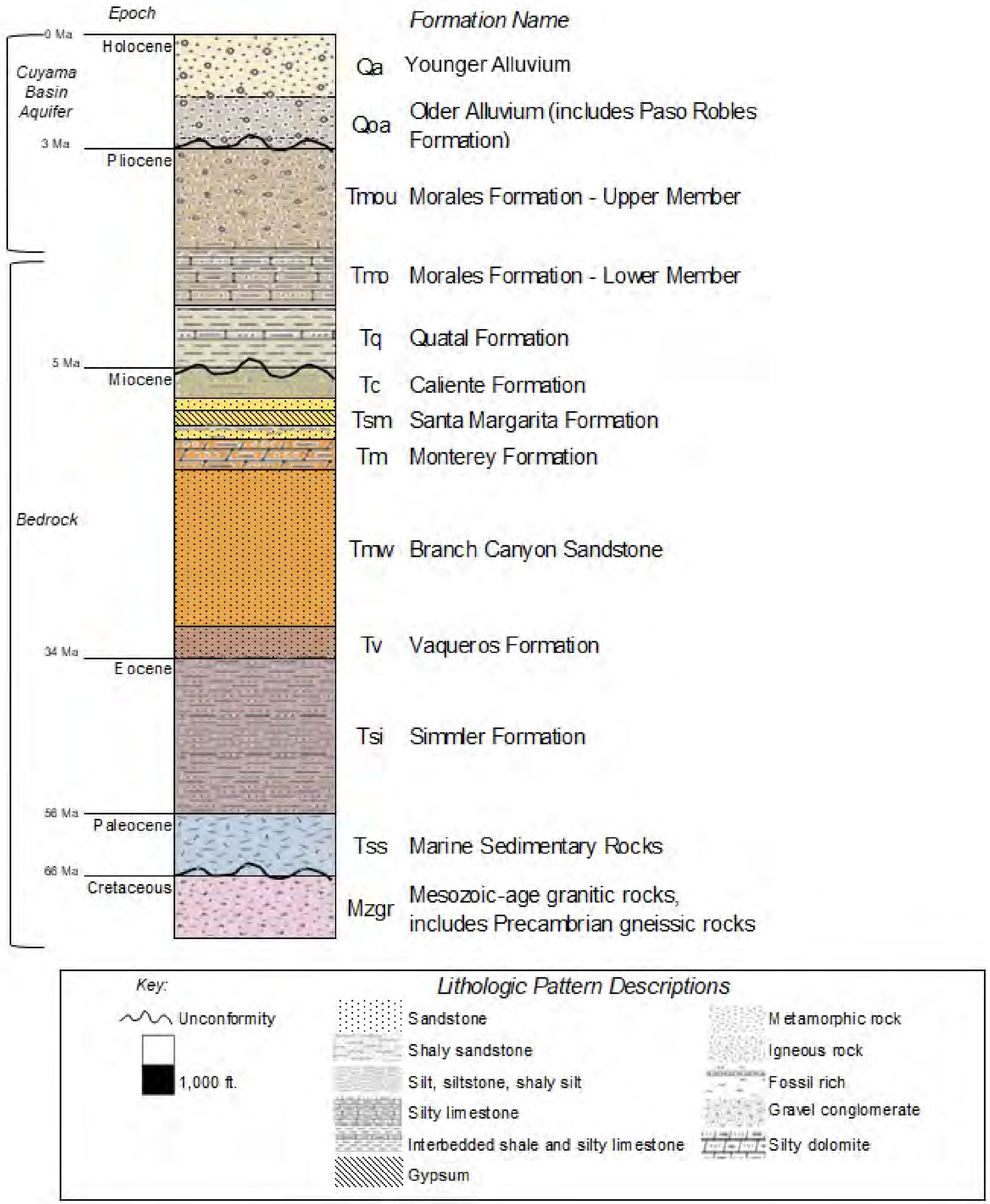
Legend

- Cuyama Basin
- Cuyama River
- Streams
- Highways

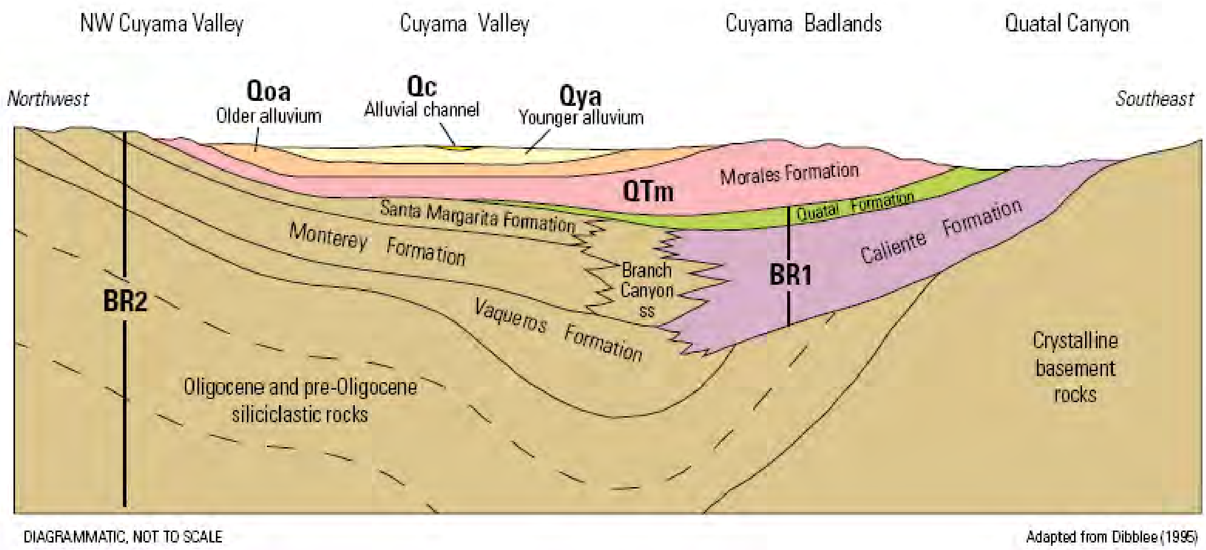
Data Source: Thomas W. Dibblee, Jr., Dibblee Foundation Relased in June 2012, Purchased from AAPG as GeoTIF 28 March 2018.

Figure Exported: 8/21/2018 By: ceggleton Using: C:\Users\ceggleton\OneDrive - Woodard & Curran\ PCFolders\Desktop\011078-003 - Cuyama\GIS Imported 20180803\MXDs\Text\HCM\Fig 2-2_Geology.mxd


Epoch
Formation Name
0 Ma
Holocene
Cuyama Basin Aquifer
Qa Younger Alluvium
Qoa Older Alluvium (includes Paso Robles Formation)
3 Ma
Pliocene
Tmou Morales Formation - Upper Member
Tmo Morales Formation - Lower Member
Tq Quatal Formation
5 Ma
Miocene
Tc Caliente Formation
Tsm Santa Margarita Formation
Tm Monterey Formation
Bedrock
Tmw Branch Canyon Sandstone
Tv Vaqueros Formation
34 Ma
Eocene
Tsi Simmler Formation
56 Ma
Paleocene
Tss Marine Sedimentary Rocks
66 Ma
Cretaceous
Mzgr Mesozoic-age granitic rocks, includes Precambrian gneissic rocks
Key:
Unconformity
1,000 ft.
Lithologic Pattern Descriptions
Sandstone
Shaly sandstone
Silt, siltstone, shaly silt
Silty limestone
Interbedded shale and silty limestone
Gypsum
Metamorphic rock
Igneous rock
Fossil rich
Gravel conglomerate
Silty dolomite

Stratigraphic Units of the Cuyama Basin Aquifer

Stratigraphic units in this section are presented in order from youngest to oldest. The USGS prepared a generalized stratigraphic diagram of the Basin and surrounding area in 2013 (Figure 2-4). The diagram shows the relationship of the Young Alluvium, Older Alluvium, Morales Formation, and basement rocks in and near the Basin. The diagram shows that the Morales formation is thicker to the east, and that the Caliente Formation is interfingered with a number of other basement rock formations (Santa Margarita, Monterey, Vaqueros) beneath the Basin (USGS 2013a). This diagram shows the general relationship of formations in the Cuyama area and is not a precise representation of unit thickness.



Source: USGS, 2013a.

Figure 2-4: Generalized Stratigraphic Diagram

Recent and Younger Alluvium

The youngest deposit of the Basin is the Recent and Young alluvium. Recent alluvium is made up of active fluvial channel deposits associated with the Cuyama River and other active channels. Deposits include river-bed gravels and grain sizes range from silt to boulder size and are found along active fluvial channels in the Basin. The Younger Alluvium is inactive fluvial deposits consisting of unconsolidated to partly consolidated sand, gravel, and boulders, with some clay deposited as part of stream channels, floodplains, alluvial fans, or stream terraces (USGS, 2013c). Younger Alluvium is exposed throughout the central portion of the Central Valley and along the active channels and flood plains of the Cuyama River and other streams. The deposits thicken to the east, typically ranging from 5 to 50 feet in the west and thickening from 630 to 1,100 feet in the east (Singer and Swarzenski, 1970). Recent and Younger alluvium are primarily Holocene in age, but the Younger alluvium can date back to the Pleistocene (USGS, 2013c). The Younger and Recent alluvium are the principal water-bearing formations in the Basin.

Older studies do not distinguish Younger Alluvium from Older Alluvium (Upson and Worts, 1951; Singer and Swarzenski, 1970), but more recent studies (Kellogg et al., 2008) mapped the two alluvium units as distinguishable mappable units at the surface, and in 2013, the USGS identified differences in the two units using electric log signatures. A greater degree of consolidation, dissection, and local deformation distinguishes the Older Alluvium deposits from the Younger alluvium.

Older Alluvium

Older Alluvium is primarily Pleistocene in age and is composed of unconsolidated to partly consolidated sand, gravel, and boulders with some clay (USGS, 2013a). The percentage of clay increases in the western part of the Cuyama Valley. Older Alluvium deposits are typically more consolidated and deformed than Younger alluvium deposits and contain a higher clay content. The Older alluvium is dissected alluvial fans, colluvial deposits and sediments on multiple terraces and alluvial surfaces and is found exposed on uplifted alluvial surfaces along the south side of the Cuyama Valley and on the caps of the Turkey Trap and Graveyard ridges (USGS, 2013a). Older Alluvium is typically 400 to 600 feet thick, but increases in thickness up to 1,000 feet near the axis of the Cuyama Valley and decreases in thickness west of the Russell fault (USGS, 2013a; Cleath-Harris, 2018). The Older Alluvium overlies the Morales Formation unconformably, west of the Cuyama Badlands (Ellis, 1994).

Paso Robles Formation

The Paso Robles Formation is part of the Quaternary alluvium series and is commonly grouped with the Older Alluvium. The Paso Robles Formation is a gray, crudely bedded alluvial gravel derived from Miocene rocks and basement rocks of western San Emigdio Mountains east of San Andreas Fault (Davis et al., 1988). The Formation is composed of pebbles, gravel, sand, and some cobbles. The Paso Robles Formation is sandwiched between two unconformities; it rests uncomformably below the Older Alluvium and with angular discordance above the Morales Formation (Davis et al., 1988; Ellis, 1994). The Paso Robles Formation is present only in a small northeastern portion of the Basin.

Morales Formation

The Pliocene to Pleistocene-aged Morales Formation (Morales) is divided into two members, the upper and lower. The Morales Formation is the oldest formation to respond to the modern topography of the Basin, indicating its deposition simultaneous to acceleration of tectonic-driven subsidence (Yeats et al., 1989). The contact between the upper and lower members of the Morales is used to define the base of water-bearing units of the Basin (USGS, 2013a).

The Morales is massively bedded and ranges from 1,000 to 5,000 feet in thickness east of the Russell fault and up to 1,200 feet thick west of the Russell fault (USGS, 2013a; Cleath-Harris, 2018). Thickness of the Morales Formation is disputed amongst published references. In 1970, Singer and Swarzenski reported the Morales Formation to be up to 10,000 feet in thickness along the northern margin of the Valley (Singer and Swarzenski, 1970). The Morales Formation is found throughout the Valley and is widely exposed to the east of the Cuyama River near Ventucopa and the Cuyama Badlands. Its lateral extent is generally limited by faults. The Morales Formation is overlain unconformably by the older and Younger Alluvium (Hill, 1958).

Upper Morales

The upper member of the Morales is composed of partly consolidated, poorly sorted deposits of gravelly arkosic sand, pebbles, cobbles, siltstone, and clay of Pleistocene age (Davis et al., 1988). The upper Morales is a water-bearing unit and the base of this member marks the base of aquifer materials in the Basin. The upper Morales is thickest to the east near the Cuyama Badlands, approximately 2,200 feet, and shallows to the west, less than 800 feet west of the Russell fault (Hill, 1958; Cleath-Harris, 2018). In the central portion of the Basin, south of the Cuyama River, the upper Morales is around 1,500 feet thick (Ellis, 1994). In some areas, such as near Ballinger Canyon, the Morales shows some degree of angular unconformity (Ellis, 1994).

Stratigraphic Units Below the Basin Aquifer

Lower Morales

The lower member of the Morales consists of clay, shale, and limestone with lacustrine clay beds with distinct coarse-grained intervals, boulder trains, and gravelly channel deposits (USGS, 2013a). The lower member of the Morales finer grained than the upper Morales and is less permeable. The lower Morales is not considered a water bearing unit. South of the Cuyama River, the lower part of the Morales consists of about 1,300 feet of gray, gypsiferous, lacustrine claystones (Hill, 1958). The lower Morales lies conformably on the Quatal Formation and, in western areas of the Basin, unconformably on other marine units (Ellis, 1994).

Quatal Formation

The Quatal Formation is a sequence of fluvial and lacustrine claystone, siltstone, and sandstone which unconformably underlies the Morales Formation. Near the Cuyama Badlands, the formation is up to 820 feet of gypsiferous claystone while in other areas the unit is nonmarine sandstones interbedded with the claystone (USGS, 2013a). The Quatal Formation thins to the west and pinches out to zero in thickness near the town of Cuyama. In the eastern and central parts of the Basin, the Quatal Formation is a distinct stratigraphic marker that defines the bottom of the Morales Formation (USGS, 2013a). The Quatal Formation is not a water bearing unit and is not considered a part of the Basin groundwater system.

Caliente Formation

The Caliente Formation is composed of nonmarine sandstones, claystones, and conglomerates of Miocene age (Davis et al., 1988). Layers of volcanic ash and basalt sills and dikes are commonly found in the formation and tertiary basalt is found interbedded with the formation in the Caliente Range (Davis, 1988; Dudek, 2016). The formation is exposed on the eastern half the Valley, along the Basin edge in the Caliente Ranges and in a footwall block of the Pine Mountain fault (Kellogg et al., 2008). The fluvial Caliente Formation was deposited in the east at the same time the marine Branch Canyon Sandstone and Santa Margarita Formation were being deposited to the west (Ellis, 1994). The Caliente Formation conformably overlies and interfingers with the marine sedimentary rocks of the Santa Margarita Formation and pinches out to zero thickness to the west (Kellogg et al., 2008; Davis et al., 1988).

Santa Margarita Formation

The Santa Margarita Formation is composed of shallow-marine, consolidated sandstones from the middle to late Miocene (USGS, 2013b). The formation contains a gypsum member and a sandstone-mudstone member. The gypsum member consists of a greenish-gray, medium to thin bedded gypsum, up to 82 feet thick (Kellogg et al., 2008). The sandstone and mudstone member consists of interbedded layers of arkosic sandstone, mudstone, and siltstone, up to 400 feet thick (Kellogg et al., 2008). The sandstone sequence is rich in shallow marine molluscan fossils. The formation unconformably underlies the Morales Formation in the northwest of the Valley and grades into the Caliente Formation to the east (Hill, 1958). Locally, the formation contains layers of volcanic ash, basalt sills, dikes and flow units (Davis et al., 1988). The Santa Margarita Formation is the youngest marine unit in the Basin and marks the final phase of marine sedimentation and sea transgression (Lagoe, 1981).

Monterey Formation

The Monterey Formation consists of intervals of dolomitic marine shale, mudstone, and siltstone. The formation is subdivided into two members: the upper Whiterock Bluff Shale member and the lower Saltos Shale member (Davis et al., 1988). The Whiterock Bluff Shale is a calcareous in the lower two-thirds and becomes gradually siliceous in the upper one-third and is found up to 1,200 feet in thickness (Bazeley, 1988; Hill, 1958). The Saltos Shale member is a calcareous shale with turbiditic sandstones and was deposited at the same time as the fluvial Caliente Formation, but in the western, bathyal portion of the Basin (Davis et al., 1988; USGS, 2013b). The Saltos Shale member is found up to 2,250 feet thick (Hill, 1958). The formation is middle Miocene in age and is cut with layers of volcanic ash and Miocene-age basalt sills (Davis et al., 1988). In the Caliente Mountain Range, tertiary basalt is found interbedded with the Monterey Formation (Davis et al., 1988). To the east, the Monterey Formation grades into the Branch Canyon Sandstone. The formation is conformably overlain by the Santa Margarita Formation.

Branch Canyon Sandstone

The Branch Canyon Sandstone is Middle Miocene in age and is a shallow marine sandstone (Davis et al., 1988). Like the Monterey and Santa Margarita formations, the Branch Canyon Sandstone contains layers of volcanic ash and is cut by basalt sills and dikes (Davis et al., 1988). The sandstone grades into the Caliente Formation to the east and is up to 2,500 feet thick (Kellogg et al., 2008). The easternmost extent of the Branch Canyon Sandstone represents an early Miocene wave-dominated shoreline and is defined by the gradational change into the nonmarine Caliente Formation to the east (Davis et al., 1988; Bazeley, 1988).

Vaqueros Formation

Most of the oil produced in the Basin comes from the Vaqueros Formation. The formation is late Oligocene to early Miocene in age and is a marine clastic unit that is subdivided into three members: the upper, shallow-marine Painted Rock Sandstone member, the middle, bathyal Soda Lake Shale member, and the lower, shallow-marine Quail Canyon Sandstone member (Davis et al., 1988). The Vaqueros Formation represents a shallow-marine, high-energy, shoreface environment where the lower half represents a transgressive environment and the upper half represents a regressive environment (Bazeley, 1988). To the east, the Vaqueros Formation grades into the lower part of the nonmarine Caliente Formation. In the Cuyama Badlands, the Vaqueros Formation rests on the Simmler Formation and crystalline basement rocks, while in the central portion of the Basin, the Vaqueros Formation rests on Paleogene sedimentary rocks (Ellis, 1994). The Branch Canyon Sandstone and Monterey Formation are conformably above the Vaqueros Formation (Davis et al., 1988).

Simmler Formation

The Simmler Formation is a terrestrial sandstone, siltstone, and conglomerate of the Oligocene epoch (Davis et al., 1988). The Simmler Formation contains a shale member containing intervals of claystones and siltstones interbedded with coarse sandstones and a sandstone member containing sandstones interbedded with siltstones and claystones (Kellogg et al., 2008). The formation is as thick as 2,800 feet and overlies the Eocene-Oligocene unconformity (Kellogg et al., 2008). To the east, the Simmler Formation interfingers with a thin section of the marine Vaqueros Formation, marking the beginning of marine regression in the early to middle Miocene (Kellogg et al., 2008). Sediments of the Simmler Formation were sourced from the erosion of the Santa Barbara Canyon area and were deposited on a wide, delta plain (Bazeley, 1988). Though rare, the Simmler Formation can contain interbedded mafic volcanics (Yeats et al., 1989).

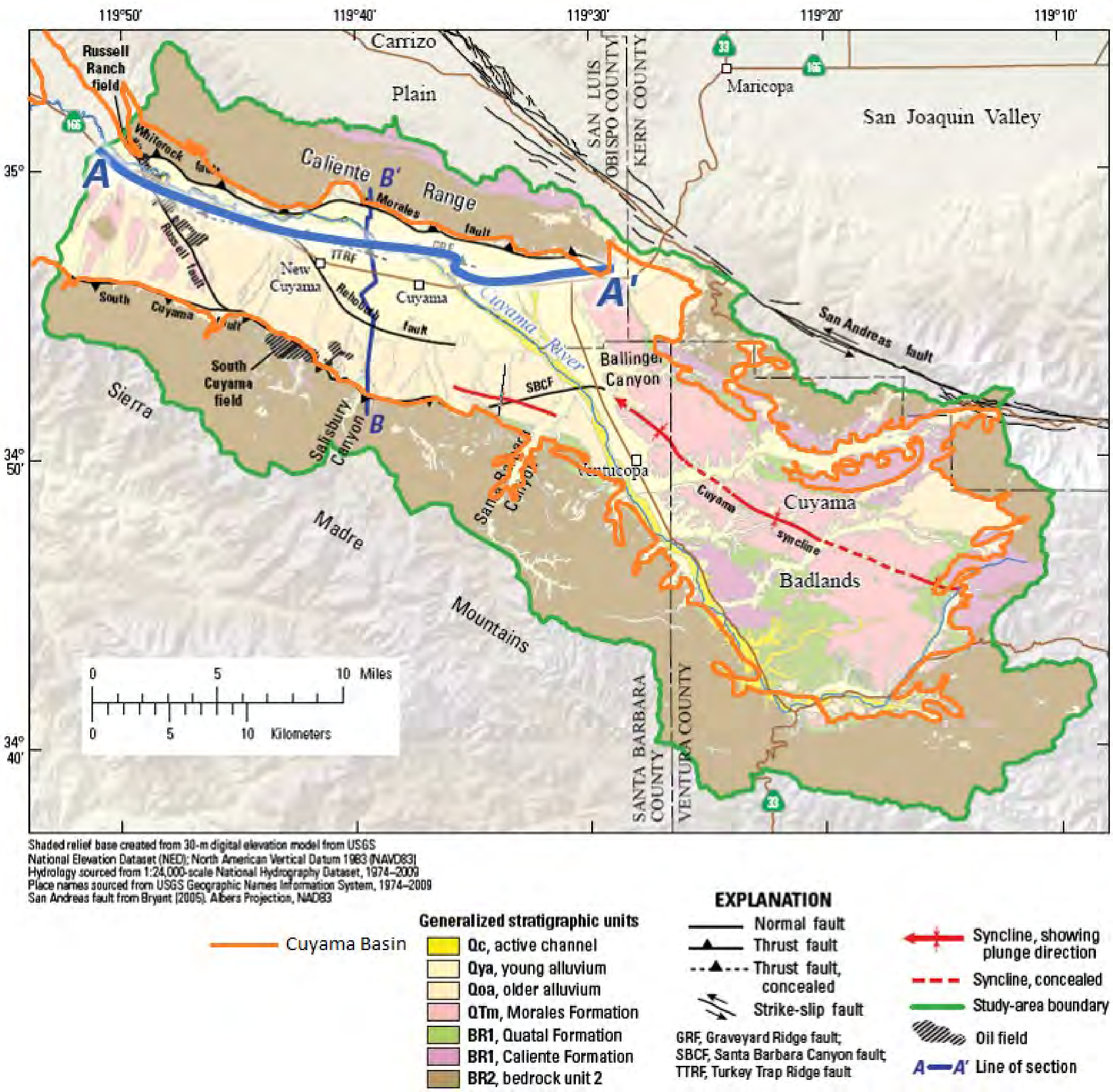
Marine Sedimentary Rocks

Late Cretaceous to Eocene marine rocks are unnamed but are part of the crystalline basement of the Cuyama Valley (Davis et al., 1988). The strata are unconformably overlain by a thick section of middle and upper Cenozoic rocks and are primarily exposed in the La Panza and Sierra Madres ranges and the hanging walls of the South Cuyama, La Panza, and Ozena faults (Davis et al., 1988).

Formations Older Than Marine Sedimentary Rocks

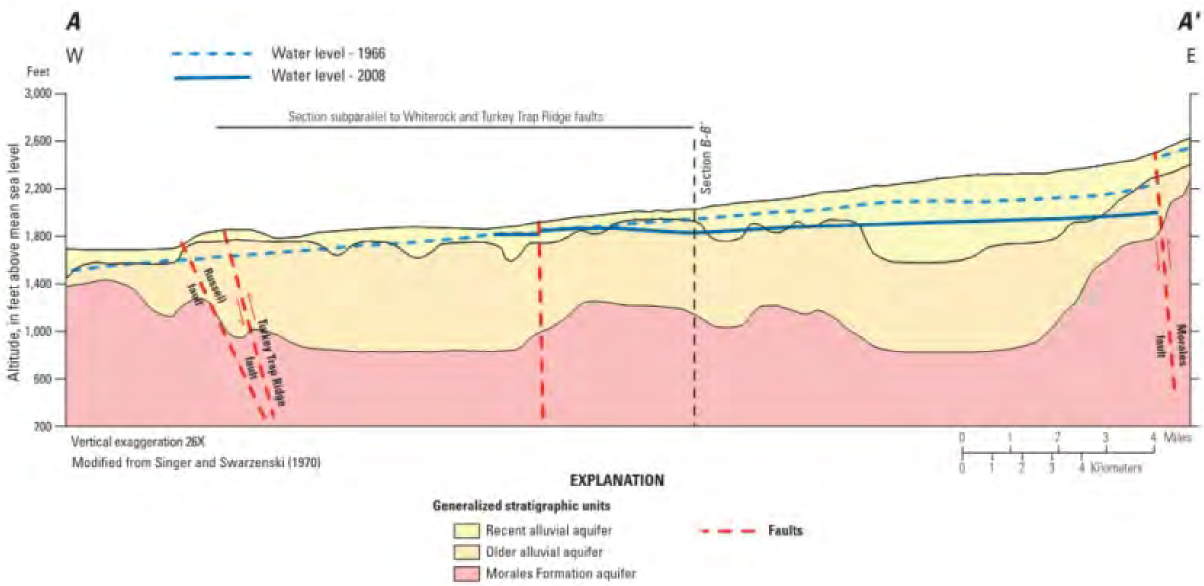
The crystalline rocks of the Cuyama Valley are composed of Mesozoic age granitic rocks and Precambrian age gneissic rocks (Davis et al., 1988). Cretaceous granitic rocks are exposed in the La Panza Range and near the San Andreas Fault, 12 to 18 miles southeast of the Cuyama Valley (USGS, 2013b). Precambrian granitic gneissic rocks outcrop east of the Cuyama Badlands and the La Panza Range (USGS, 2013b). Total thickness is unknown.

Figure 2-5 shows the locations of cross sections across the central portion of the Basin prepared by USGS in 2013. Figure 2-5 shows a west-east cross section that runs near the towns of New Cuyama and Cuyama labeled A-A’, and a south-north cross section labeled B-B’. Figure 2-6 shows the A-A’ cross section and Figure 2-7 shows the B-B’ cross section. Cross-section A-A’ shows the layering of Recent and Old alluvial aquifers and the Morales Formation aquifer. It also shows where the Russell Fault and Turkey Trap Ridge Fault cross the cross section, and shows groundwater elevation. Figure 2-7 shows cross section B-B’, which shows layering of the aquifers and the locations where the Rehoboth and Graveyard Ridge fault cross the cross section.



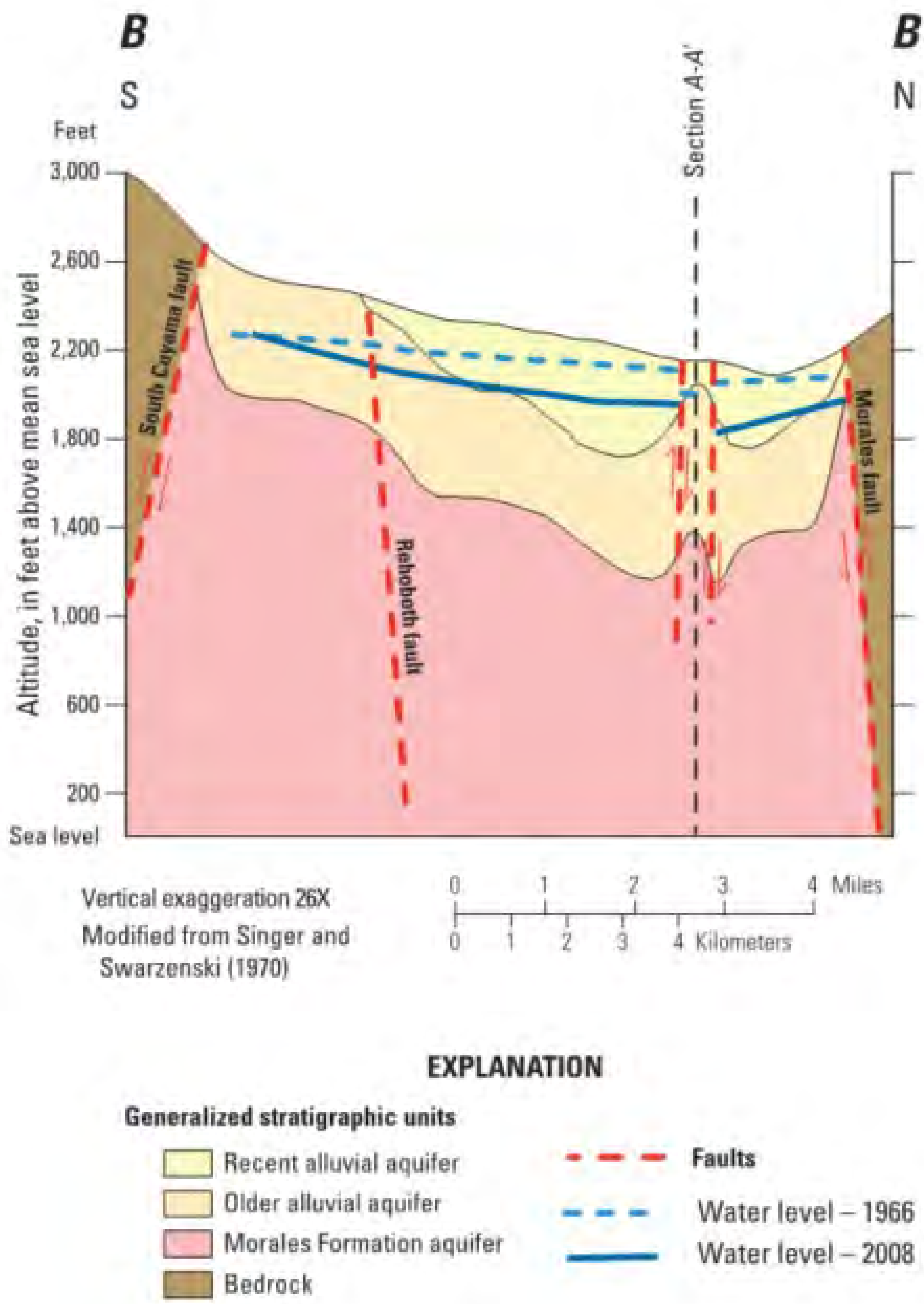
Source: USGS, 2015.

Figure 2-5: Location of USGS 2015 Cross Sections



Source: USGS, 2015

Figure 2-6: USGS Cross Section A-A'



Source: USGS, 2015

Figure 2-7: USGS Cross Section B-B'

2.1.5 Faults and Structural Features

The Basin is bounded by faults and contains a number of tectonic features including synclines, faults, and outcrops of basement rocks in the Basin. Major faults and synclines are shown in Figure 2-8. Outcrops of basement rocks are shown on the geologic maps (Figure 2-2 and Figure 2-5).

Synclines

There are a number of synclines in the Basin; they are generally oriented to the northwest/southeast consistent with how the majority of the Basin is oriented.

Cuyama Syncline

The Cuyama Syncline is located in the southeastern portion of the Basin. It stretches from the Ballinger Canyon south into the Cuyama Badlands, ending along the Cuyama River. The Cuyama Syncline plunges from the Ventucopa area northwestward to beneath the valley from the Ventucopa area to the southeast. The syncline is known from subsurface data from oil exploration wells beneath the valley and exposed near the town of Ventucopa and in the Cuyama Badlands. (USGS, 2013a). The axis of the syncline strikes roughly parallel to the San Andreas Fault (N50°W) and plunges to the northwest (13°NW) (Singer and Swarzenski, 1970; Ellis, 1994). The Cuyama syncline was a depocenter (a site of sediment accumulation) during the deposition of the Morales Formation (Ellis, 1994). The syncline has folded water and non-water bearing formations and is favorable to the transmission of water from the southeast end of the valley but otherwise has no pronounced effect on the occurrence of groundwater (Upson and Worts, 1951).

Syncline Near the Santa Barbara Canyon Fault

Near the Santa Barbara Canyon Fault (SBCF), A syncline is indicated by the USGS. The syncline runs generally east-west and is roughly 5 miles long. It ends near the southern edge of the South Cuyama fault (USGS, 2013a).

Syncline in the Northwestern Portion of the Basin

There is a syncline in the western portion of the Basin that roughly follows a west-northwest direction near the southern border of the Basin, located southwest of the Russel fault, near an outcrop of the Santa Margarita formation (Cleath-Harris, 2018). The full extent of this syncline, and its length are not documented at this time, but likely extends 5 to 10 miles, which is the length of documented faults in the area, as mapped by Dibblee. (Dibblee, 2005)

Major Faults

There are a number of faults within the Basin, many of which take the form of ‘fault zones’ where there are multiple individual faults close together oriented in the same direction. This section describes each major fault individually, with consideration that there are often additional small faults near each major fault. Major faults are shown in Figure 2-8.

Russell Fault

The Russell fault is a subsurface, right lateral, strike-slip fault that is 7 miles long and runs roughly parallel to the Russell Ranch oil field through the western portion of the Basin.

The Russell fault offsets the top of bedrock by as much as 1,500 feet (Nevins, 1982), and has had approximately 18 miles of right-lateral offset documented on the NW-striking Russell fault in the northwestern part of the Cuyama Valley have occurred between 23 and 4 Ma (USGS, 2013a; Ellis, 1994). The fault is referred to as strike-slip by several authors, and normal fault by others, and is sometimes referred to as both strike slip and normal within the same document (USGS, 2013a). Water bearing units on the western (upthrown) side of the Russell fault become thinner to the west of the Russell Fault and become thicker to the east of the Russel Fault due to this uplift. Alluvium is generally limited to stream channels and the Cuyama River bed on the western side of the fault.

The Russell fault has been analyzed by a number of authors who have come to differing conclusions regarding the fault's potential to be a barrier to groundwater flow. In 1989, Yeats stated that "the base of the Morales Formation is not cut by the fault" (Yeats et al., 1989). Using tectonic activity and decreasing offset of younger beds, Yeats concluded that the Vaqueros Formation is primarily impacted as it was deposited during the fault's most active period and that by the time the Morales Formation was deposited 19 million years later, activity on the fault had ceased (Yeats et al., 1989). The USGS in 2008 initially concluded that the fault was not a barrier to flow (USGS, 2013c). The USGS in 2013 studied the fault using interferometric synthetic-aperture radar (InSAR) data and concluded that "the Russell fault did not appear to be acting as a barrier to groundwater flow" (USGS, 2013c). In 2015 the USGS identified the Russell fault as a barrier to flow and used it as a no flow boundary in the Cuyama Valley Hydrologic Model (CUVHM) (USGS, 2015). Based on the conclusions of the USGS, Dudek stated that the fault has indicators that it obstructs groundwater flow due to truncation of older geologic formations and standing moisture near the fault and prepared a basin boundary modification request based on the conclusion that the fault is a barrier to flow (Dudek, 2016). In addition, Cleath-Harris determined that the fault is a barrier to flow and prepared a technical memorandum to document their study of the fault's behavior (Cleath-Harris, 2018). In 2016, DWR denied a request for a basin boundary modification motivated by claims that the Russell Fault is a barrier to groundwater flow and divides groundwater in the central portion of the Basin from groundwater in the west. DWR rejected the Basin boundary modification request, citing a lack of hydrogeologic data that supported evidence of barrier. EKI reviewed the USGS's work in 2017 and concluded the fault potential to be a barrier is not understood and recommended additional study to refine the fault's properties (EKI, 2017).

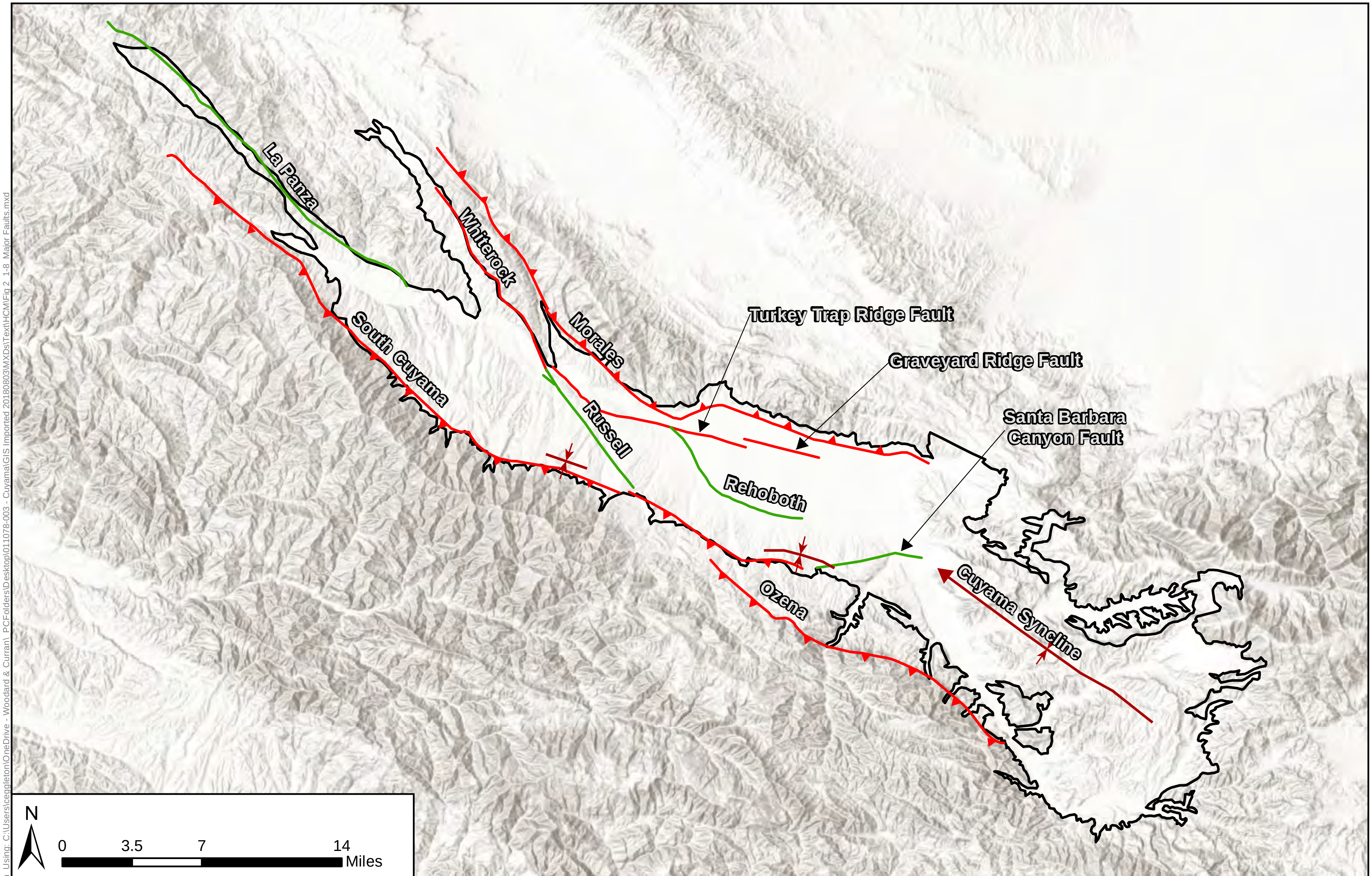


Figure 2-8: Major Faults

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Legend

Fault Types

Normal

Syncline

Thrust

Thrust Fault, Concealed

Cuyama Basin

Figure Exported: 8/21/2018 By: ceppleton Using: C:\Users\ceppleton\OneDrive - Woodard & Curran_PCFolders\Desktop\011078-003 - Cuyama\GIS Imported 20180803\MXDs\Text\HCM\Fig 2_1-8_Major Faults.mxd

Rehoboth Fault

The Rehoboth fault is a normal, subsurface fault that bisects the central portion of the Basin. The fault is approximately 8 miles long and trends to the southeast. The USGS concluded that evidence of the fault is inferred based on water level-changes in the west-central part of the valley and offset of the Morales Formation (USGS, 2013b; USGS, 2013a). The top of the Morales Formation is offset 160 feet on the northeast side of the fault and the offset increases with depth (USGS, 2013a). Surface exposures of the Older Alluvium do not appear to be offset along the trace of the fault, indicating the motion of the Rehoboth fault ceased prior to the deposition of the older and Younger Alluvium (USGS, 2013a).

Despite stating that the Rehoboth fault does not "have a discernible effect on the elevation" of the Older Alluvium and Younger Alluvium and that the fault was "not a significant barrier to groundwater flow" as symmetrical subsidence and uplift was observed on both sides of the fault, the USGS included the Rehoboth fault as a leaky, horizontal barrier to groundwater flow in the CUVHM (USGS, 2013a; USGS, 2013b; USGS, 2015). In the CUVHM, the Rehoboth fault impedes underflow in the Older Alluvium and Morales Formation along the Sierra Madre Foothills region (USGS, 2015). The USGS also listed the Rehoboth fault as affecting the younger and Older Alluviums and the Morales Formation in a summary table of "Geologic Units affected by Cuyama Valley faults" (USGS, 2013a).

Whiterock Fault

The Whiterock fault is a surface and subsurface thrust fault that runs along the northern finger of the Cuyama Basin. The fault can be traced further south under the Basin near the Cuyama River and SR 166, though it is subsurface (Calhoun, 1985). The fault dips northeast and is late Oligocene to early Miocene in age (Davis et al., 1988). The Whiterock fault is exposed at the surface where it thrusts the Monterey Formation over the Morales Formation (Davis et al., 1988). Activity along the fault began after movement ceased on the Russell fault and tectonically overrides the Russell fault (Nevins, 1982; Calhoun, 1985). The fault cuts the Morales Formation south of the Cuyama River but does not affect the younger or Older Alluviums (DeLong et al., 2011; Nevins, 1982).

Turkey Trap Ridge Fault and Graveyard Ridge Fault

The Turkey Trap Ridge fault and the Graveyard Ridge fault are normal, subsurface faults that trend slightly north of west in the center of the Cuyama Valley (USGS, 2013a). The primary difference between the two faults is that the Turkey Trap Ridge fault is 11 miles long and located southwest of the Graveyard Ridge fault; the Graveyard Ridge fault is 4 miles long. Both faults are located north of SR 166 and are oriented in a "left-stepping, echelon pattern" (USGS, 2013a). Seismic reflection profiles collected along the ridges indicate they are bounded by north-dipping, south-directed, reverse faults along the south sides (USGS, 2013a). Both faults are considered to be barriers to groundwater. Evidence of the faults and their no-flow zones include springs and seeps along the base of the faults in the 1940-50s and water-level changes across the faults of 80 to 100 feet in the area near these ridges (Upson and Worts, 1951; Singer and Swarzenski, 1970).

In 1970, Singer and Swarzenski reported that water removed by pumping from this region was slow to replenish because faults restrict movement of water from neighboring areas. The impediment to flow could be related to the hydraulic properties of the faults themselves or fault juxtaposition of older, slightly less permeable Older Alluvium to the north against Younger Alluvium to the south of the faults (USGS, 2013a).

South Cuyama Fault

The South Cuyama fault is a surficial, thrust fault that defines a 39-mile stretch of the Basin's southwestern boundary. The fault thrusts the Eocene-Cretaceous aged marine sediments against the Older Alluvium and Morales Formation and impedes groundwater flow across the fault zone.

Ozena Fault

The Ozena fault is a 17-mile long surficial, thrust fault located 3 miles south of the Cuyama Basin and locally cuts through the southeastern canyons of the Basin. Less than 1 mile of the Ozena fault is within the Cuyama Basin boundary. The fault trends west to northwest and runs parallel to the Basin boundary.

Santa Barbara Canyon Fault

The SBCF is a normal, subsurface fault that runs 5 miles perpendicular to the Santa Barbara Canyon. The fault is east-west striking and offsets basin deposits with impermeable Eocene-Cretaceous marine rocks (typically the Simmler and Vaqueros Formations) (Bazeley, 1988). Evidence of the fault comes from reported seasonal springs, a steep hydraulic gradient in the southeastern part of the Cuyama Valley near the fault, and the truncation of distinct gravel beds (Singer and Swarzenski, 1970). Water levels in the Ventucopa area have been reported 98 feet higher than water levels to the north (Singer and Swarzenski, 1970). The fault is considered a barrier to groundwater flow as it prevents groundwater flow from moving across the boundary bounded by the marine rocks (USGS, 2015). The USGS in 2013 also concluded that the SBCF was a barrier to groundwater flow: "Relatively small amount of vertical offset in the SBCF indicates changes in water levels across the fault documented in previous studies are perhaps the result of distinct fault-zone properties rather than juxtaposition of units of differing water-transmitting ability" (USGS, 2013a).

La Panza Fault

The La Panza fault is a surficial thrust fault that trends west to northwest along 22 miles of the western margin of the Basin (USGS, 2013b). The present day thrust fault is a reactivated Oligocene extensional fault that was once part of the same system with the Ozena fault (USGS, 2013b; Yeats et al., 1989). The fault defines the west-central margin of the Basin as it juxtaposes older non-water bearing Eocene to Cretaceous marine rocks and the Simmler Formation against the younger, water bearing alluvium and Morales Formation, impeding groundwater flow across the fault.

Morales Fault

The Morales fault is a 30-mile-long thrust fault that forms the boundary along the north central portion of the Basin. The Morales thrust fault has a dip of approximately 30 degrees (Davis et al., 1988).

Unnamed Fault Near Outcrop of Santa Margarita Formation

A fault located southwest of the Russell fault runs southeast to northwest and is located next to an outcrop of the Santa Margarita formation inside the Basin (Dibblee, 2005). The fault runs parallel to the long side of the outcrop and bounds the syncline that is to the south of the outcrop. The fault's extent is not well documented, and its surficial exposure is roughly 5 miles long.

Outcrops of Bedrock Inside the Basin

There are a number of outcrops of non-aquifer material within the Basin. The outcrops occur primarily in the eastern upland portion of the Basin and the western portion, near and to the west of the Russell Fault. Outcrops of basement rock in the western portion of the Basin occur in a different manner than those in the eastern portion, outcrops in the eastern portion are likely depositional contacts with the Morales Formation that were missed during basin delineation by DWR.[4] Outcrops in the western portion are likely tied to tectonic activity and faulting.

Outcrops of basement rock in the eastern upland portion of the Basin are shown in Figure 2-2. The Quatal Formation, and the Caliente Formation are present within the Basin boundary near the edges of the Basin. The Quatal formation is exposed at the surface near the Cuyama River, and in the higher elevation portions of the Basin, and in a band near the Quatal Canyon. The Caliente Formation is exposed at the surface within the Basin in the northeast portion of the Basin, near and along the Quatal Canyon. Another outcrop of Caliente Formation is present near the Cuyama River, but that outcrop has been excluded from the Basin during the Basin's delineation by DWR and is visible in Figure 2-2.

Outcrops of basement rock in the western portion of the Basin are exposed at the surface in limited areas and are tied to tectonic activity in the area.

Figure 2-9 shows the outcrops of bedrock near the Russell Fault with an overlay of areas identified by DeLong as "Tr," or out of basin bedrock, overlain on the geologic mapping performed by Dibblee. In general, the outcrops identified by DeLong and Dibblee largely overlap and indicate that in separate field study efforts, the outcrops were identified independently by different geologists. As shown in

[4] DWR delineates basins based on the type of restrictions to groundwater flow. The boundaries of the Cuyama Basin were delineated by DWR because they were the boundary between permeable sedimentary materials (within the Basin) and impermeable bedrock (outside the Basin). DWR defines this boundary as "Impermeable bedrock with lower water yielding capacity. These include consolidated rocks of continental and marine origin and crystalline/or metamorphic rock."

Figure 2-9, outcrops of non-aquifer materials are present near the Russell Fault, next to the Cuyama River, as well as to the south of the Cuyama River, both in small outcrops that are partially linear in nature, and larger outcrops that are located next to faults, such as where the Santa Margarita, Monterey and Marine Sedimentary Formations are present. The presence of these non-aquifer materials in this area likely restricts groundwater movement by limiting the extent of permeable materials in this portion of the Basin.

Data Sources:
De Long: Climate change triggered sedimentation and progressive tectonic uplift in a coupled piedmont–axial system: Cuyama Valley, California, USA.
Stephen B. DeLong, Jon D. Pelletier, and Lee J. Arnold
Earth Surface Processes and Landforms
Earth Surf. Process. Landforms 33, 1033–1046 (2008)
Published online 13 September 2007 in Wiley InterScience (www.interscience.wiley.com) DOI: 10.1002/esp.1600
Dibblee: Thomas W. Dibblee, Jr., Dibblee Foundation, Relased in June 2012, Purchased from AAPG as GeoTIF 28 March 2018.

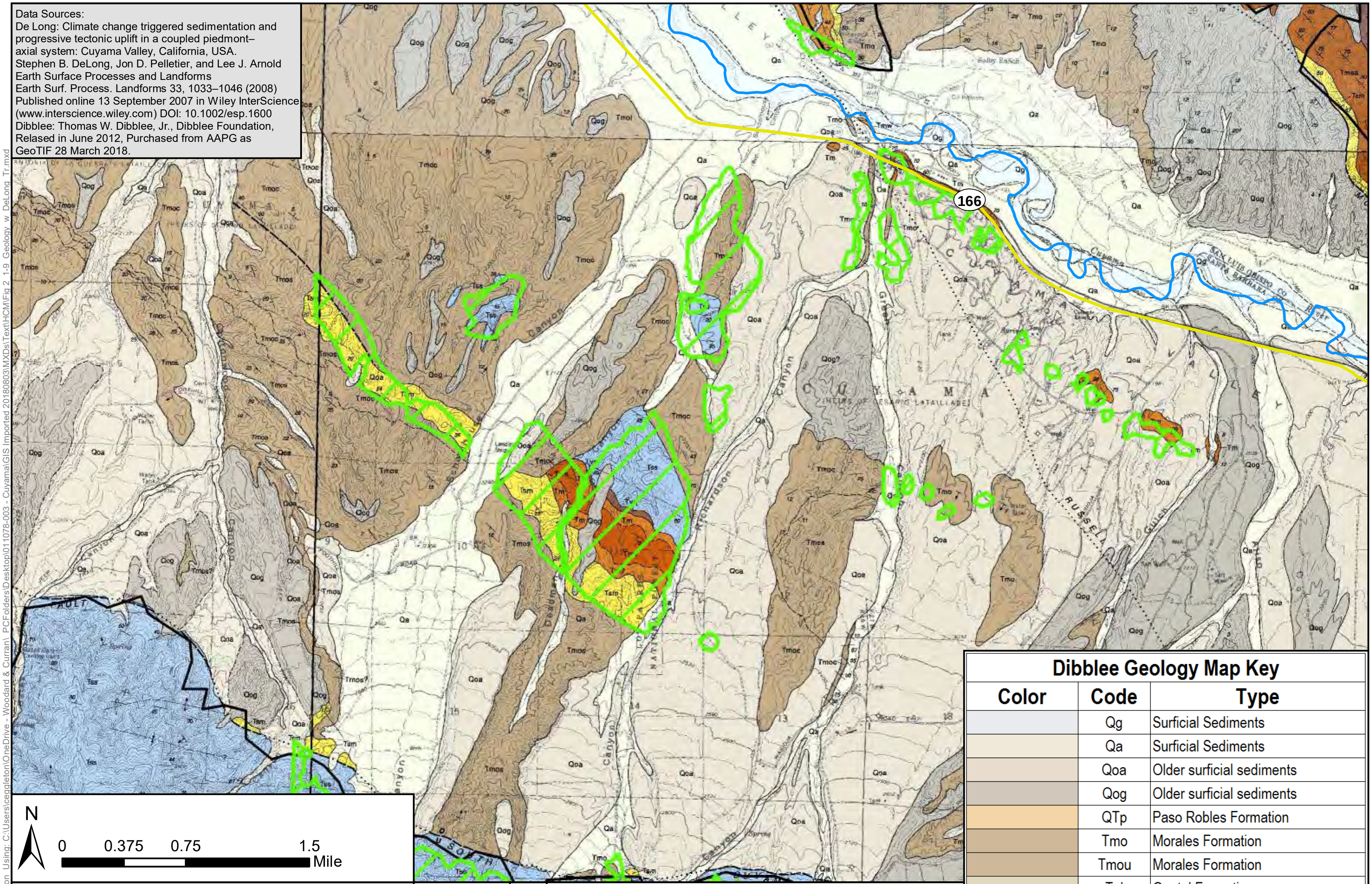

Figure 2.1-9: Geology with De Long "Tr" Overlay

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Dibblee Geology Map Key

Color	Code	Type
	Qg	Surficial Sediments
	Qa	Surficial Sediments
	Qoa	Older surficial sediments
	Qog	Older surficial sediments
	QTp	Paso Robles Formation
	Tmo	Morales Formation
	Tmou	Morales Formation
	Tql	Quatal Formation
	Tc	Caliente Formation
	Tsm	Santa Margarita Formation
	Tm	Monterey Formation
	Tvl	Vaqueros Formation
	Tvq	Vaqueros Formation
	Tss	Marine Sedimentary Rocks,

2.1.6 Basin Boundaries

The Basin has multiple types of basin boundaries. The majority of the boundaries are in contact with impermeable bedrock and faults, and a small portion is bounded by a groundwater divide between this Basin and the Carrizo Plain groundwater basin.

Lateral Boundaries

The Cuyama Basin is geologically and topographically bounded; to the north by the Morales and Whiterock faults and the Caliente Range, to the west by the South Cuyama and Ozena faults and the Sierra Madre Range, to the east within the Los Padres National Forest and Caliente Range, and to the south by the surface outcrops of Pliocene and younger lithologies, which are surrounded by Miocene and older consolidated rocks (Dudek, 2016). The boundaries of the Cuyama Basin were delineated by DWR in Bulletin 118 because they were the boundary between permeable sedimentary materials and impermeable bedrock. DWR defines this type boundary as: “Impermeable bedrock with lower water yielding capacity. These include consolidated rocks of continental and marine origin and crystalline/or metamorphic rock” (DWR, 2003). The thrust faults bounding the Cuyama Basin juxtapose younger, water-bearing lithologies against older, impermeable rocks. The consolidated continental and marine rocks and shales of the bordering mountain ranges mark a transition from the permeable aquifer sediments to impermeable bedrock.

Boundaries with Neighboring Subbasins

The Cuyama Basin shares a boundary to the east with the Carrizo Plain Groundwater Basin (Carrizo Plain Basin) and the Mil Potrero Area Groundwater Basin, as shown in Figure 1-3. The Cuyama and Carrizo Plain basins share a 4-mile boundary along Caliente Ranges, which is a groundwater divide basin boundary. DWR defines this type of boundary as “A groundwater divide is generally considered a barrier to groundwater movement from one basin to another for practical purposes. Groundwater divides have noticeably divergent groundwater flow directions on either side of the divide with the water table sloping away from the divide” (DWR, 2003).

The Cuyama and Mil Potrero basins are share a less than 1 mile boundary along the San Emigdio Canyon. The division between the Cuyama and Mil Potrero basins is also a groundwater divide basin boundary.

Bottom of the Cuyama Basin

The bottom of the Basin is generally defined by the base of the upper member of the Morales Formation (USGS, 2015). The lower member of the Morales Formation is composed of clay, shale, and limestone and is less permeable than the upper member of the Morales Formation (USGS, 2013a). The USGS describes the Morales Formation (both the upper and lower member combined) as up to 5,000 feet thick (USGS, 2013a). The top of the Morales Formation is generally encountered 750 feet below ground surface (bgs) but ranges up to 1,750 feet bgs in the Sierra Madre Foothills (USGS, 2013a). When referring to the Morales Formation in the context of the Cuyama aquifer, this is a reference to only the upper member of the Morales Formation.

2.1.7 Principal Aquifers and Aquitards

There is one principal aquifer in the Basin composed of the Younger Alluvium, Older Alluvium, and the Morales Formation. DWR's *Groundwater Glossary* defines an aquifer as "a body of rock or sediment that is sufficiently porous and permeable to store, transmit, and yield significant or economic quantities of groundwater to wells and springs" and an aquitard as "a confining bed and/or formation composed of rock or sediment that retards but does not prevent the flow of water to or from an adjacent aquifer." Most of the water pumped in the valley is contained in the younger and Older Alluviums. These two units are indistinguishable in the subsurface and are considered, hydrologically, one unit. There are no major stratigraphic aquitards or barriers to groundwater movement, amongst the alluvium and the Morales Formation. The aquifer is considered to be continuous and unconfined with the exception of locally perched aquifers resulting from clays in the formations.

Aquifers

The aquifers making up the principal aquifer in the Cuyama Basin are Younger Alluvium, Older Alluvium, and the Upper Member of the Morales Formation. These units consist of unconsolidated to partly consolidated sand, gravel, silt, clay, and cobbles within alluvial fan and fluvial deposits and in total range from 3,000 to 4,000 feet in thickness (Upson and Worts, 1951). Rocks older than the upper Morales Formation are generally considered either non-water bearing or contain water, but the water is released too slowly or of quality that is too poor for domestic and irrigation uses (USGS, 2013a). Historically, most of the water pumped in the Cuyama Valley has been extracted from the Younger and Older alluvium.

Recent and Younger Alluvium

Historically, most of the water pumped in the Cuyama Basin was sourced from the saturated portions of the Younger and Older alluvium (Singer and Swarzenski, 1970). Groundwater is found in the permeable Holocene alluvial fill and in the underlying, less permeable, Pliocene-Pleistocene continental deposits. Younger Alluvium deposits thicken to the east, typically ranging from 5 to 50 feet in the west and thicken from 630 to 1,100 feet in the east (Singer and Swarzenski, 1970).

The Younger Alluvium varies compositionally across the Basin (Upson and Worts, 1951). The Recent and Younger alluvium is the primary source of groundwater on the western side of the Basin. In the west, Younger Alluvium consists of interbedded layers of sand and gravel and thick beds up clay (ranging from 1 to 36 feet thick) (Upson and Worts, 1951). Clay beds, found 100 to 150 feet bgs, define the base of the Younger Alluvium (Upson and Worts, 1951). Wells in the western part of the Basin that are screened in the Younger Alluvium are shallow but have moderately large yields, as the sands and gravels have high permeabilities (Singer and Swarzenski, 1970).

In the south-central part of the Basin, the alluvium contains more gravel and is less fine grained compared to western alluvium. The alluvium is predominantly sand and silt with some beds of gravel and clay, though no continuous layers of any material exist (Upson and Worts, 1951).

Older Alluvium

Older Alluvium consists of unconsolidated to partly consolidated sand, gravel, boulders, and some clay. Similar to the Younger Alluvium, clay content increases to the west (Upson and Worts, 1951). Like the Younger Alluvium, historically most of the water pumped in the Cuyama Basin was sourced from the saturated portions of the younger and Older Alluvium (Singer and Swarzenski, 1970). More wells are perforated in the Older Alluvium in the western portion of the Basin than to the east (USGS, 2013c). In most regions of the Basin, the top of the saturated zone (the water table) is either deep in the alluvium or below its base (Upson and Worts, 1951).

Upper Morales Formation

The Pliocene to Pleistocene-aged Morales Formation is divided into two members, the upper and lower. The upper member of the Morales Formation is composed of partly consolidated, poorly sorted deposits of gravelly arkosic sand, pebbles, cobbles, siltstone, and clay and is considered water bearing (USGS, 2013a). Water bearing properties of the Morales Formation are not well defined, but available data indicate that the hydraulic conductivity of the formation varies greatly laterally and with depth (USGS, 2013c). Permeabilities of the upper Morales Formation vary greatly laterally and with depth; the highest values occur in the syncline beneath the central part of the valley and decrease to the west (Singer and Swarzenski, 1970). In the east and southeastern parts of the valley where the Morales Formation crops out, the formation is coarse grained and moderately permeable, but land is topographically unsuited to agricultural development and few wells have been installed.

Aquifer Properties

The highest yielding wells are screened in the alluvium and located in the north-central portion of the Basin. Pumping in the alluvium also occurs in the eastern part of the Cuyama Valley, along the Cuyama River and its tributary canyon as far as a few miles upstream from Ozena (Singer and Swarzenski, 1970).

Hydraulic Conductivity

DWR defines hydraulic conductivity as the "measure of a rock or sediment's ability to transmit water" (DWR, 2003). The hydraulic conductivity is variable within the principal aquifer, varying laterally, vertically, and amongst the three aquifer formations. In general, conductivity is highest near the center of the Basin and decreases to the west and east with the highest values associated with the Younger Alluvium and the Morales Formation with the lowest. Conductivity data are widely available for the central portion of the Basin (near the towns of New Cuyama and Cuyama) and near the western vineyards; data are sparse elsewhere.

Available data from field tests (including pump and slug tests) were reviewed from the following sources:

- 3 multi-completion USGS wells (USGS, 2013c)
- 51 Pacific Gas & Electric (PG&E) wells (USGS, 2013c)
- 66 private landowner wells in the central portion of the Basin
- 2 private landowner wells in the western portion of the Basin

Figure 2-10 shows the locations of these wells. Dates of field tests range from 1942 (PG&E tests) to 2018 (Grapevine Capital tests), and wells are screened in all three of the main aquifer formations, including the Younger Alluvium, Older Alluvium, and Morales Formation. Additional sources include the USGS's 2015 *Hydrologic Models and Analysis of Water Availability in Cuyama Valley, California*, which describes conductivity values used in the CUVHM, along with Singer and Swarzenski (1970) and a 2011 USGS study. The CUVHM characterizes the recent and Younger Alluvium as having the highest hydraulic conductivity of all aquifer units (USGS, 2015). Conductivity values calculated from field tests for the wells are used to characterize each aquifer formation, as described below and summarized in Table 2-1.

Recent and Younger Alluvium – As shown in Table 2-1, wells screened exclusively in the Younger Alluvium in the central portion of the Basin have hydraulic conductivities ranging from 1 to 31.9 feet per day and a median conductivity of 9.5 feet per day. Wells screened in both the younger and Older Alluvium in the central portion of the Basin had a higher median conductivity of 10.1 feet per day. Field tests are lower than those reported by the USGS in 2015 which reported hydraulic conductivity for the recent and Younger Alluvium ranged from 5.2 to 85 feet per day (USGS, 2015). Within the Recent and Younger Alluvium, the highest horizontal conductivity is near the Cuyama River. Vertical conductivity ranges from 0.2 feet per day in tributaries crossing the alluvium in areas west of the Russell fault up to 49 feet per day in the Cuyama River in the Ventucopa Uplands (USGS, 2015).

Older Alluvium – In the central portion of the Basin, hydraulic conductivity in the Older Alluvium ranges from 0 to 81.2 feet per day, with a median conductivity of 16 feet per day. Field tests are higher than those reported by the USGS in 2015, which reported conductivity for the Older Alluvium ranges from 0.3 to 28 feet per day in the central Basin (USGS, 2015; USGS, 2011). West of the Russell fault, conductivity ranges from 0.77 to 1.79 feet per day with a median value of 1.24 feet per day in areas west of the Russell Fault, near the vineyards. Conductivity generally decreases with depth. Field data show that while the range in hydraulic conductivity for wells screened in both the Older Alluvium and Morales Formation is lower than wells screened exclusively in the Older Alluvium (ranging from 0 to 61.2 feet per day), the median value is higher at 21.4 feet per day. The USGS calculated the median hydraulic conductivity for the Older Alluvium (15 feet per day) to be about five times the estimated value for the Morales Formation (i.e., 3.1 feet per day) (USGS, 2013c).

Morales Formation – The Morales Formation has the lowest hydraulic conductivity of all aquifer units. In the central portion of the Basin, conductivity for wells exclusively screened in the Morales Formation range from 1.6 to 9.9 feet per day, with a median value of 3.15 feet per day. Two wells were interpreted to be screened exclusively in the Morales Formation west of the Russell fault; hydraulic conductivity for these wells ranges from 1.6 – 1.98 feet per day. The hydraulic conductivity of the Morales Formation decreases with depth and the lower member of the formation (the clay and limestone unit) has a lower conductivity than the upper member (sandstone). The highest values in the Morales Formation occur in the central portion of the valley and decrease west (Singer and Swarzenski, 1970).

Table 2-1: Summary of Hydraulic Conductivities in Aquifer Formations

Well Owner	Number of Wells	Formation(s) Well is Screened In	Conductivity Range (feet/day)	Median Conductivity (feet/day)
USGS	6[a]	Older Alluvium	1.5 – 18.1	15
	6[a]	Upper Morales Formation	1.6 – 9.9	3.15
PG&E[b]	22	Younger Alluvium	1 - 30	9
	19	Younger and Older Alluvium	0.1 - 37	4.5
	8	Older Alluvium	0.1 – 17	4
	2	Older Alluvium and Upper Morales Formation	0.1 – 4	2
Private Landowners, Central Portion of the Basin[c]	2	Younger Alluvium	28.9 – 31.9	30.4
	19	Younger Alluvium and Older Alluvium	3.9 – 68.6	17.1
	6	Younger Alluvium and Upper Morales Formation	1 – 21.3	12
	16	Older Alluvium	3.2 – 81.2	17.15
	23	Older Alluvium and Upper Morales Formation	3.6 – 61.2	23
Private Landowners, Western Portion of the Basin[c]	4	Older Alluvium	0.77 – 1.79	1.47
	6	Older Alluvium and Upper Morales Formation	0.64 – 1.59	1.22
	2	Upper Morales Formation	1.6 – 1.98	1.79

Notes**:**
[a]Three wells with four completions each; each well completion is reported as a single well.
[b]Conductivity estimated using transmissivity field tests.
[c]Conductivity estimated using specific capacity field tests.

Specific Yield

DWR defines specific yield as the "amount of water that would drain freely from rocks or sediments due to gravity and describes the portion of groundwater that could actually be available for extraction" (DWR, 2003). Specific yield is a measurement specific to unconfined aquifers, such as the primary aquifer in the Cuyama Basin.[5] The dewatered alluvium has an average specific yield of 0.15 (Singer and Swarzenski, 1970). The USGS estimated the specific yields of the three aquifer formations during CUVHM calibration, calculating that the recent alluvium had the lowest specific yield ranging from 0.02 to 0.14, the Older Alluvium has a specific yield ranging from 0.05 to 0.19, and the Morales Formation has the highest specific yield ranging from 0.06 to 0.25 (USGS, 2015).

Specific Capacity

Specific capacity is defined as "the yield of the well, in gallons per minute, divided by the pumping drawdown, in feet" (Singer and Swarzenski, 1970). Specific capacity in the aquifer varies laterally and vertically but is typically highest in the Younger Alluvium and lowest in the Morales Formation. Wells perforated in the Younger Alluvium have a median specific capacity of 60 gallons per minute (gpm) per foot (USGS, 2013c). Wells perforated in both the Younger and Older alluvium have a median specific capacity of 40 gpm per foot (USGS, 2013c). Wells perforated in the Older Alluvium have a median specific capacity of 20 gpm per foot (USGS, 2013c). The silt and clay content of the Older Alluvium increases to the west and corresponds to a decrease in specific capacity in the alluvium; specific capacities are less on the western half of the valley compared to the eastern half. However, a greater percentage of wells in the western part are perforated in the Older Alluvium (USGS, 2013c). The specific capacity of the Morales Formation varies laterally but is generally less than the specific capacity of the younger and Older Alluvium. In the western part of the valley, the Morales Formation has a specific capacity ranging from 5 to 25 gpm per foot. In the north north-central portion of the Basin the specific capacity increases to 25 to 50 gpm per foot (Singer and Swarzenski, 1970).

[5] For confined aquifers, the measurement of "storativity" is used instead of specific yield.

Transmissivity

DWR defines transmissivity as the “aquifer’s ability to transmit groundwater through its entire saturated thickness” (DWR, 2003). Using aquifer tests from 63 wells (shown in Figure 2-10), estimates of transmissivity ranged from 560 to 163,400 gallons per day per foot (gpd/foot) and decreased with depth (USGS, 2013c). Among the aquifer units, wells screened in the Younger Alluvium had the highest transmissivity, with a median value of 15,700 gpd/foot (USGS, 2013c). Wells screened in Older Alluvium had a transmissivity three times less than the Younger Alluvium wells, at a median value of 5,000 gpd/foot (USGS, 2013c). Wells screened in both the younger and alluvium had a median transmissivity of 11,300 gpd/foot (USGS, 2013c). Data from the 61 wells were not available for the Morales Formation, but a transmissivity estimate from two wells screened in both the Older Alluvium and Morales Formation averaged 4,900 gpd/foot (USGS, 2013c). Using groundwater level contours, Singer and Swarzenski determined the range of transmissivity values in the Morales Formation to change much more than the transmissivity values of the younger and Older Alluvium; in general, values are highest in the central portion of the valley and decline to the west as the thicknesses of the younger and Older Alluvium become more shallow.

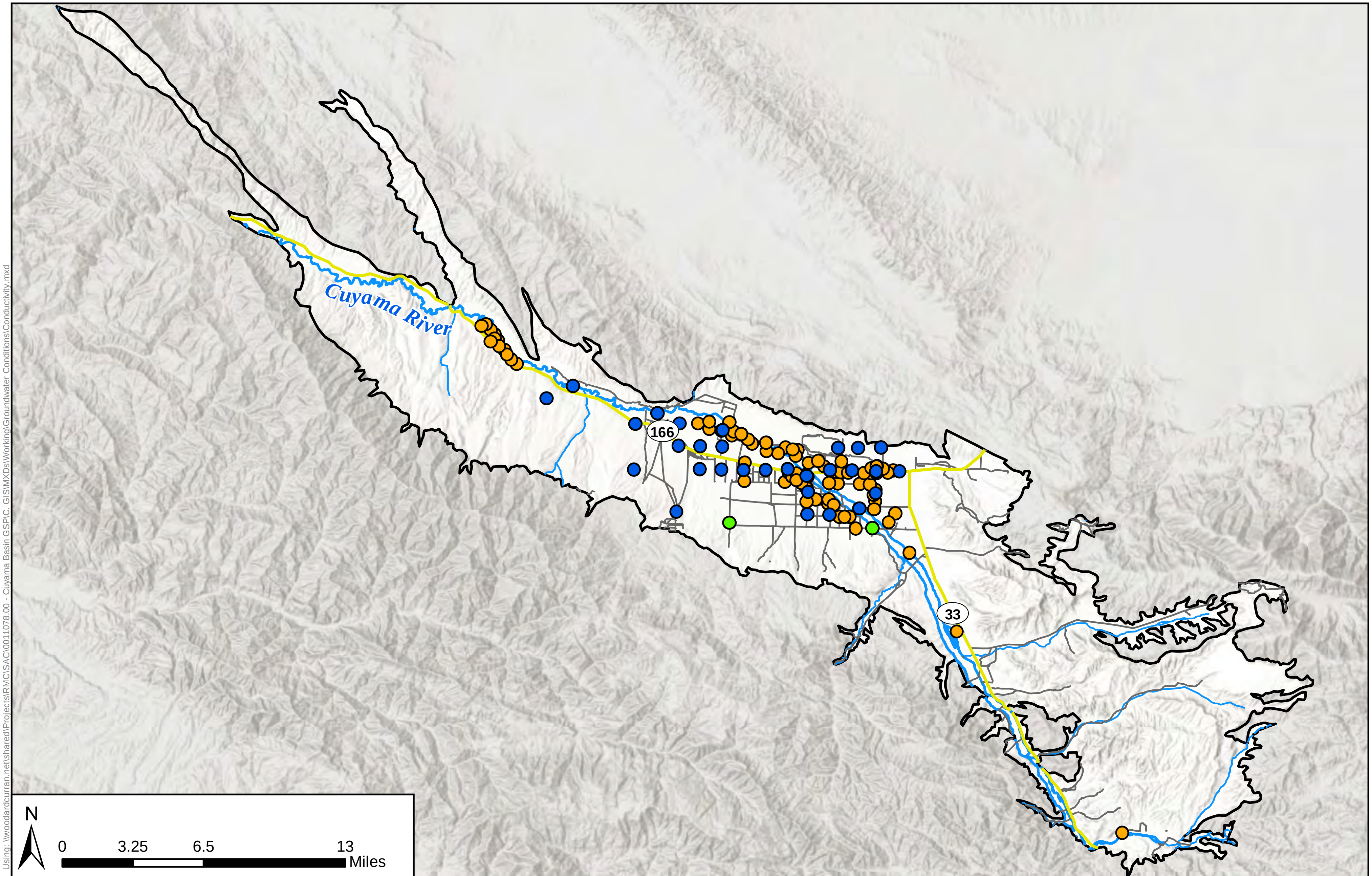

Figure 2-10 Location of Aquifer Testing Wells

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Legend

- Highways
- Local Roads
- Cuyama River
- Streams
- Cuyama Basin

Well Owner

- Private Landowners
- PG&E
- USGS

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2.1.8 Natural Water Quality Characterization

Water quality in the Basin has historically had a high level of TDS and sulfates. High concentrations of other constituents, such as nitrate, arsenic, sodium, boron, and hexavalent chromium are localized (USGS, 2013c). Locations where water quality measurements were taken by the USGS are shown in Figure 2-11.

Singer and Swarzenski studied groundwater in the Basin in 1970. Groundwater ranged from hard to very hard and is predominantly of the calcium-magnesium-sulfate type (Singer and Swarzenski, 1970). Averages of concentrations include 30 milligrams per liter (mg/L) chloride, 0.20 mg/L of boron, and 1,500 to 1,800 mg/L TDS (Singer and Swarzenski, 1970). Along the periphery of the Basin, groundwater quality is variable. Along the southern boundary and near the eastern badlands, the groundwater quality reflects the recharge from springs and runoff from the Sierra Madre Mountains; TDS concentrations range from 400 to 700 mg/L and most of the water is sodium calcium bicarbonate (Singer and Swarzenski, 1970). Along the eastern edge of the valley, near the Caliente Range, water quality declines as concentrations of sodium, chloride, TDS, and boron increase. Concentrations of boron range up to 15 mg/L, concentrations of chloride increase up to 1,000 mg/L, and TDS concentrations range from 3,000 to 6,000 mg/L (Singer and Swarzenski, 1970).

Singer and Swarzenski in 1970 also concluded that the Basin's water quality potentially results from the mixing of water from the marine rocks: "This water quality presumably results from the mixing of water from the marine rocks of Miocene age with the more typical water from the alluvium and is characterized by increased sodium, chloride, and boron. Although chloride and boron concentrations commonly are less than 30 and 0.20 mg/L, respectively, in the central part of the valley, the water from many wells is close to the Caliente Range contains several hundred to nearly 1,000 mg/L of chloride and as much as 15 mg/L of boron." (Singer and Swarzenski, 1970). Singer and Swarzenski did not provide a map showing their sampling locations.

In 2011, the USGS published the *Kirschenmann Road Monitoring Well Site Open File Report* (USGS, 2011), which included analysis of major-ion composition for samples collected from the multiple-well monitoring site CVKR, and samples from selected water supply and irrigation wells in the Cuyama Valley. Figure 2-12 shows a Piper diagram of the major-ion analysis. Figure 2-12 shows that groundwater in the central portion of the Basin shares similar major-ions, and is largely chloride, fluoride, sulfate and calcium magnesium type water. Figure 2-13 shows the locations USGS sampled to perform this analysis.

In 2017 EKI compiled water quality data contained in the appendices of the USGS report *Geology, Water-Quality, Hydrology, and Geomechanics of the Cuyama Valley Groundwater Basin, California, 2008-12* (USGS 2013c). and prepared a Piper diagram with the data (Figure 2-14). The locations of the data used in this Piper diagram are shown in Figure 2-15. The Piper diagram shows the majority of samples indicate that water in the Basin can be characterized as calcium-magnesium sulfate waters, which agrees with conclusions made by USGS in 2013.

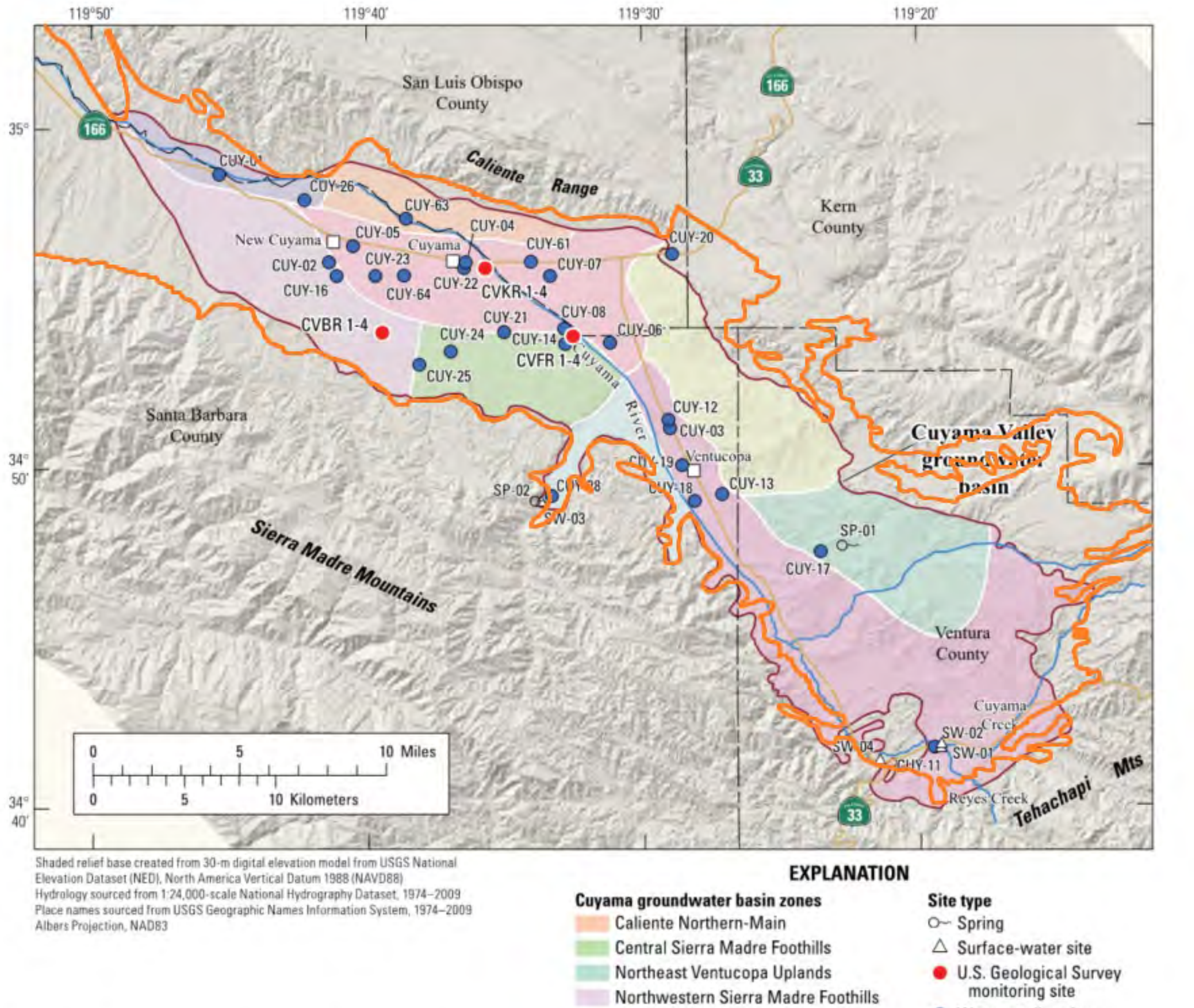

Figure 8. The location of multiple-well monitoring sites, domestic and supply wells, springs, and surface water sites with available water-quality data, Cuyama Valley, Santa Barbara County, California.

Source: USGS, 2013c.

Figure 2-11: Location of USGS 2013 Groundwater Quality Sampling Sites

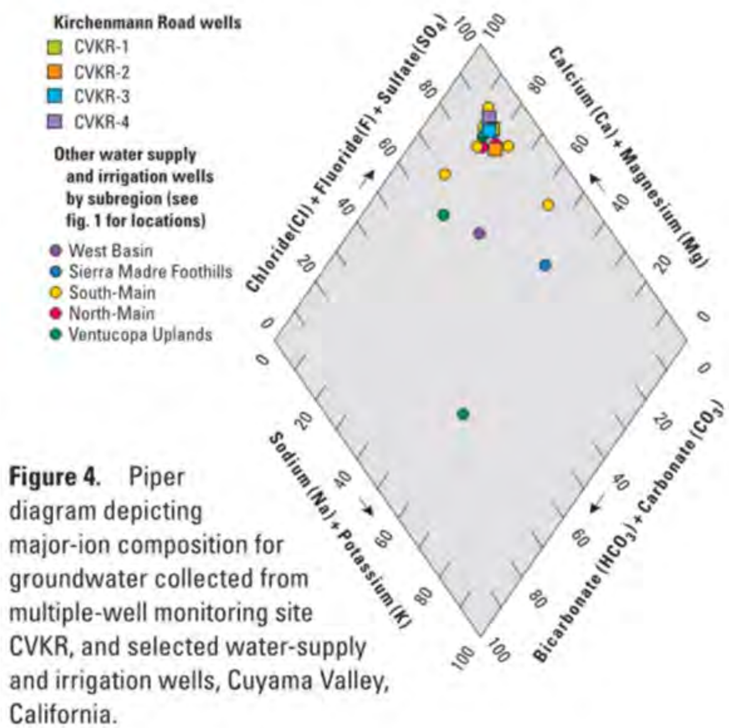

Figure 2-12: Piper Diagram for Well CVKR1-4

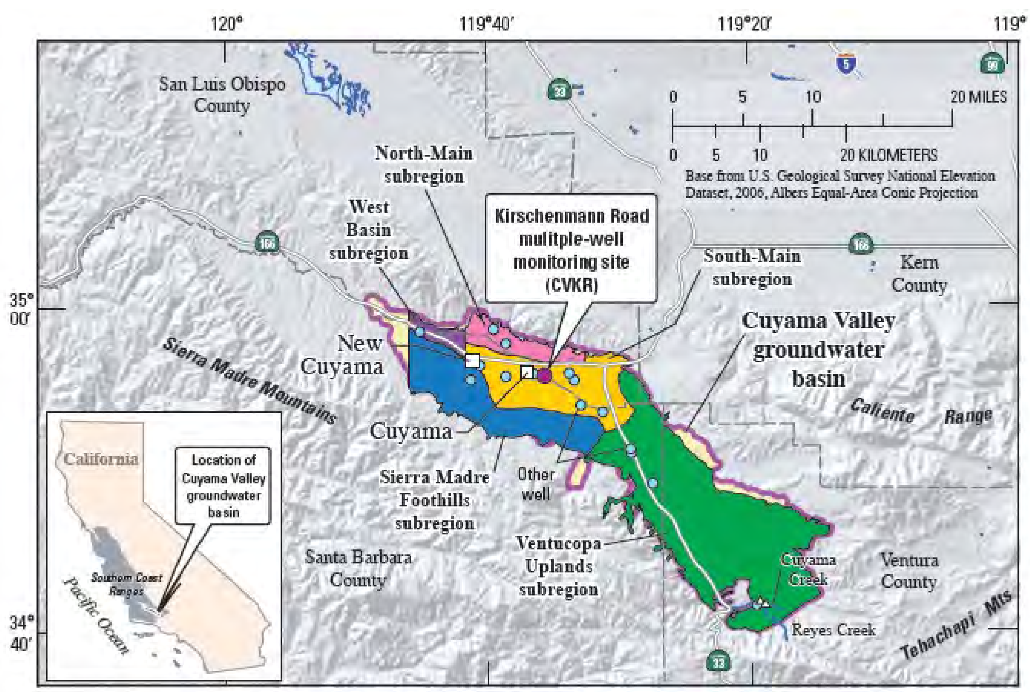

Figure 2-13: Location Map for Samples Used in Figure 2-12

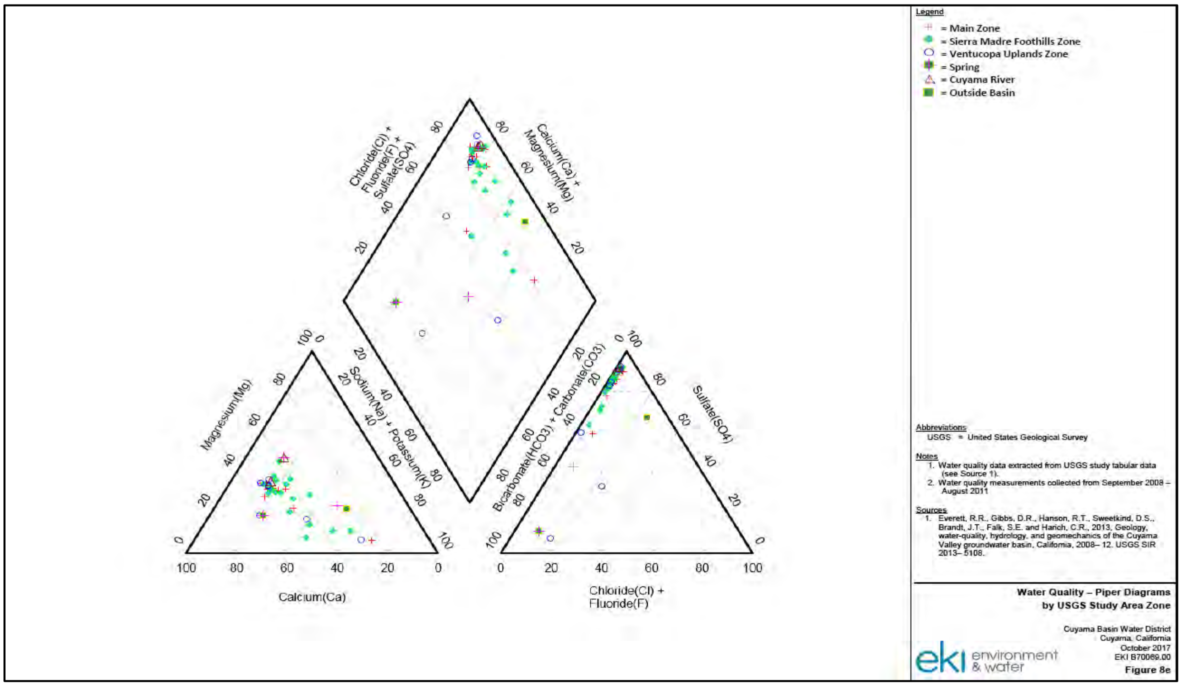

Figure 2-14: Piper Diagram of USGS 2013 Water Quality Sampling

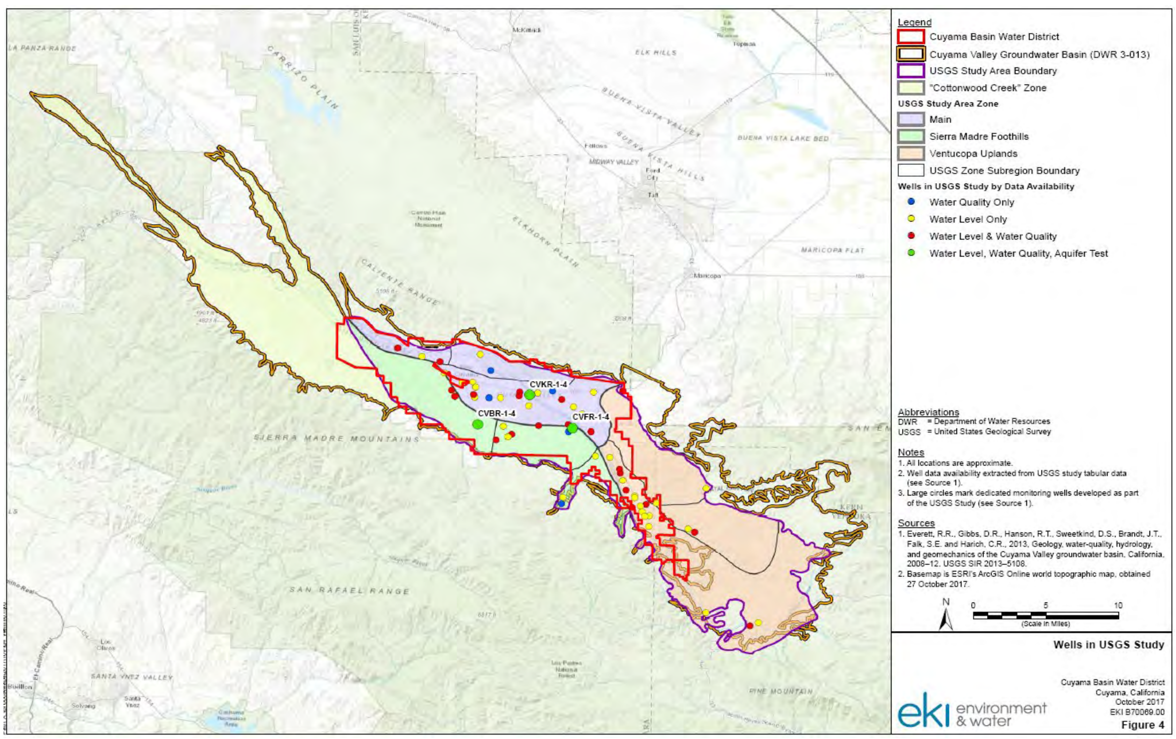

Figure 2-15: Location Map of USGS 2013 Sampling

Aquifer Use

The Cuyama Valley is dependent on groundwater as its sole source of supply. Groundwater is used for irrigation, domestic and municipal use (USGS, 2013c). The majority of agricultural activity occurs between the New Cuyama and Ventucopa areas, and west of the Russell fault near the north fork.

2.1.9 Topography, Surface Water and Recharge

This section describes the topography, surface water, soils, and groundwater recharge potential in the Basin. There are no imported water supplies to the Cuyama Basin and are not discussed in this section.

Topography

The Basin is lowest in the northwest, and highest in the southeast. The lowest elevation in the Basin is located at the west edge where the Cuyama River exits at approximately 1,300 feet, while the highest point is approximately 7,250 feet on the eastern boundary. Figure 2-16 shows the topographic characteristics of the Basin. The south facing northern slopes of the valley are generally steeper than the north facing south slopes. The eastern portion of the Basin along the valley walls becomes steep, characterized by mountainous runoff-cut topography.

Surface Water Bodies

The Cuyama River is the primary surface water feature in the valley and flows from an elevation of 3,800 feet on the eastern side to the west of the Basin to 1,300 feet at the western outlet of the Basin. The Cuyama River travels approximately 55 miles through the Basin and has a slope ratio of approximately 1:125. The river is perennial, with most dry seasons seeing little to no flows. Large flows usually occur in flashes due to the small watershed and storms that provide precipitation onto the surrounding Coastal Range Mountains. Peak flows through the Cuyama River, dated between 1929 and 2017, range from approximately 6,000 cubic feet per second to the highest recorded flow of 15,500 cubic feet per second on February 18, 2017 (National Watershed Information System [NWIS], 2018). There are approximately four main perennial streams that feed the Cuyama River: Aliso Creek, Santa Barbara Creek, Quatal Canyon Creek, and Cuyama Creek. However, during precipitation events many more smaller streams flow from the valley walls and surrounding mountains. Figure 2-17 shows the locations of surface water bodies in the Basin.

Downstream on the Cuyama River lies Twitchell Reservoir, however this is an artificial body of water outside of the Basin.

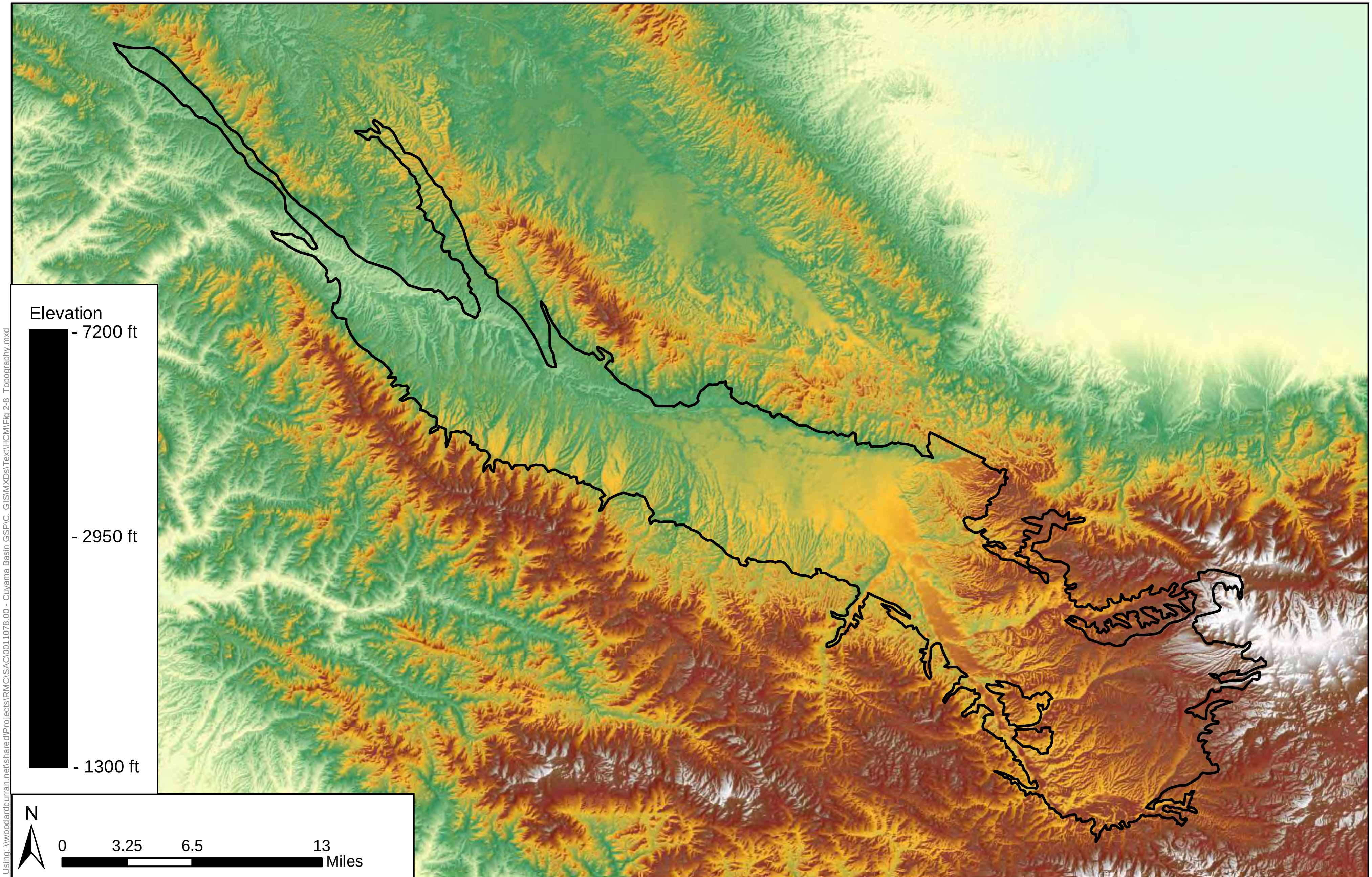

Figure 2-16: Topography

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Cuyama Basin

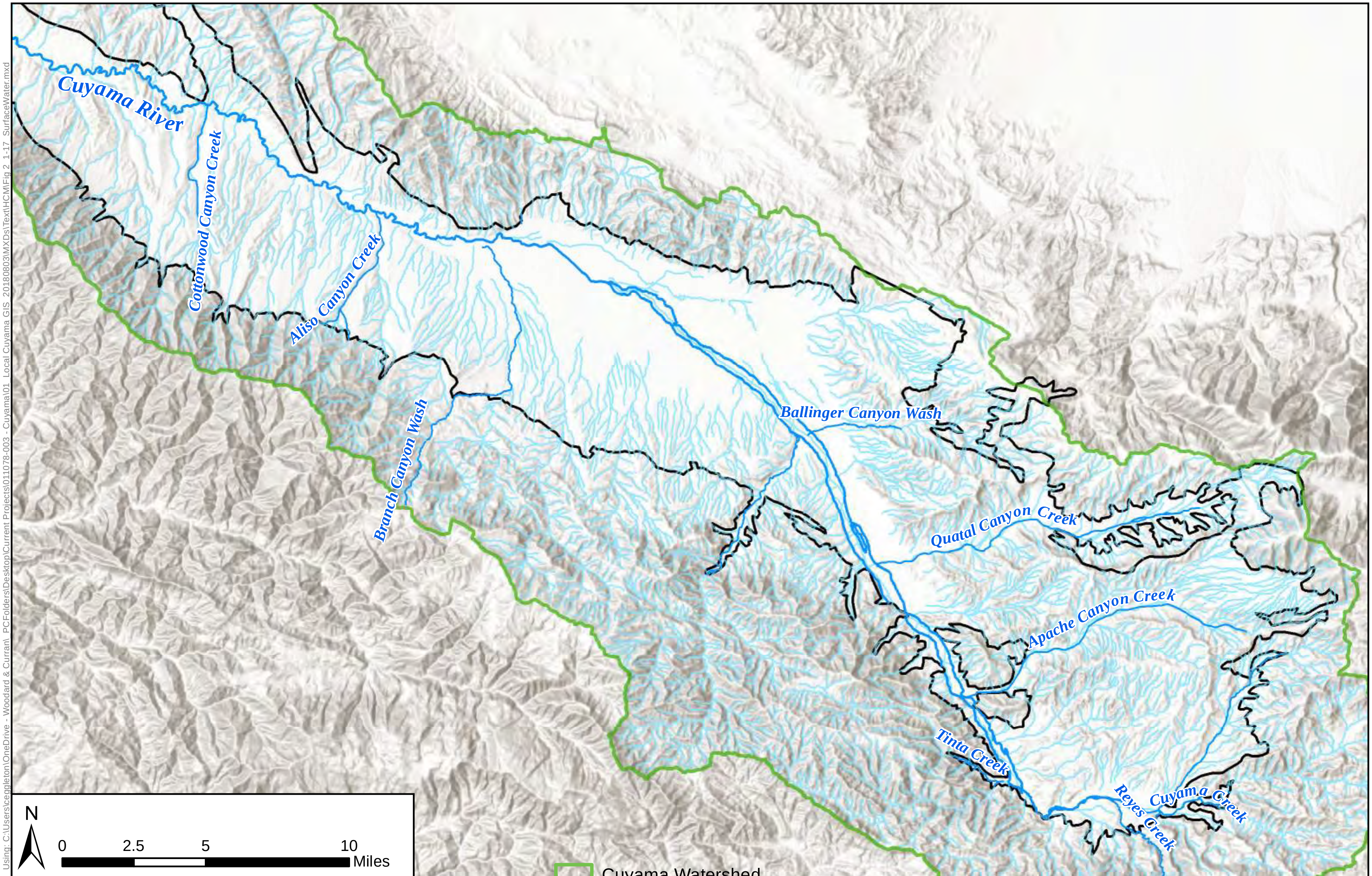

Figure 2-17: Surface Water

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- Cuyama Watershed
- Cuyama River
- Streams/Creeks
- OtherImportantDrainages
- All Other NHD Flow Lines, Creeks, and Streams in the Cuyama Watershed
- Cuyama Basin

Areas of Recharge, Potential Recharge, and Groundwater Discharge Areas

Areas of recharge and potential recharge lie primarily within the central and low-lying areas of the Cuyama Valley. Agricultural and open space lands are considered areas of potential recharge. Figure 2-18 shows areas with their potential for groundwater recharge, as identified by the Soil Agricultural Groundwater Banking Index (SAGBI). SAGBI provides an index for the groundwater recharge for agricultural lands by considering deep percolation, root zone residence time, topography, chemical limitations, and soil surface condition. SAGBI data categorizes 22,675 acres out of 37,568 acres (60 percent) of agricultural and grazing land within the Basin as moderately good, good, or excellent for groundwater recharge (University of California, Davis, 2018). SAGBI data shown in Figure 2-18 is derived from "modified" SAGBI data. "Modified" SAGBI data show higher potential for recharge than unmodified SAGBI data because the modified data assume that the soils have been or will be ripped to a depth of 6 feet, which can break up fine grained materials at the surface to improve percolation.

Groundwater discharge areas are identified as springs located within the Basin. Figure 2-18 shows the location of historical springs identified by the USGS (NWIS, 2018). The springs shown in represent a dataset collected by the USGS and are not a comprehensive map of springs in the Basin.

Soils

Soils in the Basin were categorized by the National Resource Conservation Service (NRCS). The Basin is comprised mostly of fine- to coarse-loamy soils (NRCS STATSGO2, 2018). As shown in Figure 2-19, the valley bottom and primary soil surrounding the Cuyama River and its tributaries is primarily fine-loamy soils, while the northern boundary of the Basin has coarse-loamy soils.

Figure 2-20 shows soils by hydrologic soil group. Hydrologic soil groups were calculated by the NRCS on a by-county basis. As shown in Figure 2-20, interpretations of soil groups varied by county in each study. In general, hydrologic soil groups are sorted by permeability, with class A being the most permeable and class D being the least permeable. Figure 2-20 shows that in general most of the soils in the Basin have lower permeabilities and are listed as class C or D, with higher permeabilities being located near streams and rivers.

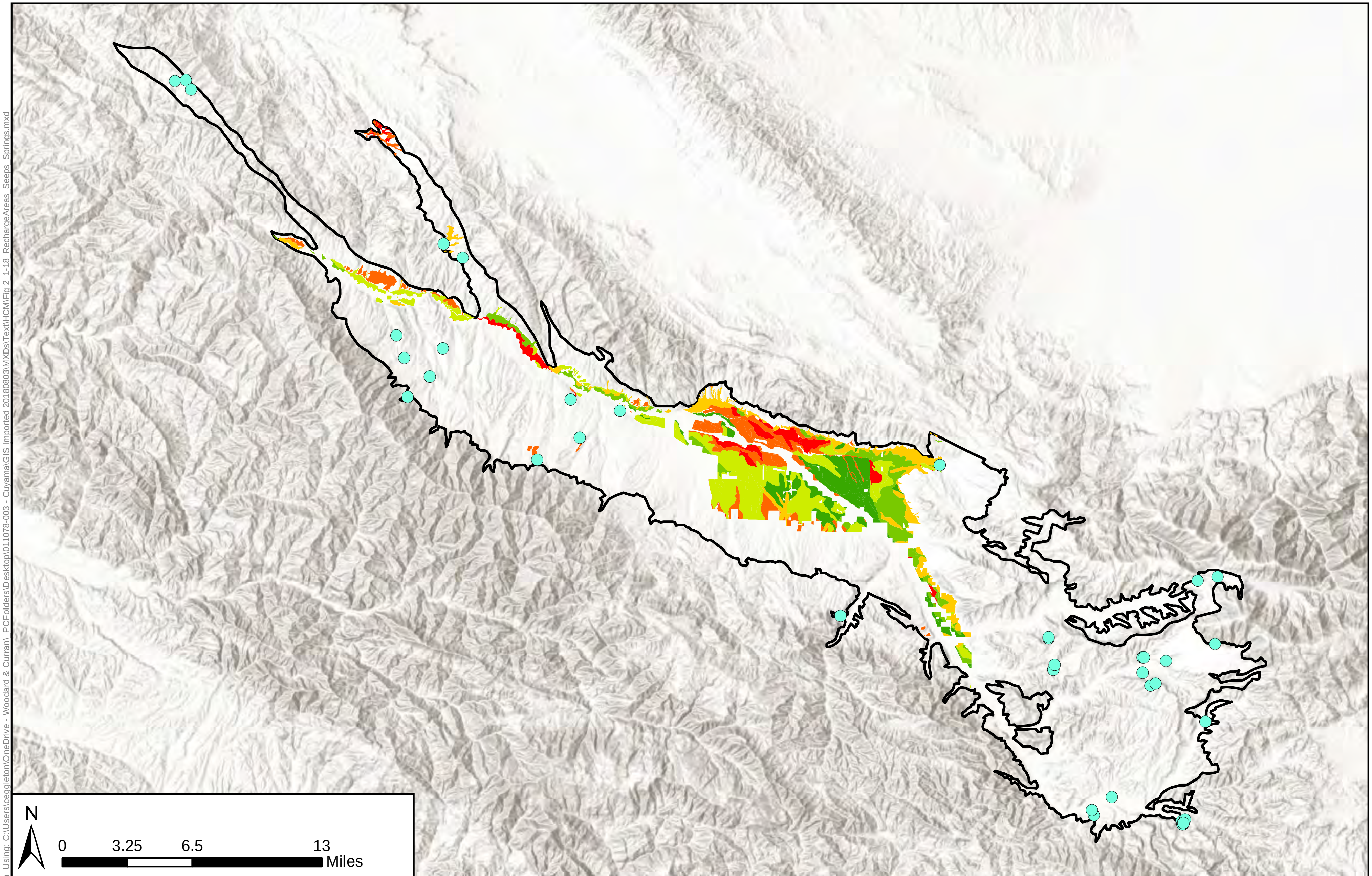

Figure 2-18: Recharge Areas, Seeps, and Springs

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Cuyama Basin

Spring/Seep

Modified SAGBI Soils of Cuyama Basin

- Excellent (85-100)
- Good (69-85)
- Moderately Good (49-69)
- Moderately Poor (29-49)
- Poor (15-29)
- Very Poor (0-15)

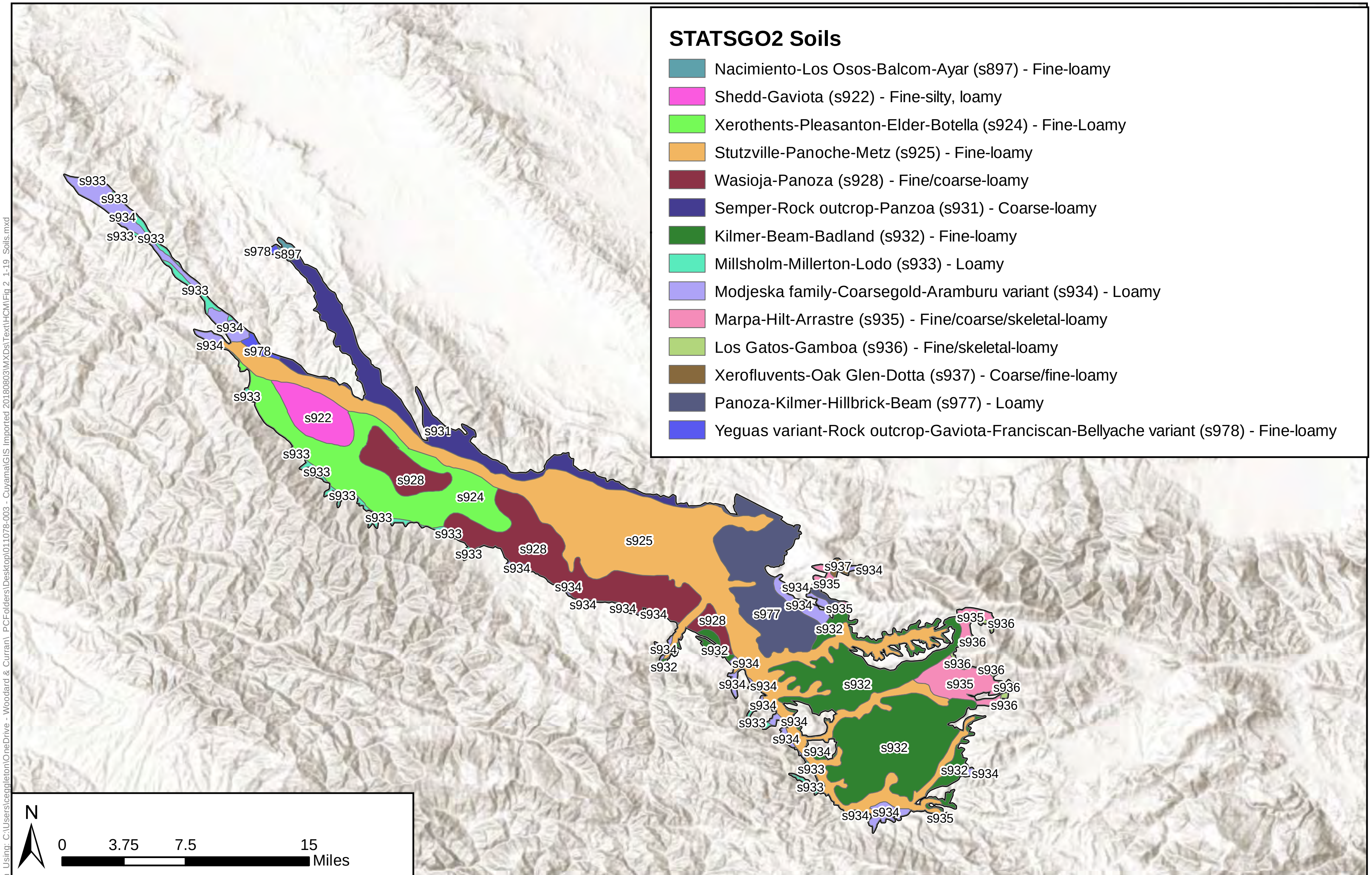

Figure 2-19: Soils

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Cuyama Basin

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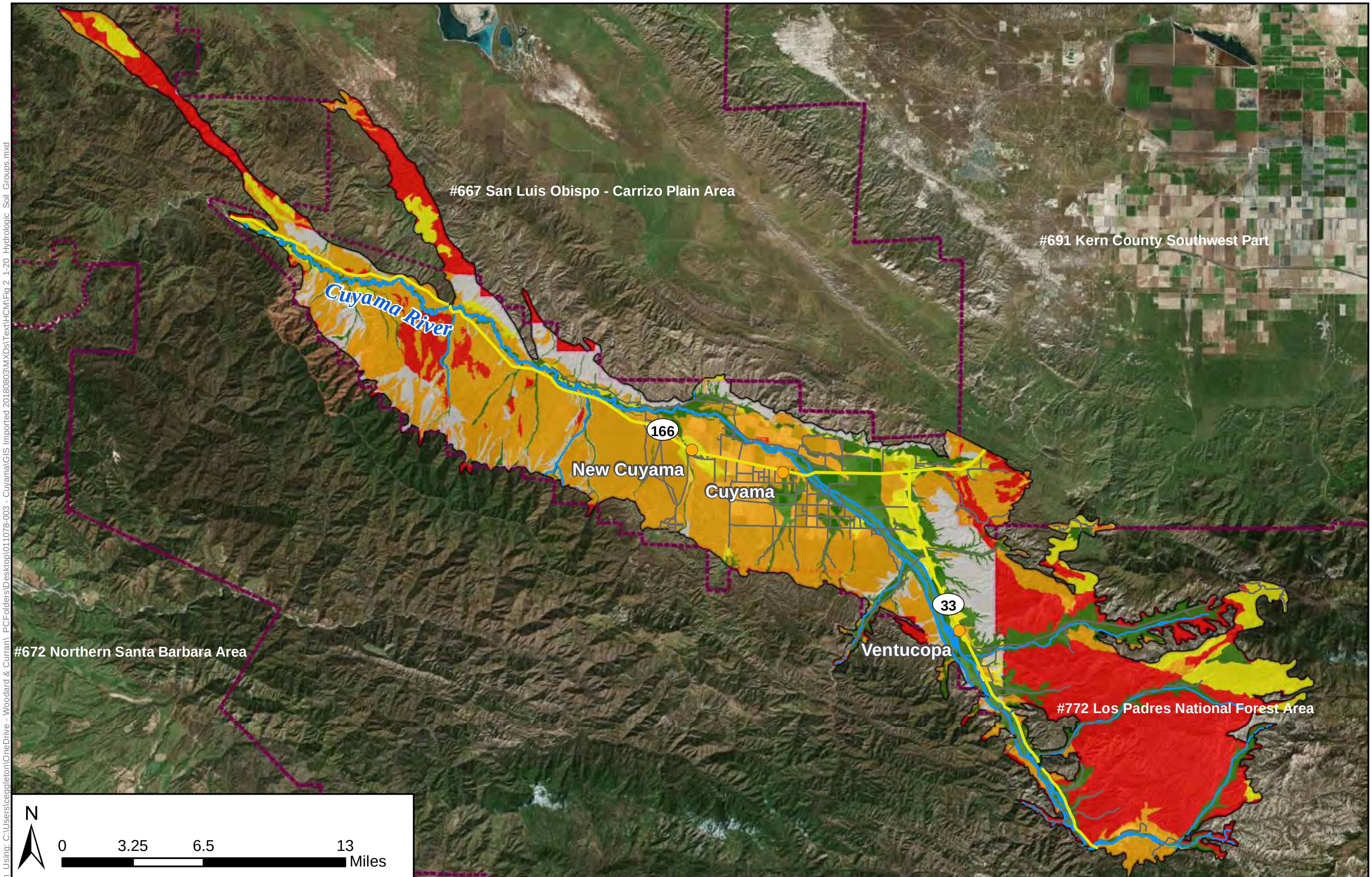

Figure 2-20: Hydrologic Soil Groups

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

Hydrologic Soil Group

- A
- B
- C
- D
- Not classified

Soil Survey Boundary

Soil Survey Key:

#772 Los Padres National Forest Area

Soil Survey Number — Survey Name

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2.1.10 Hydrogeologic Conceptual Model Data Gaps

The following are the HCM data gaps that were identified during the development of this GSP. There is no consensus about whether faults are barriers to flow in the Basin, and if so, at what depth are they a barrier to flow. There is also confusion about whether smaller faults and fault splays are barriers to flow. Aquifer properties in areas where aquifer testing has not been conducted are not well defined, and are estimated. The connection between groundwater levels upstream of Ventucopa and in the Ventucopa region are not well understood; additionally, it is not well understood if groundwater flows are channelized in the Ventucopa and upland regions. Lastly, connectivity between the alluvium west of the Russel Fault and areas in upland areas is not agreed upon. Other data gaps may be discovered during implementation of the GSP.

2.2 Basin Settings: Groundwater Conditions

This section of Chapter 2 satisfies Section 354.8 of the SGMA regulations, and describes the historical and current groundwater conditions in the Basin. Water budget components follow in Section 2.3.

As defined by the SGMA regulations, this section does the following:

- Defines current and historical groundwater conditions in the Basin
- Describes the distribution, availability, and quality of groundwater
- Identifies interactions between groundwater, surface water, groundwater-dependent ecosystems, and subsidence
- Establishes a baseline of groundwater quality and quantity conditions that will be used to monitor changes in the groundwater conditions relative to measurable objectives and minimum thresholds
- Provides information to be used for defining measurable objectives to maintain or improve specified groundwater conditions
- Supports development of a monitoring network to demonstrate that the CBGSA is achieving Basin sustainability goals

The majority of published information about groundwater in the Basin is 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 have been studied less, and consequentially, fewer publications have been written about those areas, and less historical information is available in those areas.

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 2-21 shows selected landmarks in the Basin to assist discussion of the location of specific groundwater conditions. Figure 2-21 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.

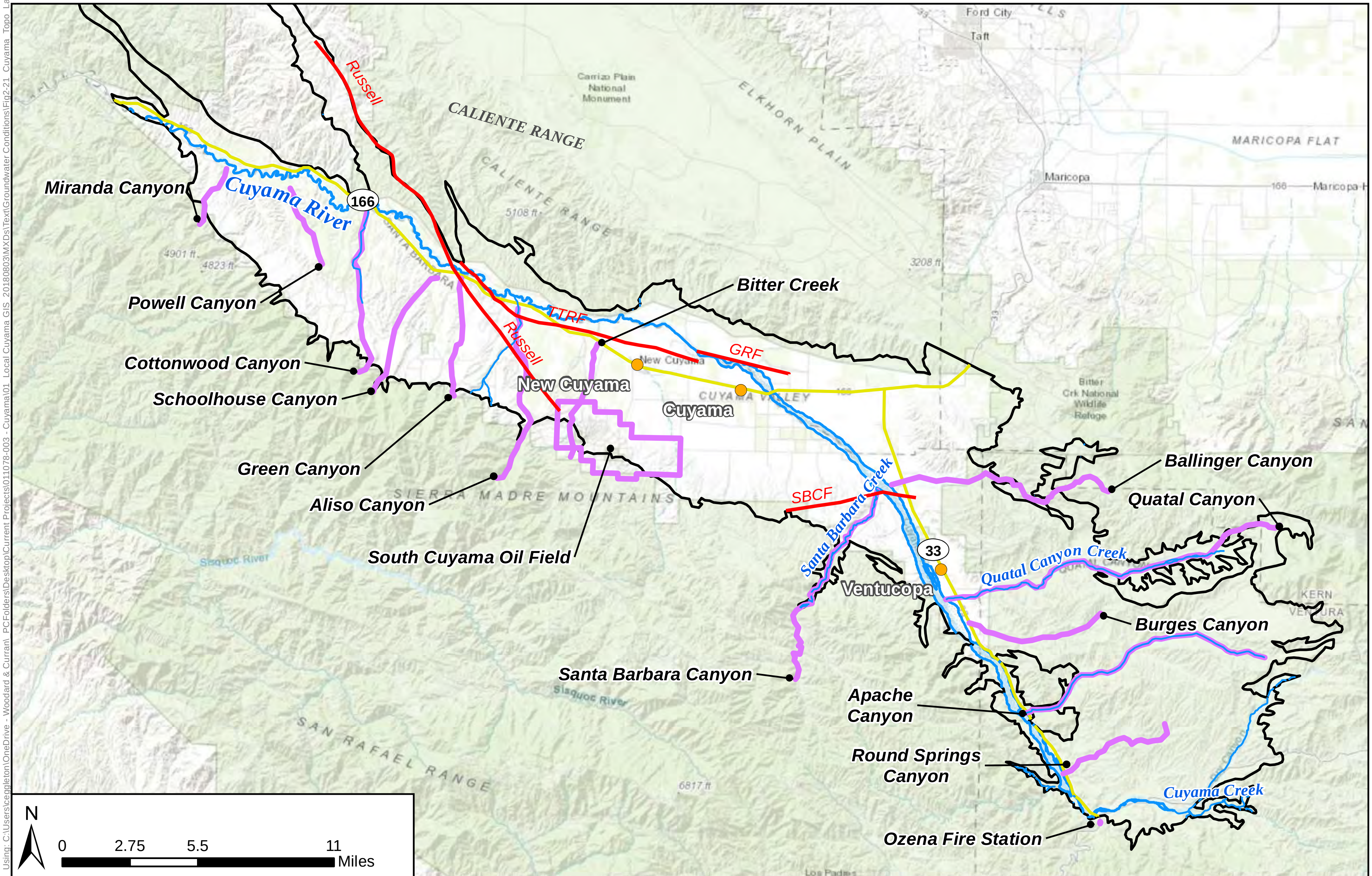

Figure 2-21 - Cuyama Basin Landmarks

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

2.2.1 Useful Terms

This section of Chapter 2 includes descriptions of the amounts, quality, and movement of groundwater, among other related components. A list of technical terms and their definitions are below. These definitions are given to guide readers through the section and are not a definitive definition of any term.

- **Depth to groundwater –** This is the distance from the ground surface to groundwater, typically reported at a well.
- **Horizontal gradient** – The horizontal gradient is the slope of groundwater from one location to another when one location is higher, or lower than the other. The horizontal 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 shown in this section as follows:
  - Elevation of groundwater above mean sea level, which is useful because it can help identify the horizontal gradients of groundwater, and
  - Depth to water (i.e. the distance from the ground surface to groundwater), which is useful because it can help 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.
- **Maximum contaminant level (MCL)** – An MCL is a standard set by the State of California regarding drinking water quality. An MCL is the legal threshold on the amount of a substance that may appear in public water systems. MCLs are different for different constituents in drinking water.
- **Elastic land subsidence** – 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** – 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 compiled from four public sources, with additional data compiled from private landowners. These include the following:

- USGS
- DWR
- SBCWA
- San Luis Obispo County
- Private landowners

Data provided by these sources included well information such as location, well construction, well owner, ground surface elevation and other related components, as well as groundwater elevation data including information such as date measured, depth to water, groundwater surface elevation, questionable measurement code, and comments. At the time that this analysis was performed, groundwater elevation data was available for the time period from 1949 to June 2018.[6] There are many wells with monitoring data from some time in the past, but no recent data, while a small number of wells have monitoring data recorded for periods of greater than 50 years. Figure 2-22 through Figure 2-25 show well locations with available monitoring data, and the entity that maintains monitoring records at each well. These figures also show in a larger, darker symbol if the monitoring well has been measured in 2017 or 2018.

Figure 2-22 shows the locations of well data received from the DWR database. As an assessment of which wells have been monitored recently, the wells with monitoring data collected between January 2017 and June 2018 were identified. Roughly half of the wells from DWR's database contain monitoring data in 2017-18, with roughly half the wells having no monitoring data during this period. Wells in DWR's database are concentrated in the central portion of the Basin, east of Bitter Creek and north of the SBCF. Many wells in DWR's database have been typically measured bi-annually, with one measurement in the spring, and one measurement in the fall.

Figure 2-23 shows the locations of well data received from the USGS database. Many of these wells are duplicative of wells contained in the DWR 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. Many wells in the USGS database haves been typically measured bi-annually, with one measurement in the spring, and one measurement in the fall.

[6] The analysis shown in this section was performed in the summer of 2018 and does not reflect data that may have been collected after June 2018. In addition, the analysis reflects the available data as provided by each entity - an assessment has not been performed on the standards and protocols followed by each entity that compiles and maintains the available datasets.

Figure 2-24 shows the locations of well data received from Santa Barbara and San Luis Obispo counties. Wells from both counties were monitored in 2017-18. Wells monitored by Santa Barbara County are concentrated in the western portion of the Basin west of Bitter Creek. The two wells monitored by San Luis Obispo County are in the central portion of the Basin; these wells also appear in the USGS database. Data are collected in many of these wells on a bi-annual basis, with one measurement in the spring, and one measurement in the fall, with some measurements at some wells occurring on a quarterly basis.

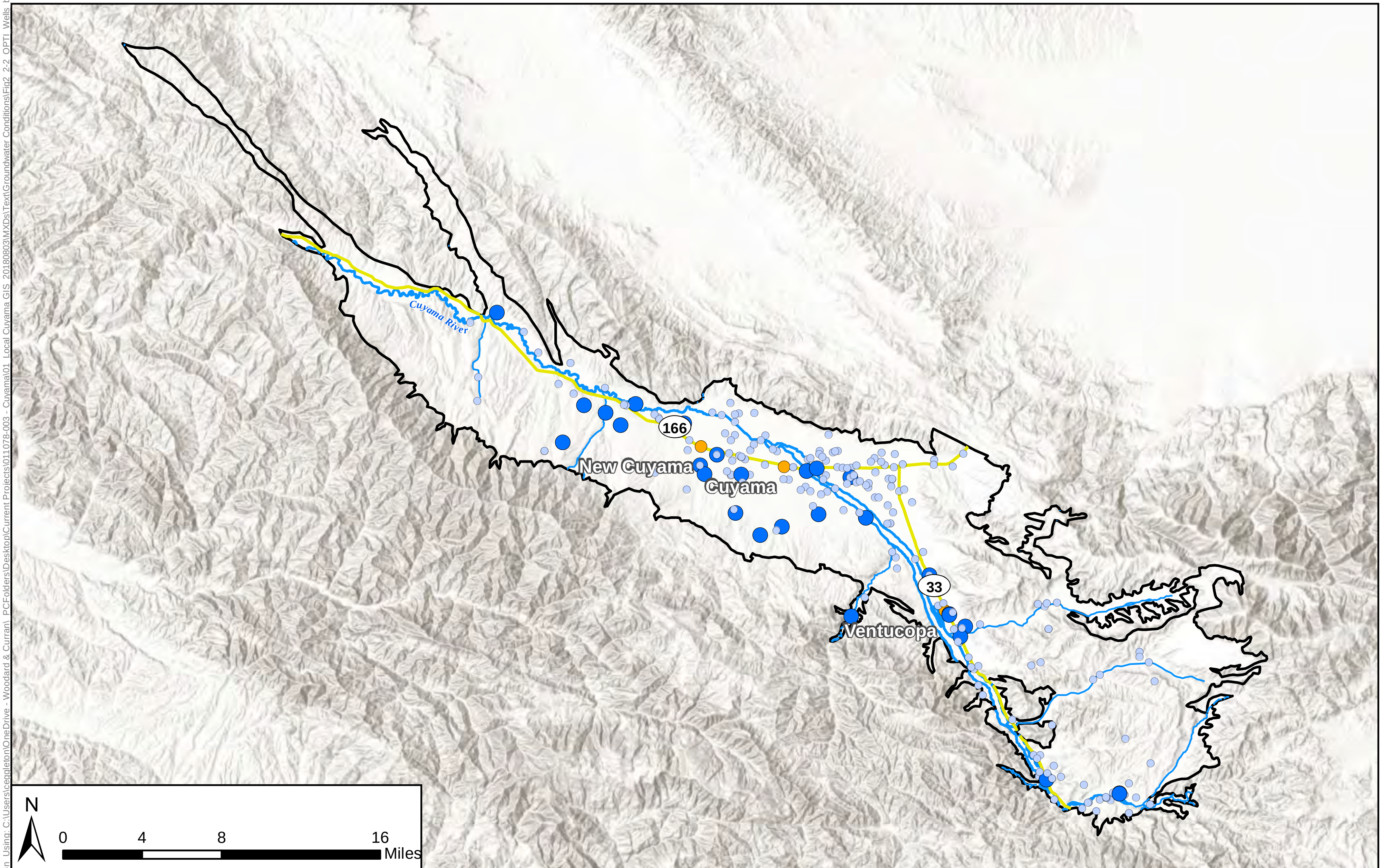

Figure 2-22: Cuyama GW Basin
Wells with Monitoring Data Provided by DWR

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

December 2019

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Legend

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

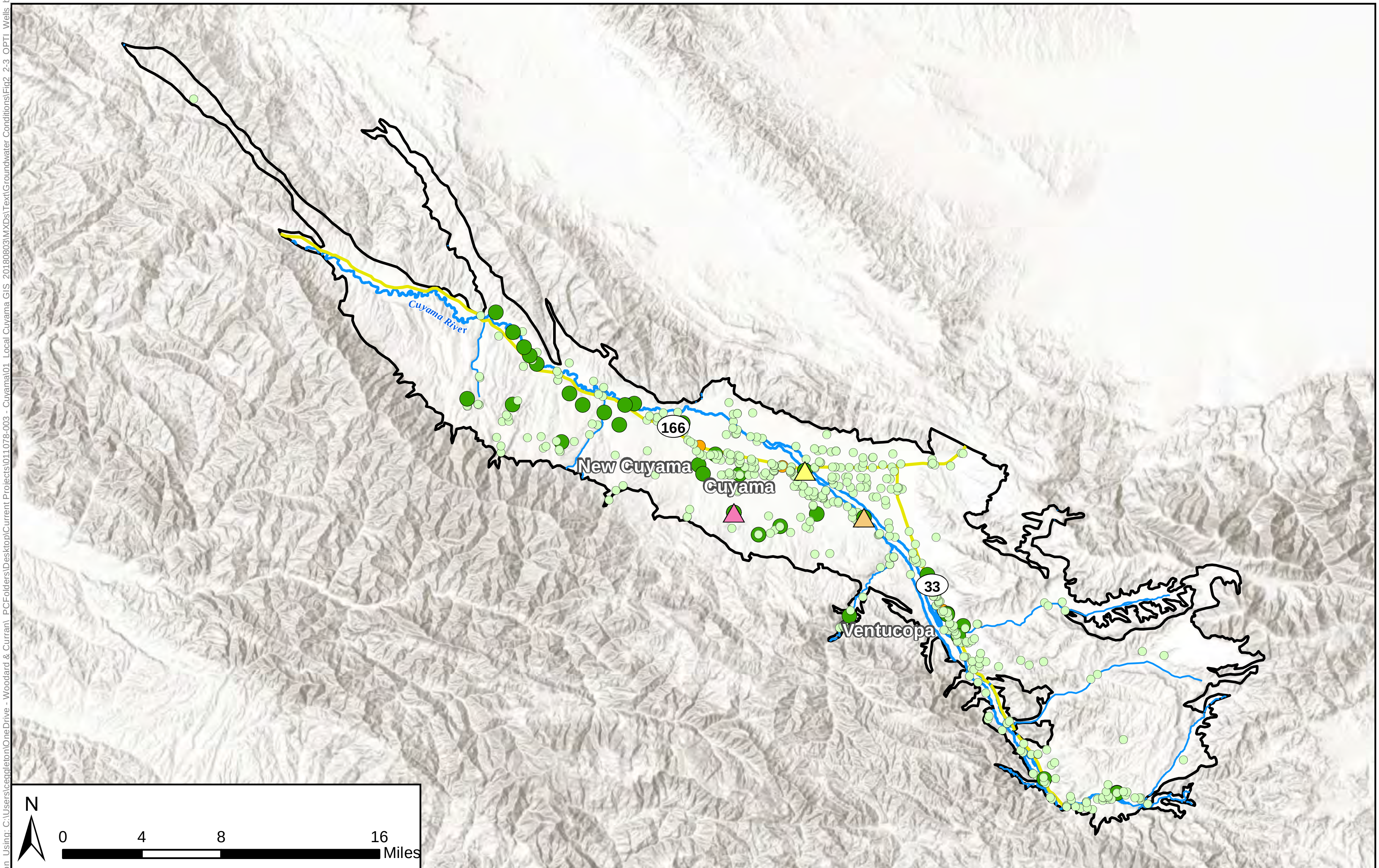

Figure 2-23: Cuyama GW Basin Wells with Monitoring Data Provided by USGS

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

December 2019

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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

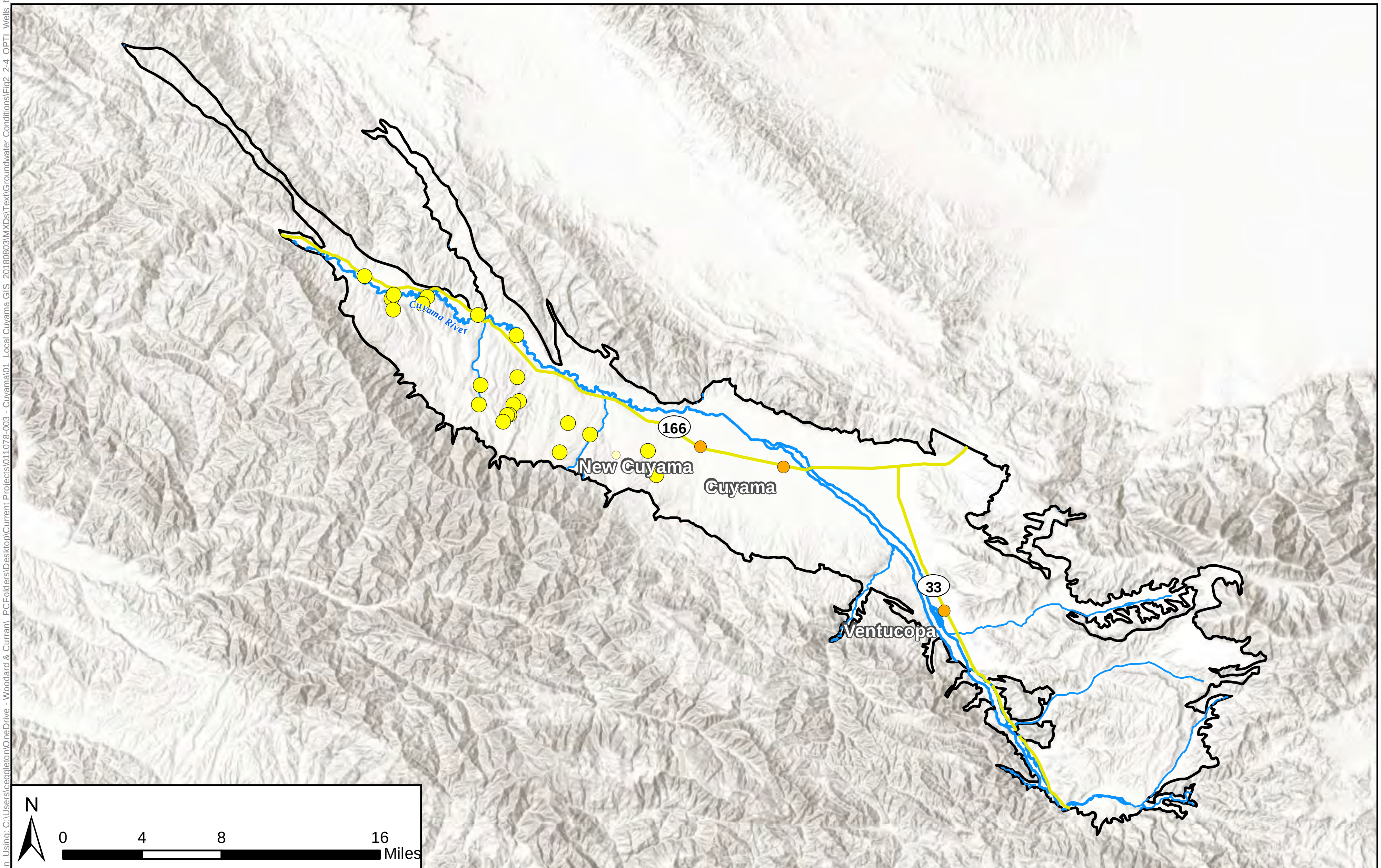

Figure 2-24: Cuyama GW Basin Wells with Monitoring Data Provided by Local Agencies

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

December 2019

WOODARD & CURRAN

Legend

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

Figure 2-25 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 SR 166. Additional wells provided by private landowners are located along the Cuyama River and SR 166, near the Russell Ranch Oilfields. Associated data provided with private landowners varies by source. Some data and measurements were taken annually, while other well owners were taken biannually or quarterly.

Figure 2-26 shows the locations of collected data from all entities by their last measured date. Wells with monitoring data in 2017-2018 are shown in bright green triangles. There are recent measurements in many different parts of the Basin as follows:

- Near the Cuyama River in the eastern uplands and near Ventucopa
- In the central portion of the Basin, especially north of SR 166 but with some wells located in the southern portion of the central basin
- 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 2-27 shows a comparison of data provided by private landowners and data compiled from the DWR and the USGS databases in the central portion of the Basin. This figure was developed to provide information on the consistency between data from these differing sources. 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 approximately match in tracking historical trends from the public databases.

Figure 2-28 shows a comparison of data collected from other private landowners, and data collected from SBCWA. This figure was developed to provide information on the consistency between data from these differing sources. 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.

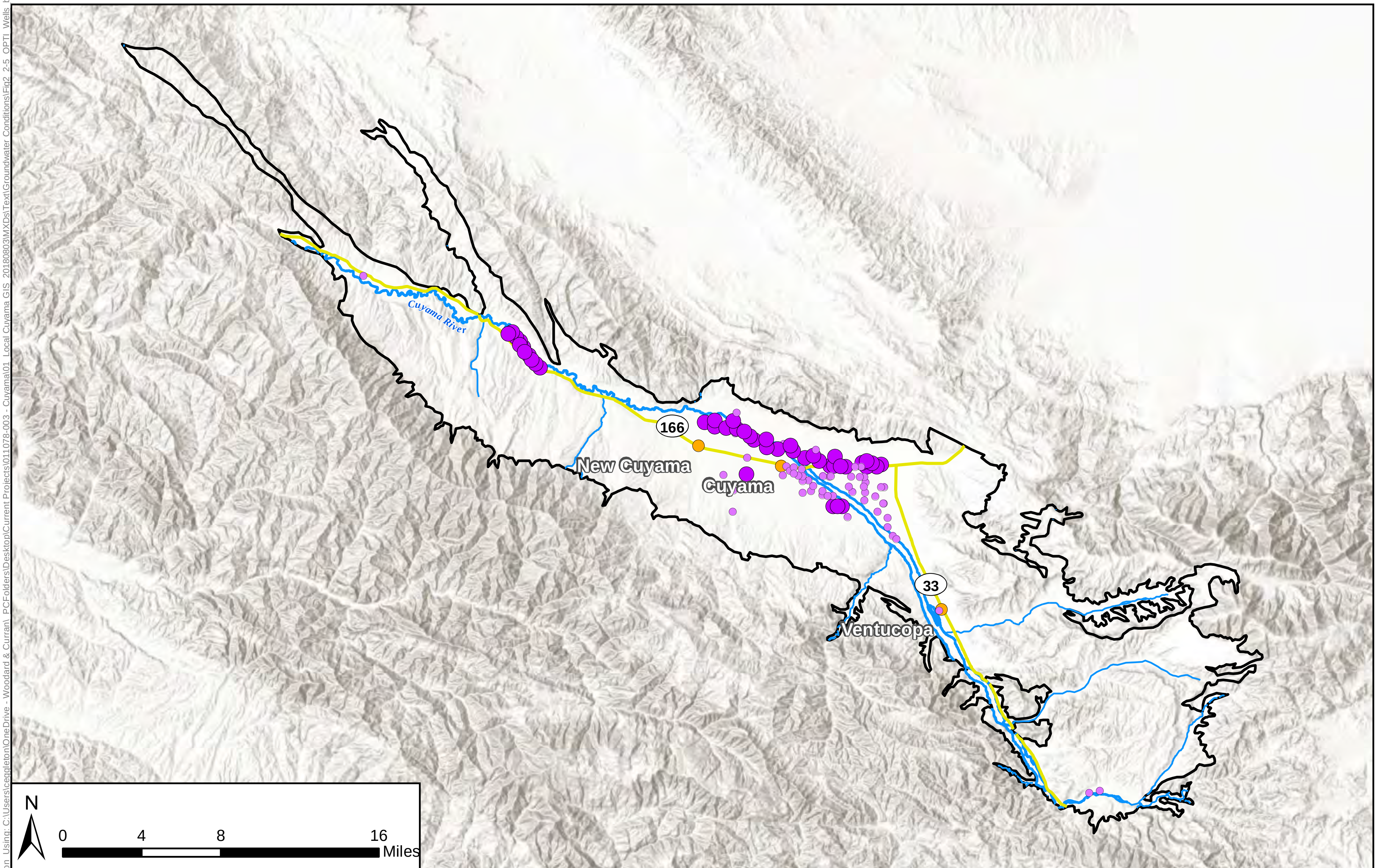

Figure 2-25: Cuyama GW Basin Wells with Monitoring Data Provided by Private Landowners

Cuyama Basin Groundwater Sustainability Agency

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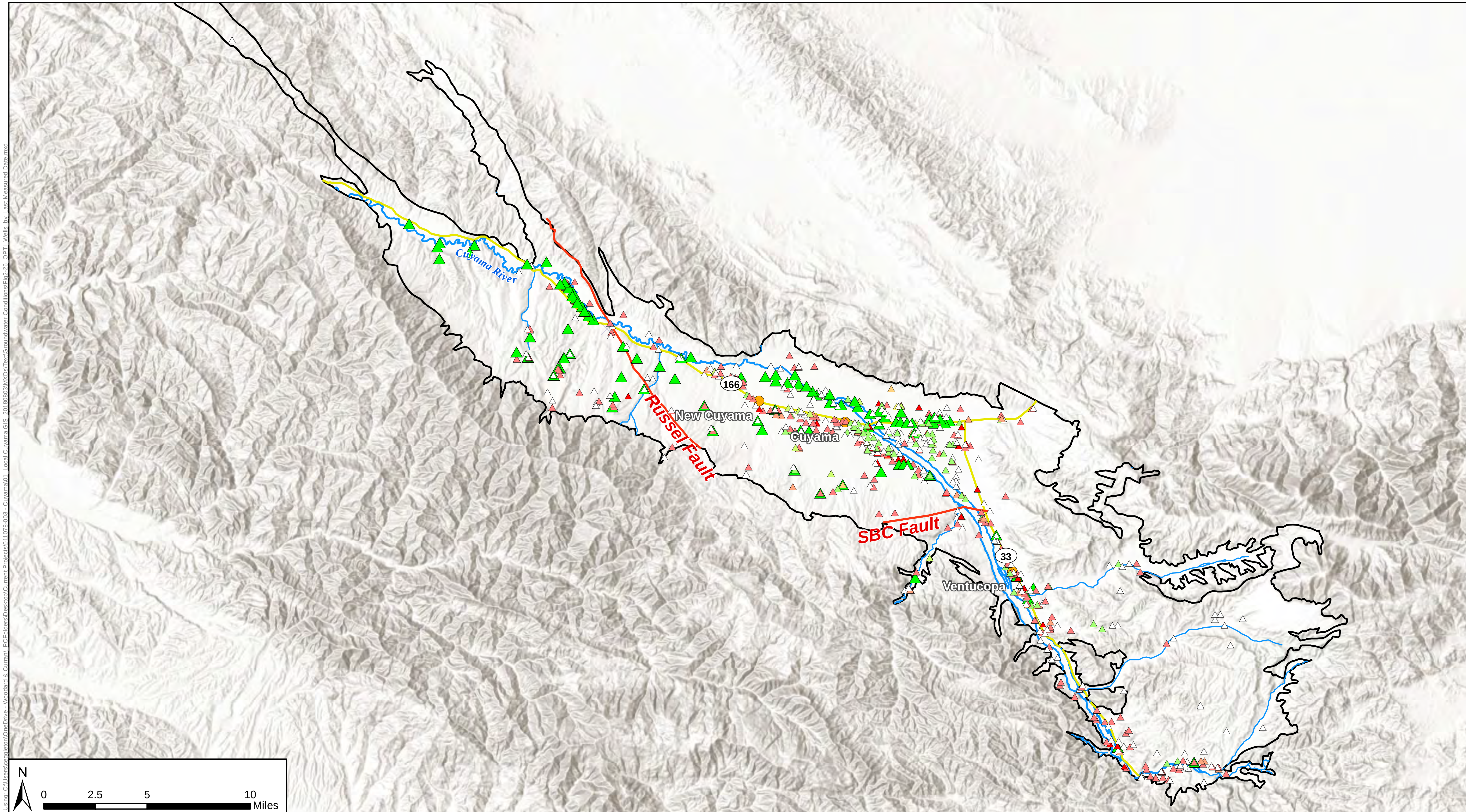
Legend

- 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



Legend

Cuyama Basin
Highways
Towns
Cuyama River
Streams
Fault

Most Recent Year with Measurements

- 2017 - 2018
- 2010 - 2016
- 2000 - 2009
- 1990 - 1999
- 1980 - 1989
- 1970 - 1979
- 1960 - 1969
- 1950 - 1959
- Pre-1950
- No Measurment Data

Figure 2-26: Cuyama GW Basin Wells by Last Measurement Date

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September 2019

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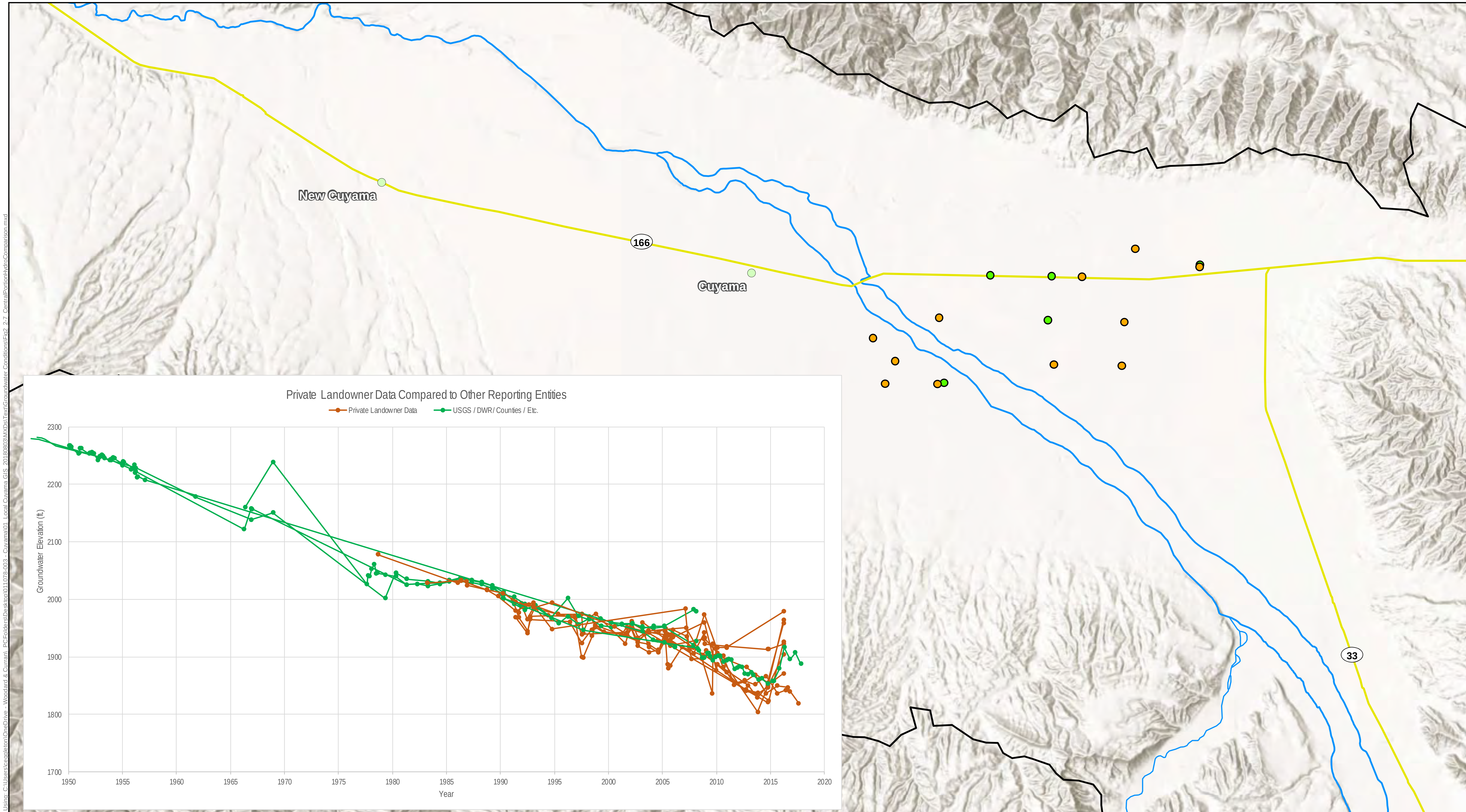

Figure 2-27: Central Cuyama GW Basin Wells and Hydrographs by Data Source

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

December 2019

WOODARD & CURRAN

Legend

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

N

0 0.5 1 2 Miles

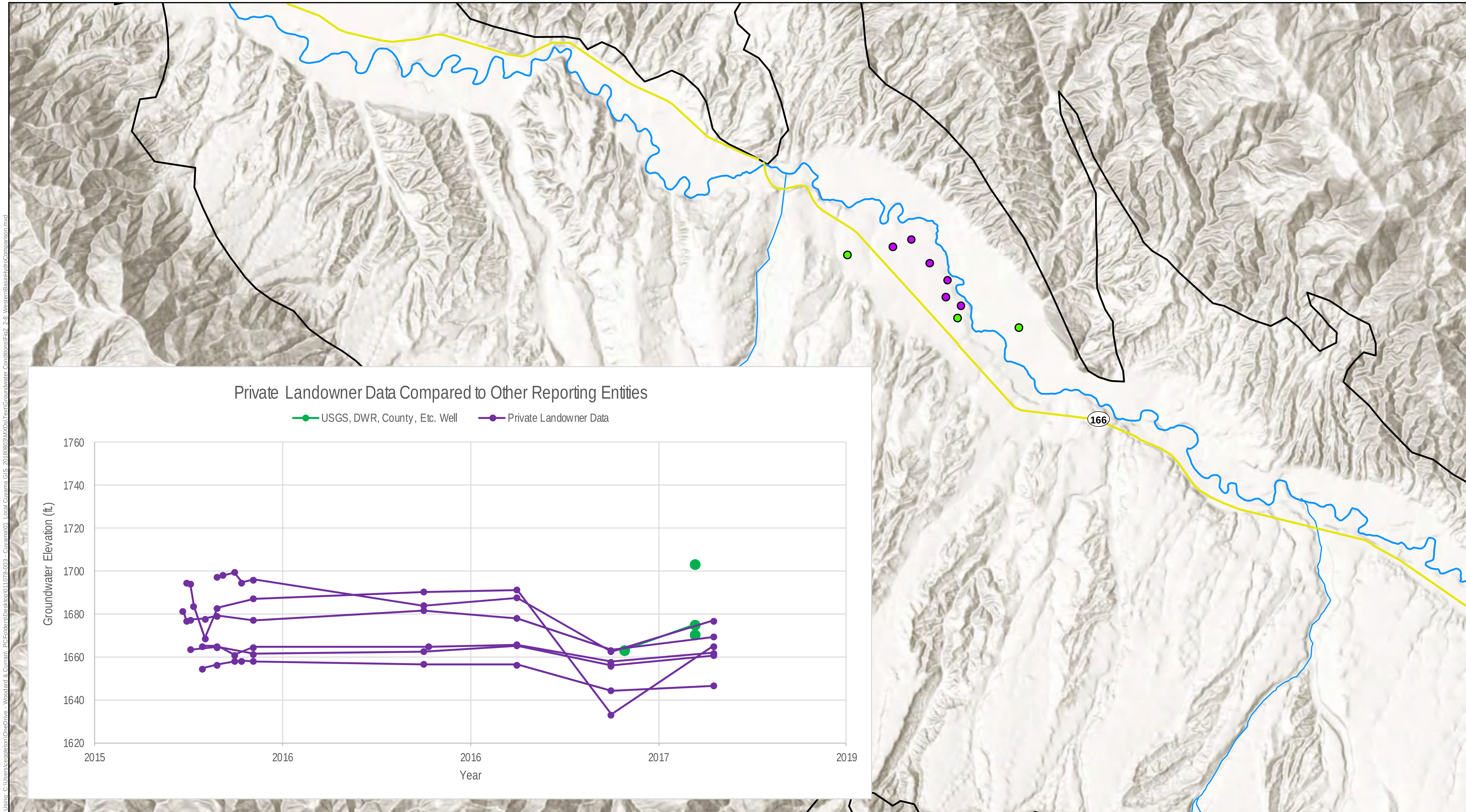

Figure 2-28: Western Cuyama GW Basin Wells and Hydrographs by Data Source

Cuyama Basin Groundwater Sustainability Agency

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WOODARD & CURRAN

Legend

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

N

0 0.5 1 2 Miles

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. In the following sections, historical context is provided by summarizing information from relevant studies about conditions from 1947 to 1966, followed by discussion of how groundwater conditions have changed based on available historical groundwater level monitoring data.

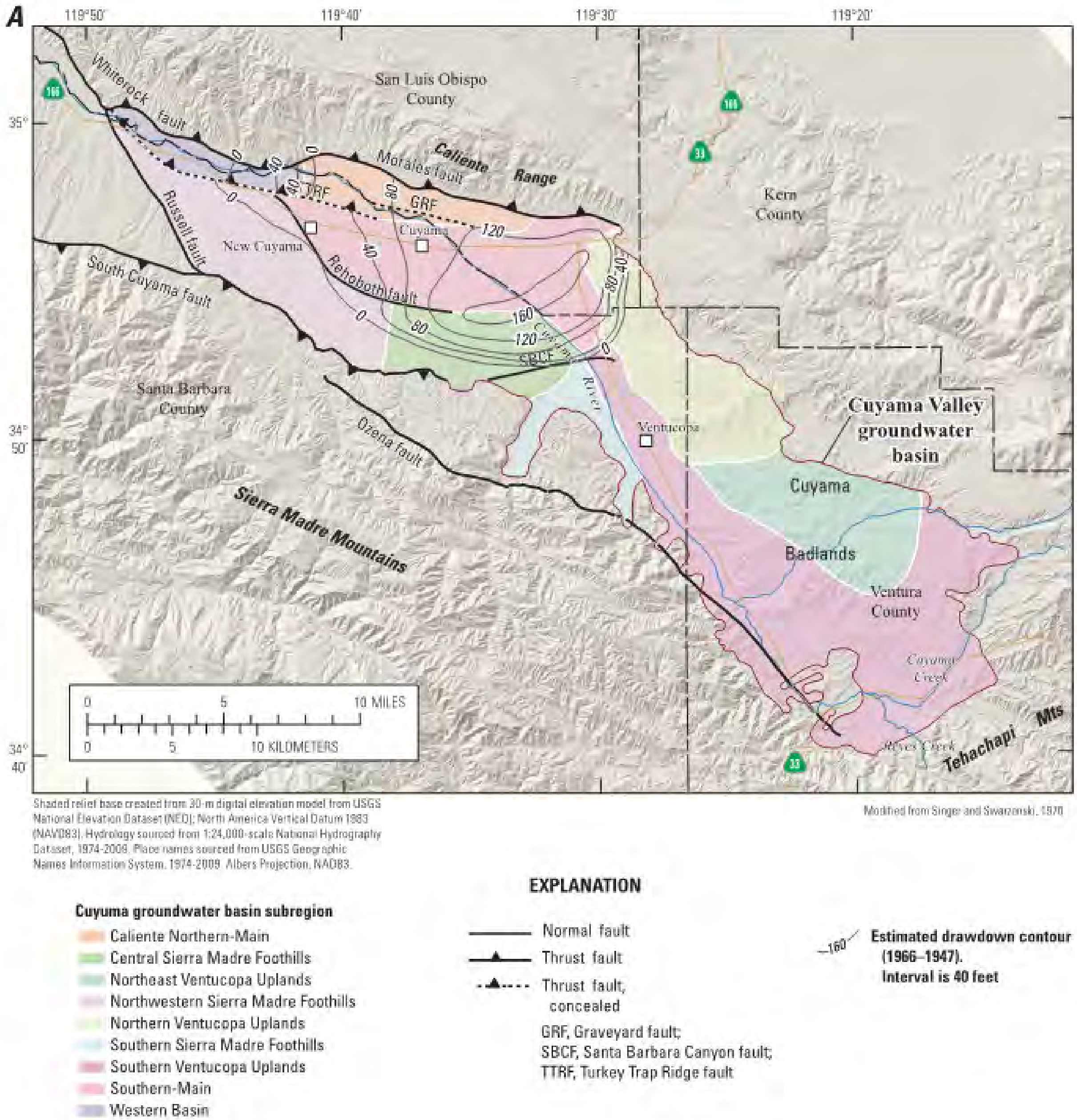
Historical Context – 1947 to 1966 Groundwater Trends

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

A USGS report titled *Water Levels in Observation Wells in Santa Barbara County, California* (USGS, 1956) discussed groundwater elevation monitoring in the Basin. The report states that ,prior to 1946, there was no electric power in the Cuyama 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," and that 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" (USGS, 1956).

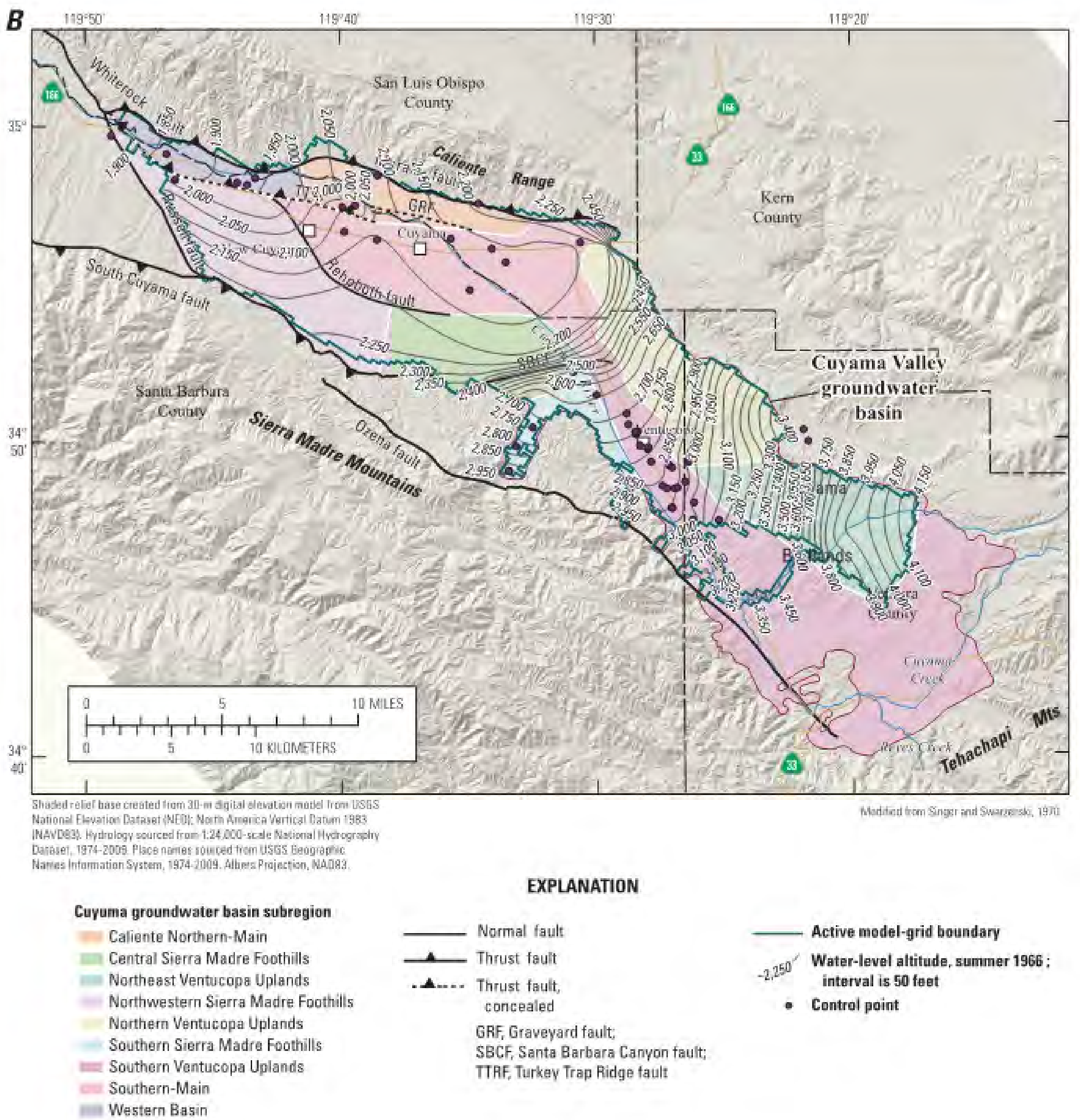
A USGS report titled *Hydrologic Models and Analysis of Water Availability in the Cuyama Valley, California* (USGS, 2015) presents two maps generated by using CUVHM simulated data. Figure 2-29 shows the estimated drawdown in the central portion of the Basin from 1947 to 1966. Figure 2-29 shows that estimated drawdown ranged from zero at the edges of the central basin to over 160 feet in the southeastern portion of the central Basin.

Figure 2-30 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.



Source: USGS, 2015

Figure 2-29: Water Level Drawdown Contours, 1966 to 1947



Source: USGS, 2015

Figure 2-30: 1966 Water Level Contours

Groundwater Trends According to Available Monitoring Data

To understand how groundwater conditions have changed in the Basin in recent decades, analysts developed and analyzed groundwater hydrographs, vertical gradients and contours, which are discussed below.

Groundwater Hydrographs

Groundwater hydrographs were developed to provide indicators of groundwater trends throughout the Basin. Measurements from each well with historical monitoring data were compiled into one hydrograph for each well. These hydrographs are presented in Appendix A.

In many cases, changes in historical groundwater conditions at particular wells have been influenced by climactic patterns in the Basin (Section 2.3). Historical precipitation is highly variable, with several relatively wet years and some multi-year droughts.

Groundwater conditions generally vary in different parts of the Basin. Figure 2-31 shows hydrographs in select wells in different portions of the Basin. These wells were selected they broadly represent Basin conditions in their areas. More information about conditions is below.

- In the area southeast of Round Springs Canyon, near Ozena Fire Station (Well 89), groundwater levels have stayed relatively stable with a small decline during the 2012 to 2015 drought, and showed quick recovery.
- In the vicinity of Ventucopa (at Well 62), groundwater levels have followed climactic patterns and have generally been declining since 1995.
- Just south of the SBCF (at Well 101), 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 (at Wells 55 and 615), groundwater levels have been declining consistently since 1950.
- In the area west of Bitter Creek (at Wells 119 and 830), groundwater levels are near ground surface near the Cuyama River, and are below ground in the area to the south, uphill from the river. Levels have been generally stable since 1966.

Figure 2-32 shows selected hydrographs for wells in the area near Ventucopa. 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. The hydrograph for Well 85 shows that prior to 1985 groundwater levels responded to drought conditions but recovered during wetter years. Well 40 is located just south of the SBCF and its hydrograph indicates that groundwater levels in this location have remained stable from 1951 to 2013, when monitoring ceased. Wells 91 and 620 are north of the SBCF and their hydrographs show more recent conditions, where depth to water has declined consistently and is below 580 feet below ground surface (bgs).

Figures 2-33 and 2-34 show hydrographs of discontinued and currently monitored wells in the central portion of the Basin, north of the SBCF and east of Bitter Creek. The hydrographs of discontinued wells in this area are shown in Figure 2-33. These hydrographs show consistent declines of groundwater levels and little to no response 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 2-34 shows hydrographs of currently monitored wells in the central portion of the Basin. In general, these hydrographs 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 618, 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, almost all monitoring wells in this area show consistent declines in elevation.

Figure 2-35 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 to 1969, and three more recent measurements. All measurements for Well 119 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 have recent measurements, and show groundwater levels that range from 120 to 140 feet bgs.

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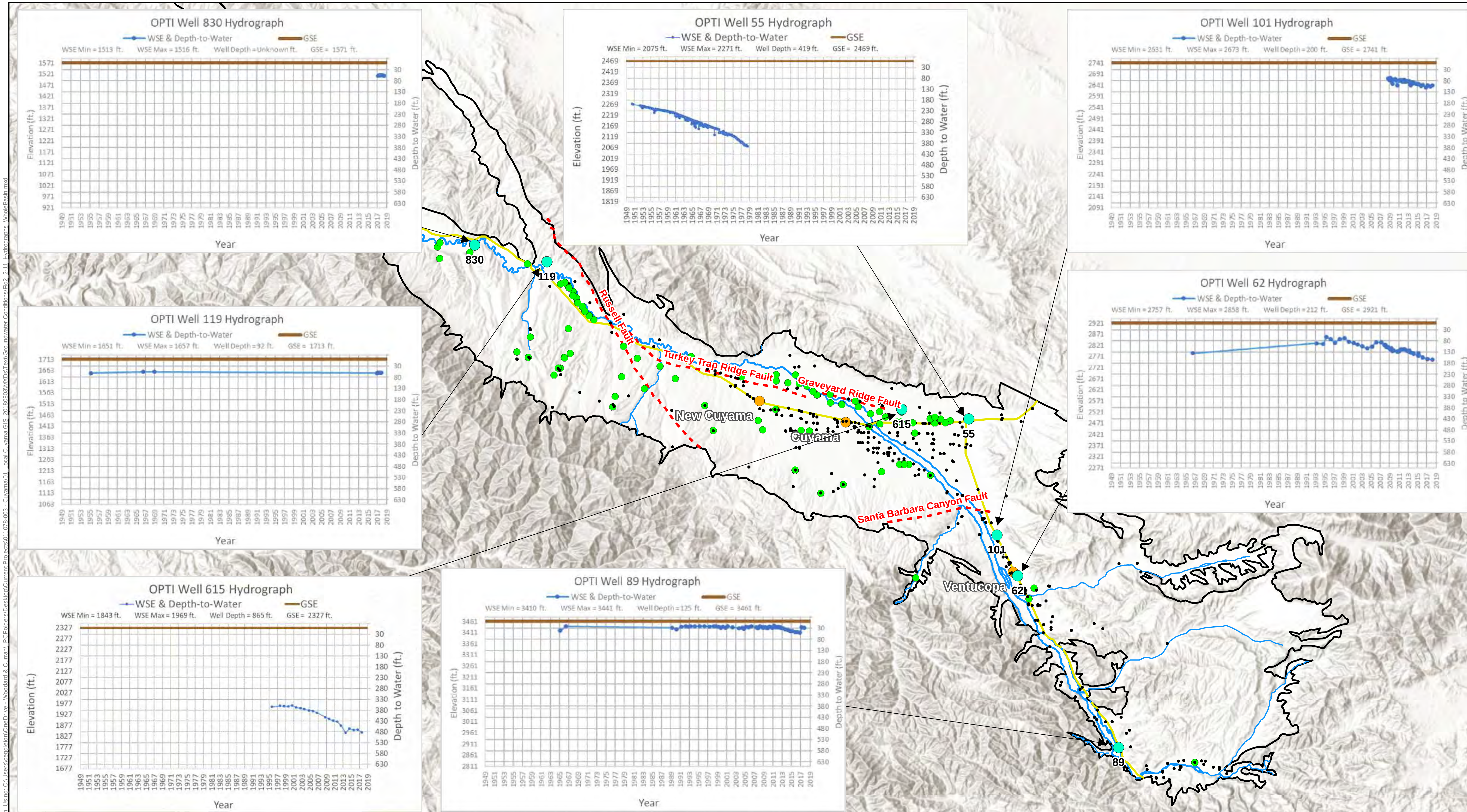

Legend
Cuyama Basin
Towns
Highways
Cuyama River
Streams
Faults
Hydrographed Wells
Currently Monitored Wells
Not Currently Monitored
N
0 2.5 5 10 Miles

Figure 2-31: Cuyama GW Basin Hydrographs

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Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

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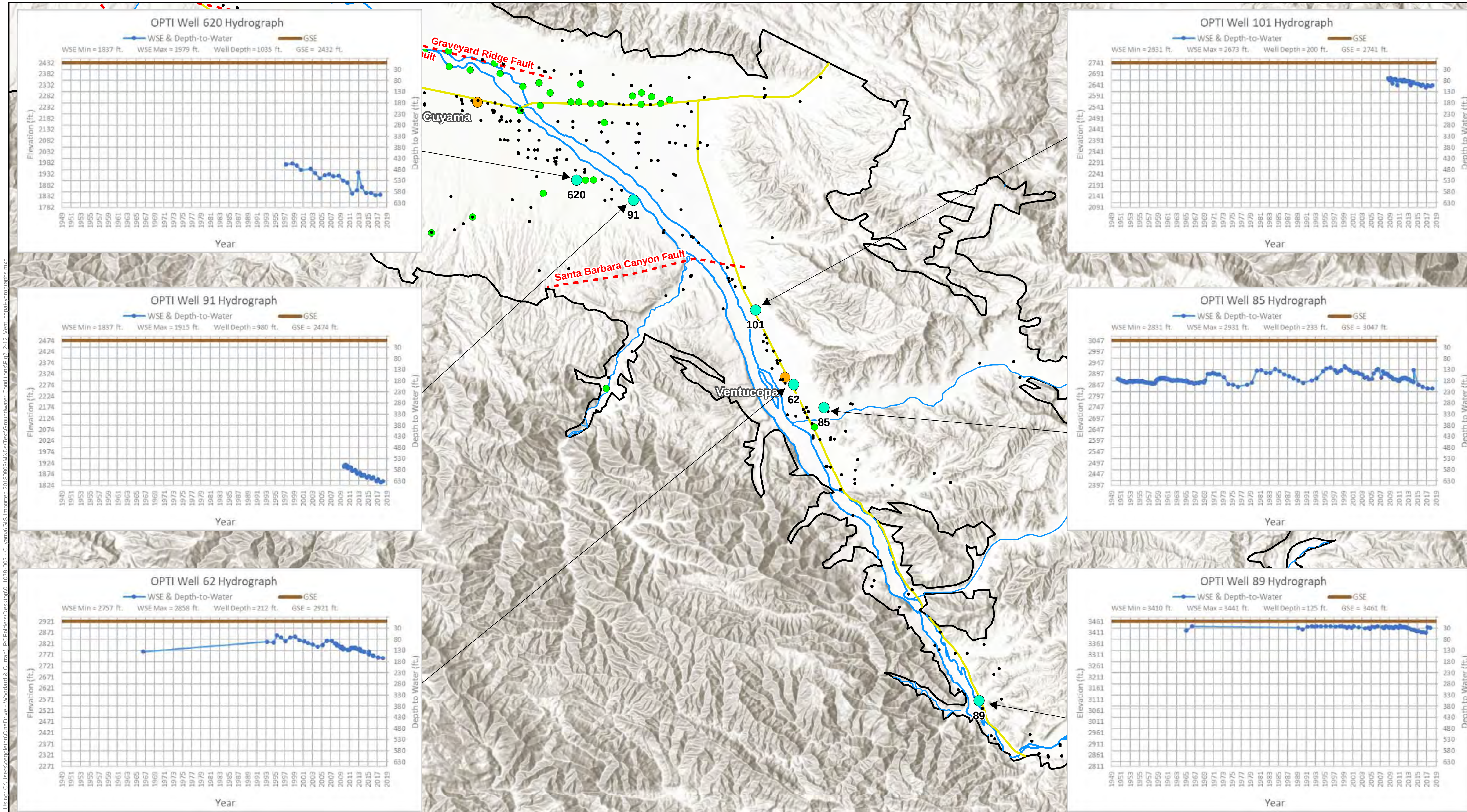

Figure 2-32: Cuyama GW Basin Hydrographs for the Ventucopa Area of the Basin

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Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

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Legend

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

N

0 1.25 2.5 5 Miles

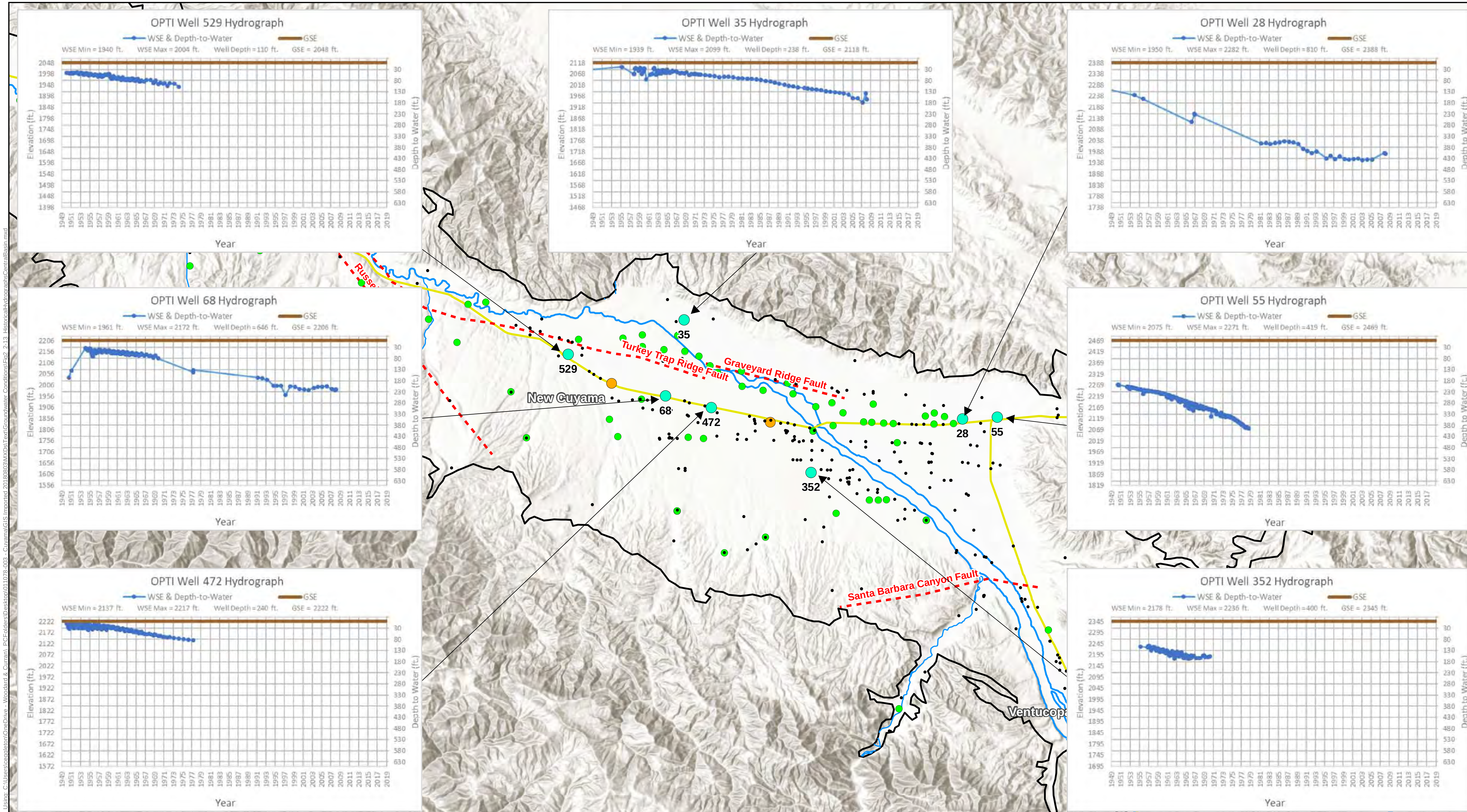

Figure 2-33: Cuyama GW Basin Hsitorical Hydrographs in the Central Basin

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Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

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Legend

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

N

0 1.25 2.5 5 Miles

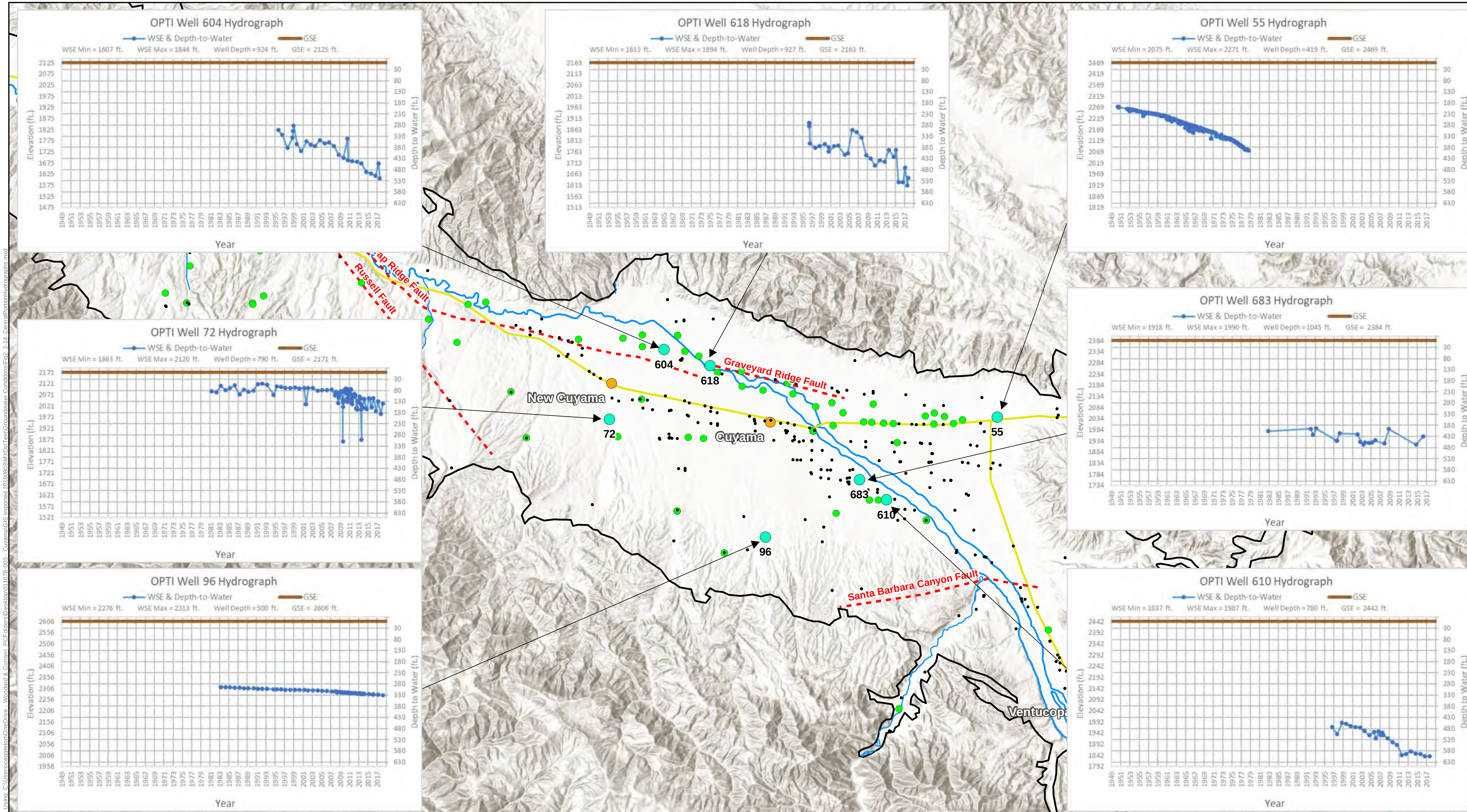

Figure 2-34: Cuyama GW Basin Hydrographs for the Central Portion of the Basin

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Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

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Legend

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

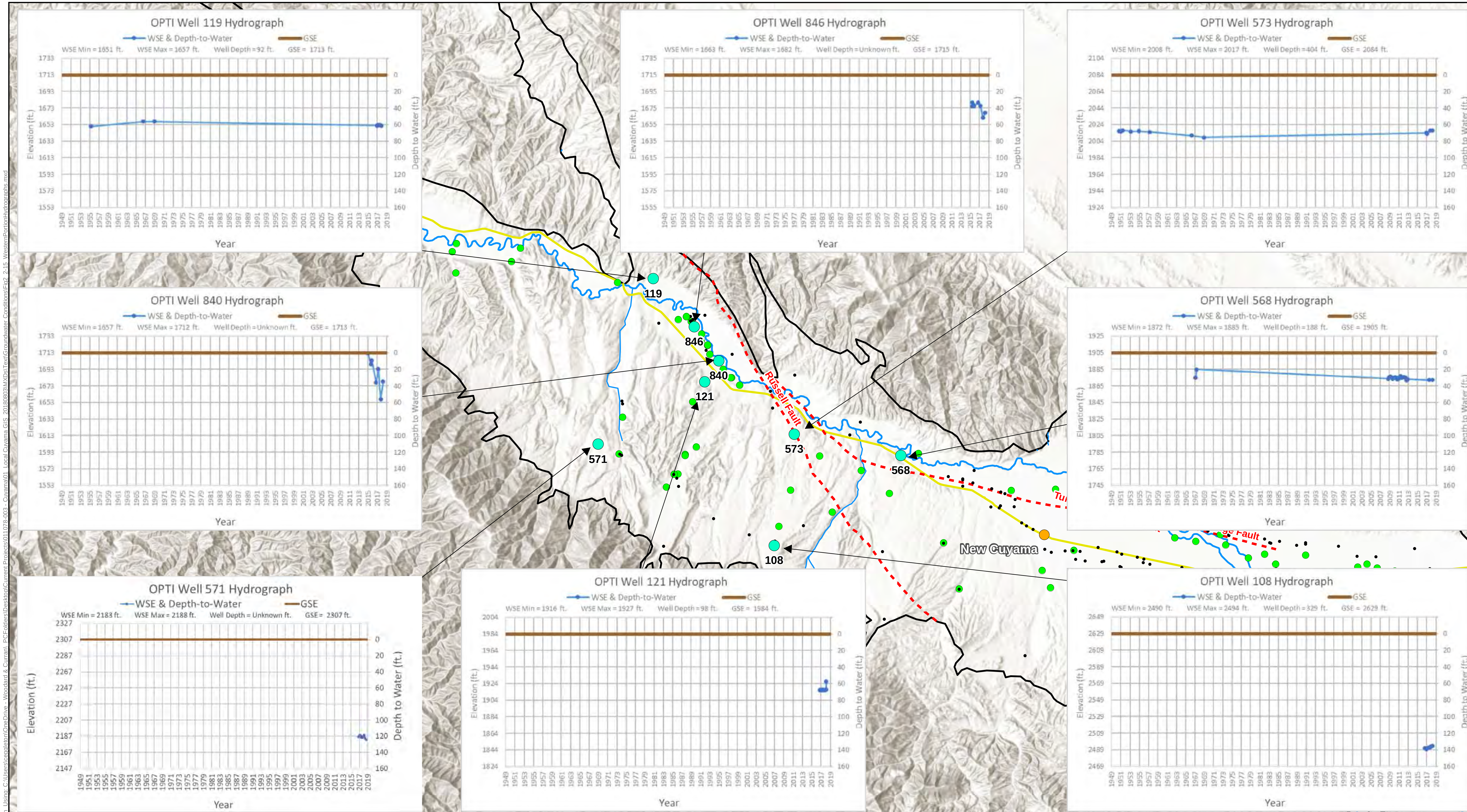

Figure 2-35: Cuyama GW Basin Hydrographs for the Westside Area of the Basin

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Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

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WOODARD & CURRAN

Legend

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

N

0 1.25 2.5 5 Miles

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Vertical Gradients

A vertical gradient describes the movement of groundwater perpendicular to the ground surface. A 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. An understanding of the Basin's vertical gradients is required by Section 354.16(a) of the SGMA regulations, and this understanding further describes how groundwater moves in the Basin.

There are three multiple completion wells in the Basin. A multiple completion well includes perforations at multiple intervals, and therefore provides information at multiple depths in the well. Figure 2-23 shows the locations of the multiple completion wells in the Basin, and are located in the central portion of the Basin, north of the SBCF and east of Bitter Creek.

Figure 2-36 shows the combined hydrograph for the multiple completion well CVFR, which was installed by USGS.[7] CVFR is comprised of four completions, each at different depths as follows:

- 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 close to the same elevation at each completion, and therefore it is unlikely that there is any vertical gradient at this location.

Figure 2-37 shows the combined hydrograph for the multiple completion well CVBR, which was installed by USGS. CVBR is comprised of four completions, each at different depths as follows:

- 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

[7] All three multiple completion wells were installed by the USGS as part of the Cuyama Valley Water Availability Study in cooperation with SBCWA

The hydrograph of the four completions shows that at the deeper completions, groundwater elevations are slightly lower than the shallower completions in the winter and spring, and deeper completions are generally lower than the shallower completion in the summer and fall. This indicates that during the irrigation season, the deeper portions of the aquifer are likely to be where pumping occurs. This pumping 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 or horizontally to replace removed water, and the vertical gradient is significantly smaller at this location in the spring measurements.

Figure 2-38 shows the combined hydrograph for the multiple completion well CVKR, which was installed by the USGS. CVKR is comprised of four completions, each at different depths as follows:

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

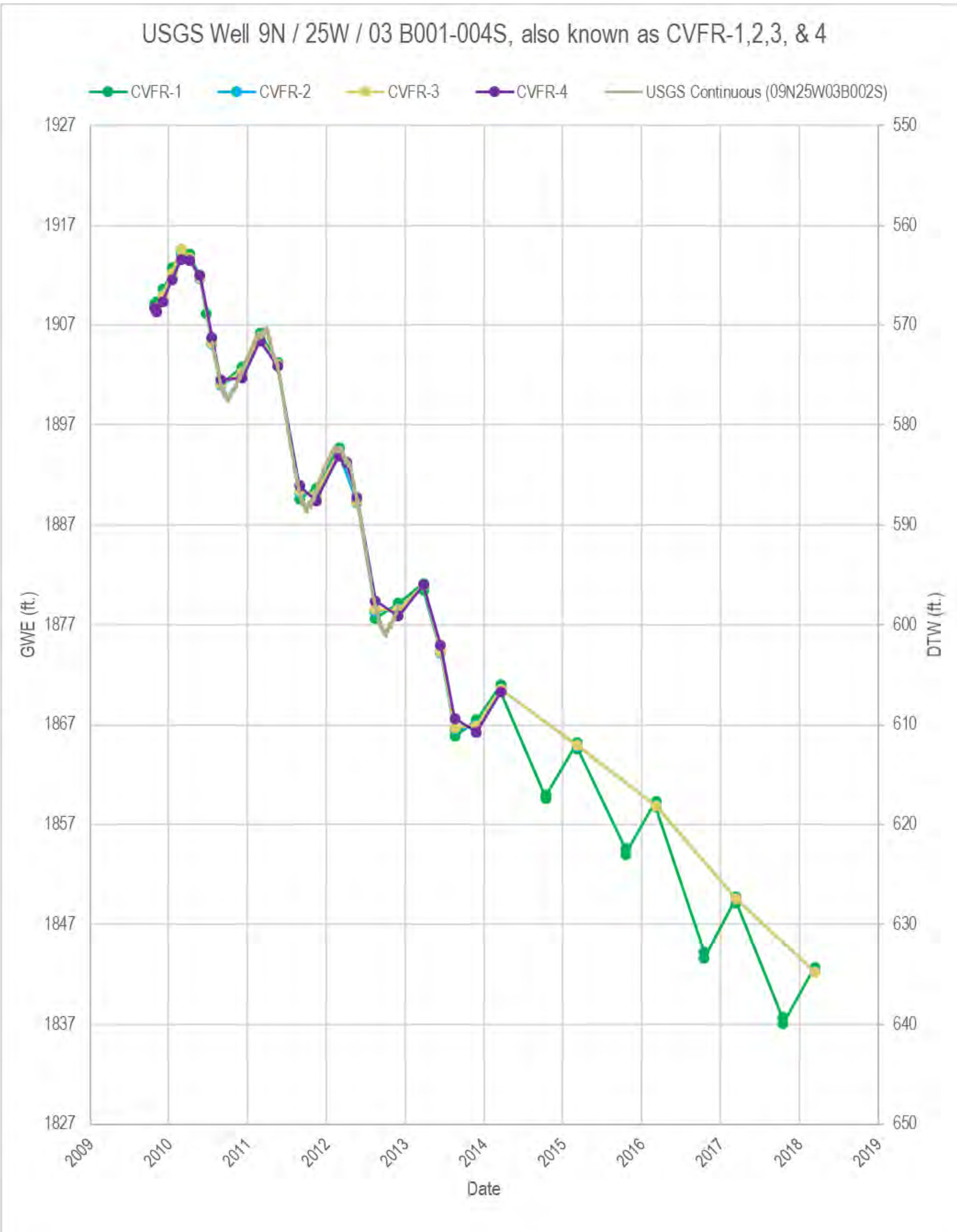

Figure 2-36: Hydrographs of CVFR1-4

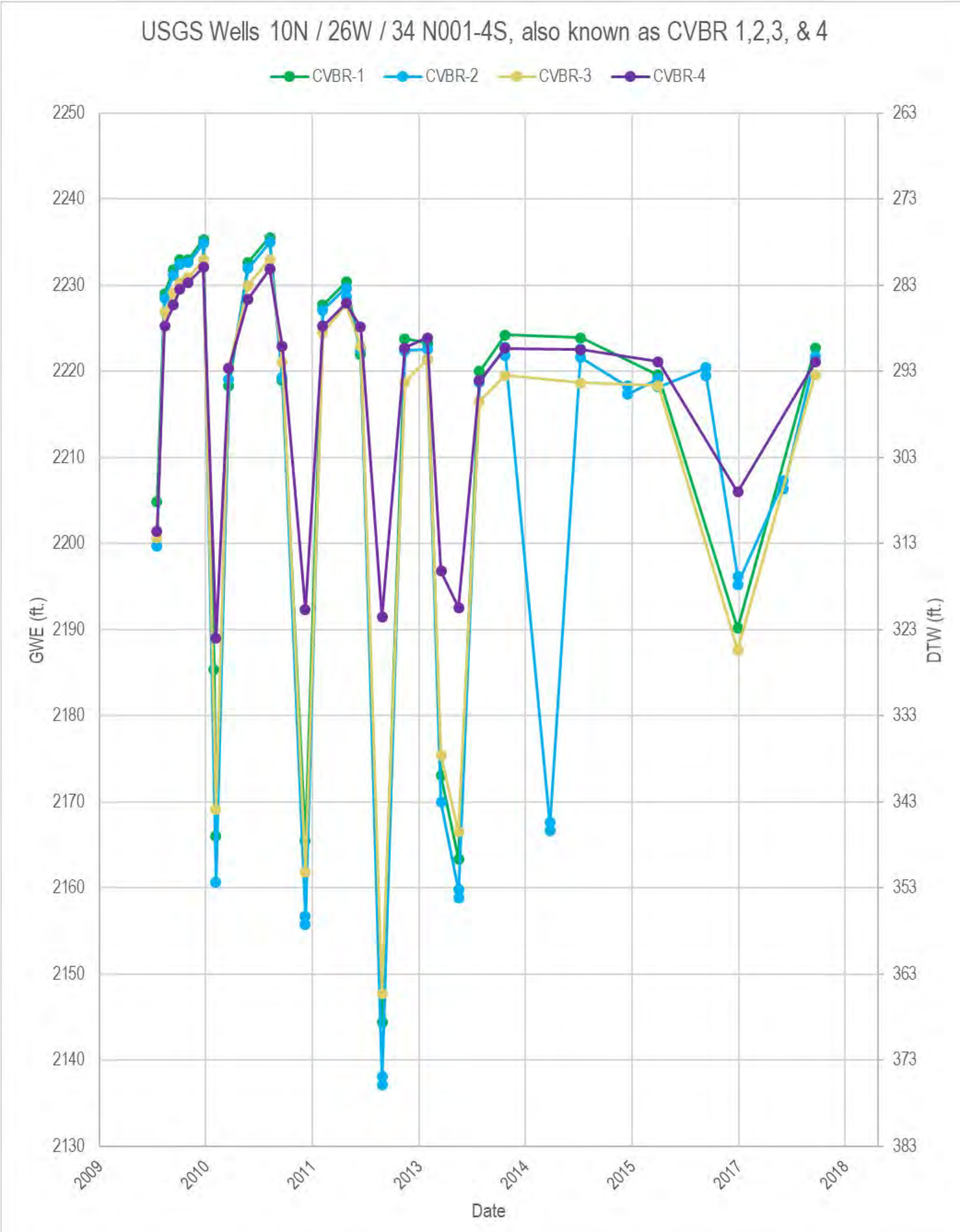

Figure 2-37: Hydrographs of CVBR1-4

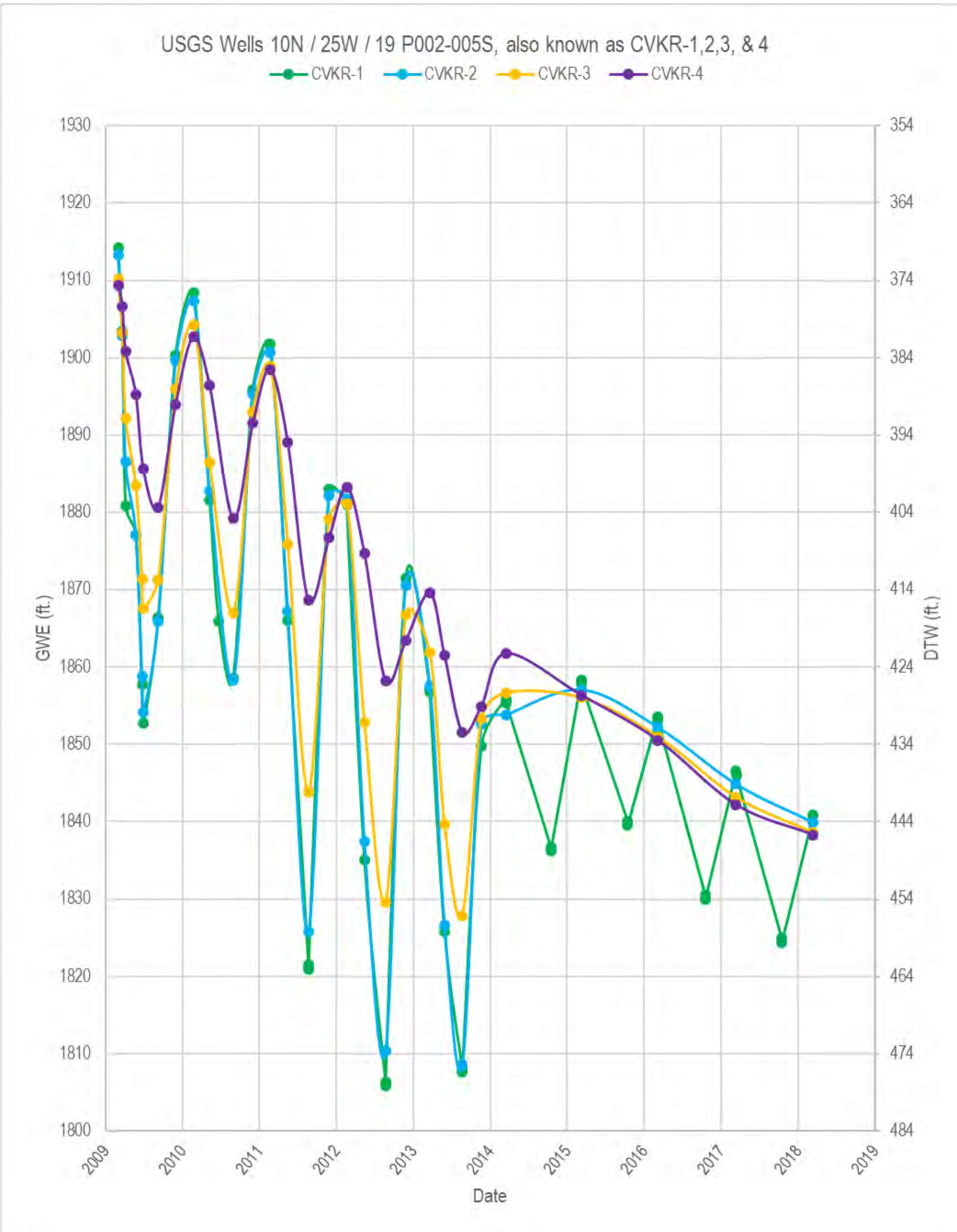

Figure 2-38: Hydrographs of CVKR1-4

Groundwater Contours

Analysts prepared groundwater contour maps to improve understanding of recent groundwater trends in the Basin. Analysts used the data collected and described in Section 0 to develop these 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, the line represents groundwater at the elevation indicated. There are two versions of contour maps used in this section: one that shows the elevation of groundwater above mean sea level, which is useful because it can be used to identify the horizontal gradients of groundwater, and one that 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.

Analysts prepared groundwater contour maps for both groundwater elevation and depth to water for the following periods:

- Spring 2018
- Fall 2017
- Spring 2017
- Spring 2015
- Fall 2014

These years were selected for contours because they are representative of current conditions, and because these years identify conditions near January 1, 2015, when SGMA came into effect. The contour maps are described below.

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 were also based on assumptions in order to accumulate enough data points to generate useful contour maps. Assumptions are as follows:

- 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 generate contours that are useful at the planning level for understanding 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 to generate a more accurate understanding of groundwater trends in the Basin is discussed in Chapter 4.

Figure 2-39 shows groundwater elevation contours for spring of 2018, along with arrows showing the direction of groundwater flow. 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. Lowered groundwater elevations in this area are also associated with a flow gradient to the southeast from 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 2-40 shows depth to groundwater contours for spring of 2018. 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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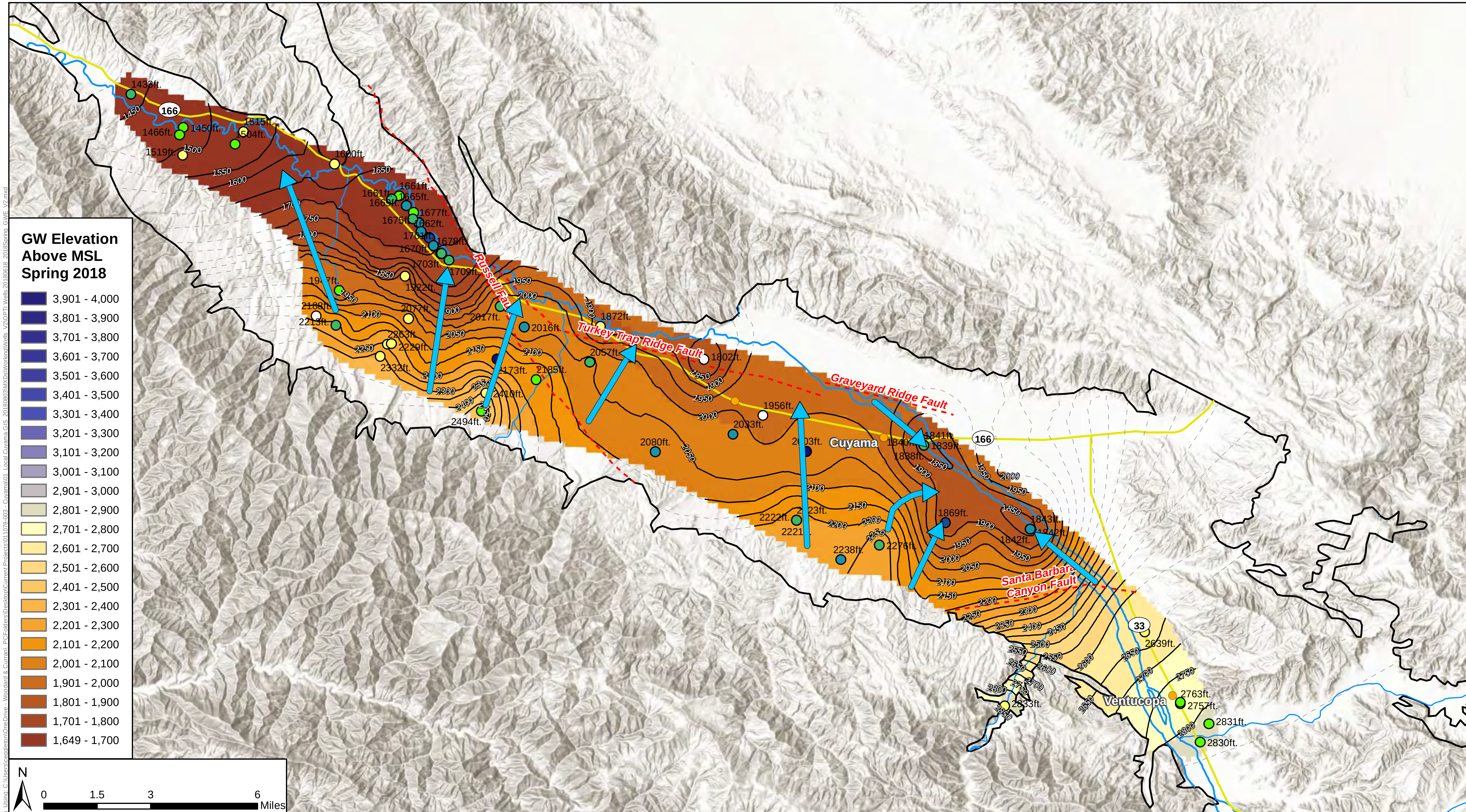

Figure 2-39: Cuyama GW Basin Wells by Groundwater Surface Elevation

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

December 2019

WOODARD & CURRAN

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.

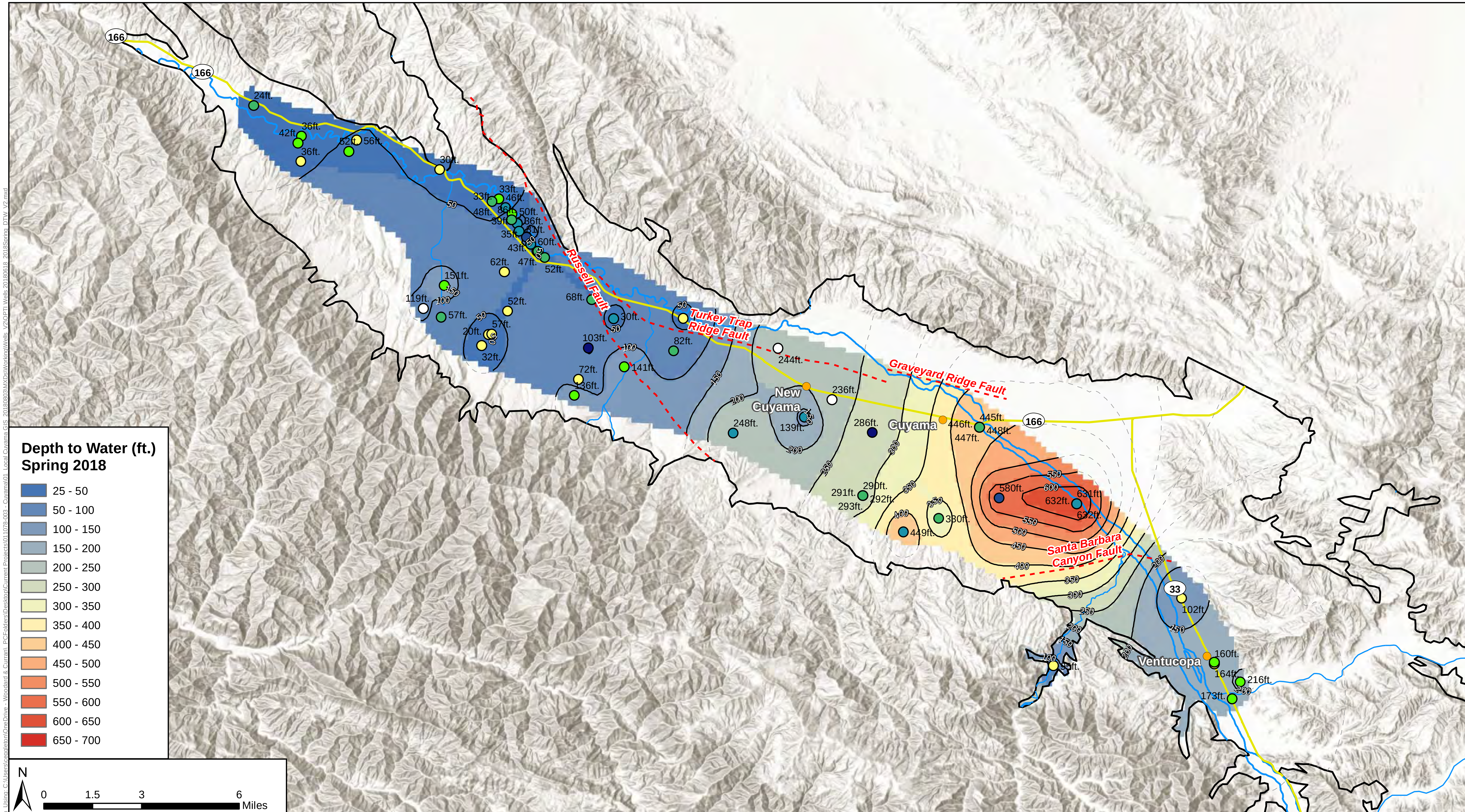

Figure 2-40: Cuyama GW Basin Wells by Depth to Water

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

December 2019

WOODARD & CURRAN

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
- 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 limitated data availability.

Contours Interval: 50 ft.

The remaining contour maps for spring 2017, fall 2017, spring 2015, and fall 2014 are shown below. These dates were selected to show the changes over the most recent period of three years for which data were available in the spring (from 2015 to 2018) and from the fall (from 2014 to 2017).

Figure 2-41 shows groundwater elevation contours for fall of 2017. Because more data were available in this time frame, the contour map shows 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 across 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.

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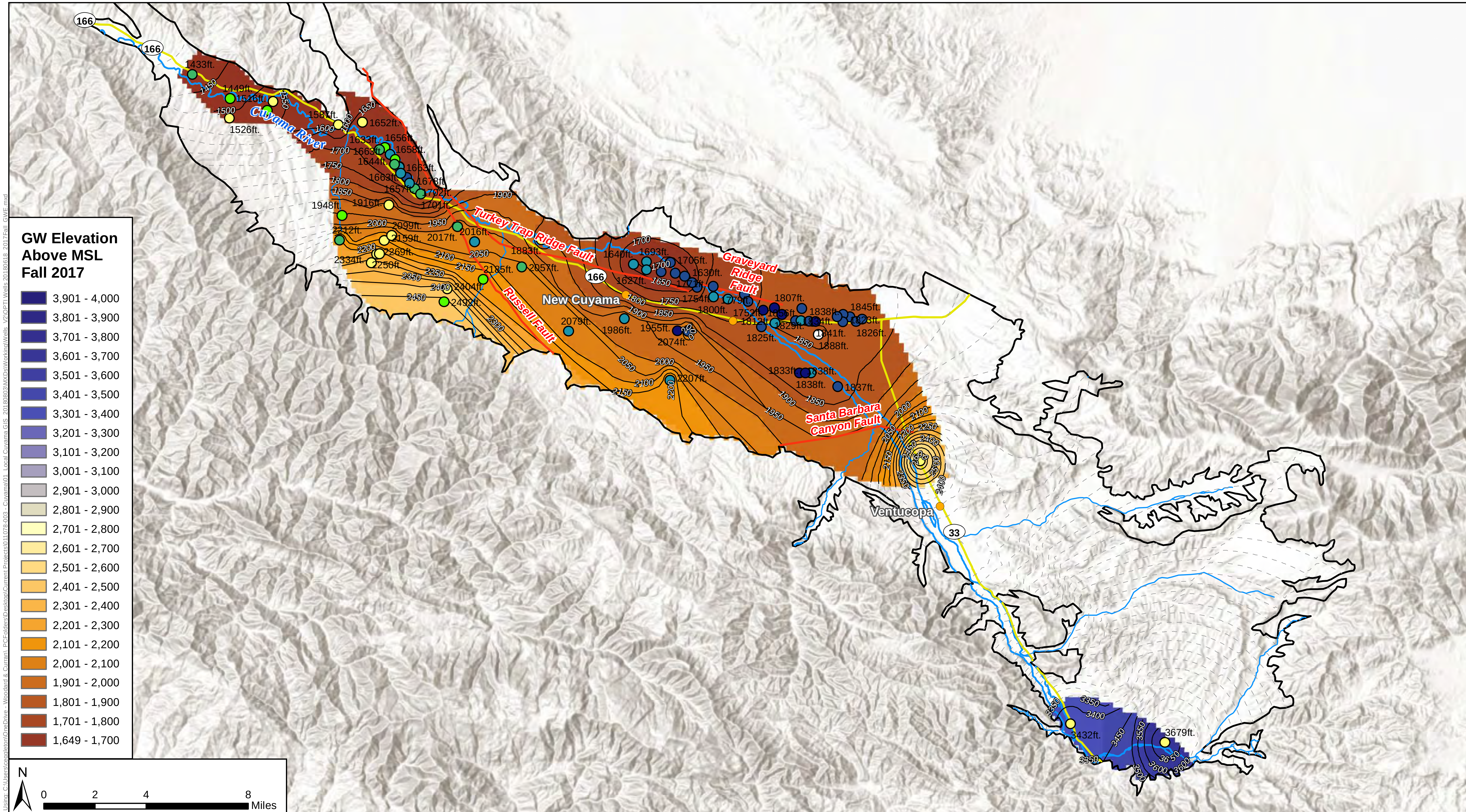

Figure 2-41: Fall 2017 Groundwater Elevation

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

September 2019

WOODARD & CURRAN

Legend

- Cuyama Basin
- Cuyama River
- Faults
- Groundwater Elevation Above MSL
- Inferred Groundwater Elevation Above MSL

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 8/1/2017 - 11/30/2017 due to limitaed data availbility.

Contours Interval: 50 ft.

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Figure 2-42 shows depth to water contours for fall of 2017. Because more data were 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 depth to groundwater decreasing 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.

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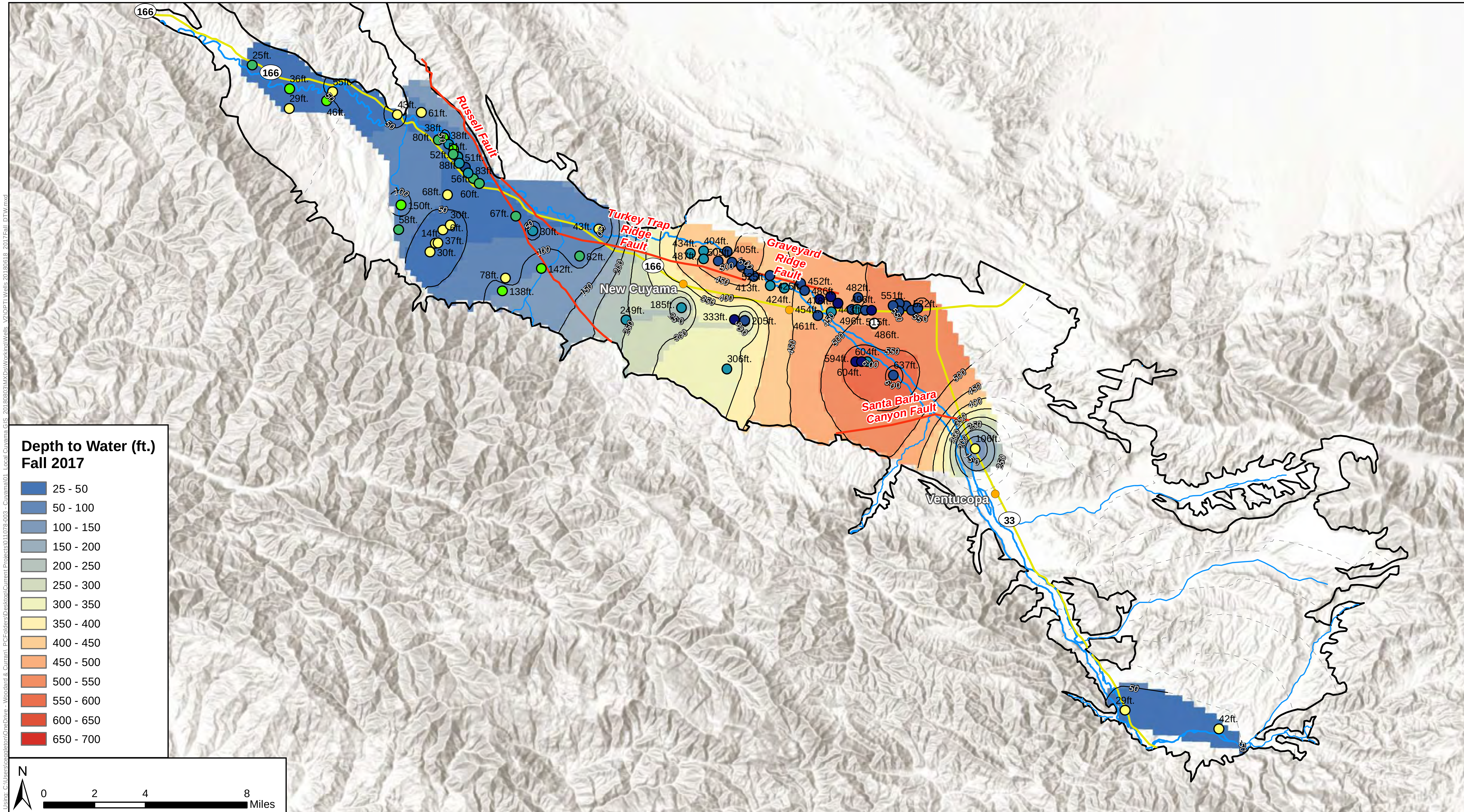

Figure 2-42: Fall 2017
Depth to Water

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

September 2019

WOODARD & CURRAN

Legend

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

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 8/1/2017 - 11/30/2017 due to limitated data availability.

Contours Interval: 50 ft.

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Figure 2-43 shows groundwater elevation contours for spring of 2017. Because more data were 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 across 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.

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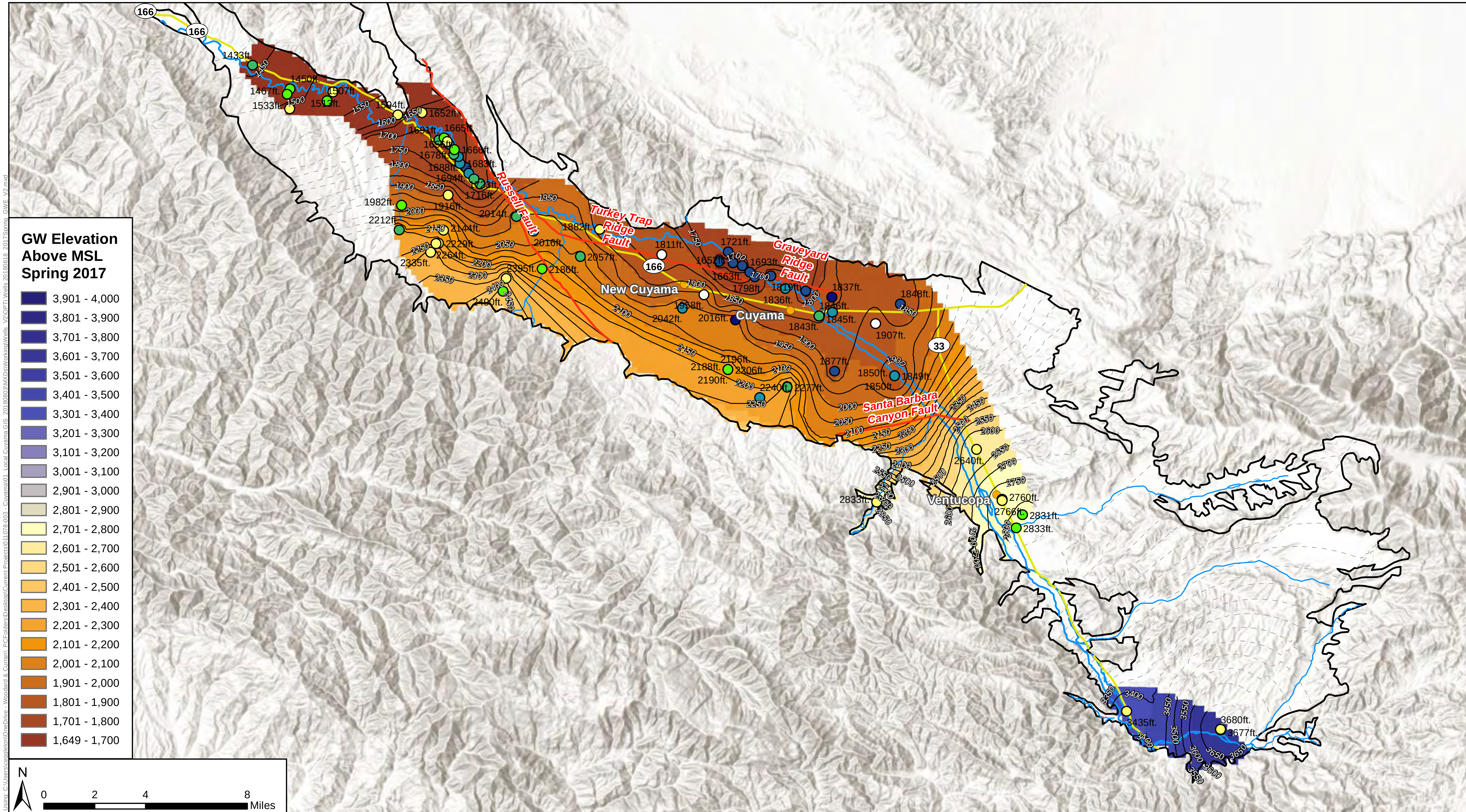

Figure 2-43: Spring 2017 Groundwater Elevation

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

September 2019

WOODARD & CURRAN

Legend

- Cuyama Basin
- Cuyama River
- Faults
- Groundwater Elevation Above MSL
- Inferred Groundwater Elevation Above MSL

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 1/1/2017 - 4/30/2017 due to limitated data availability.

Contours Interval: 50 ft.

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Figure 2-44 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 depth to groundwater decreasing 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.

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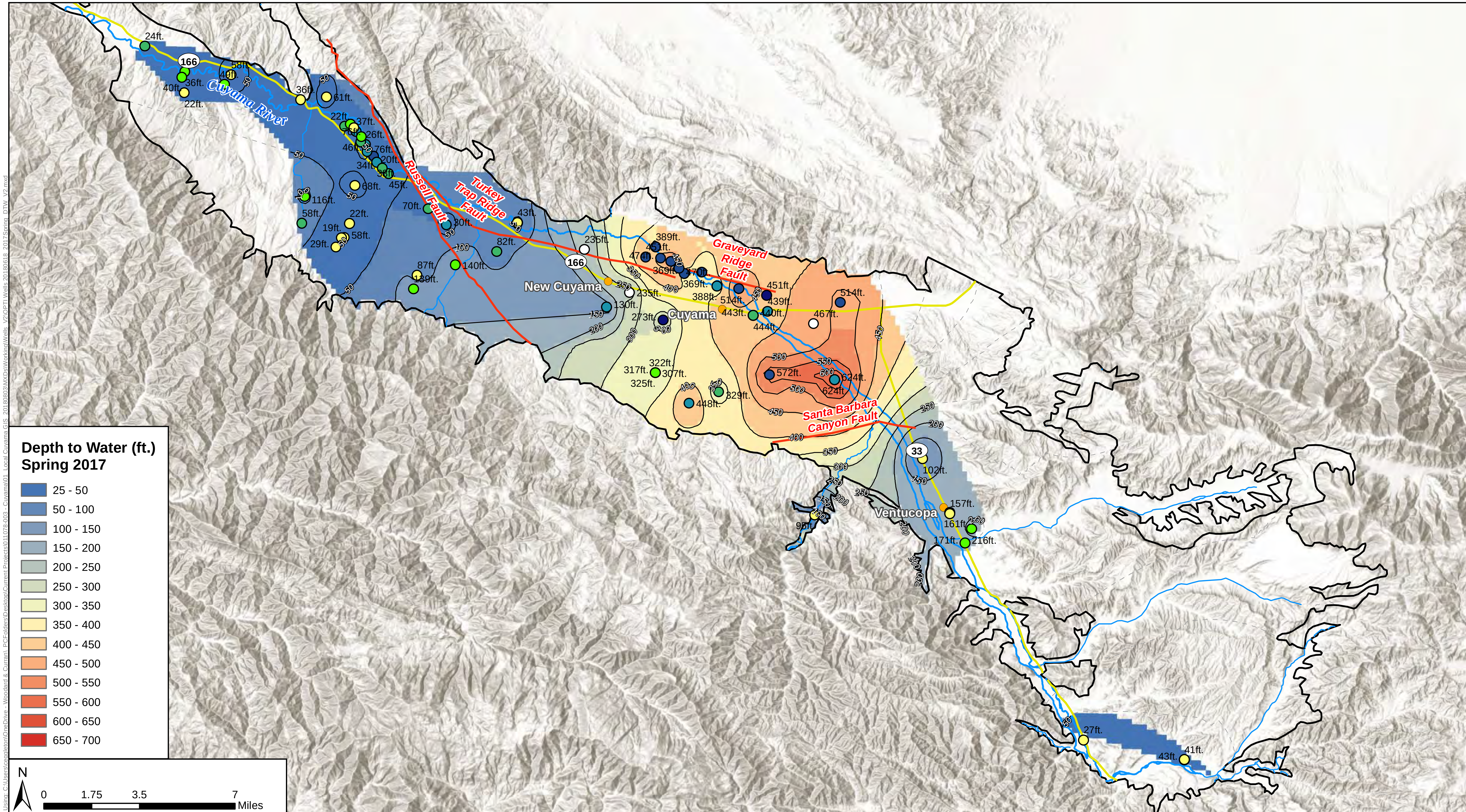

Figure 2-44: Spring 2017 Depth to Water

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

September 2019

WOODARD & CURRAN

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
- 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 1/1/2017 - 4/30/2017 due to limitated data availability.

Contours Interval: 50 ft.

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Figure 2-45 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 across 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.

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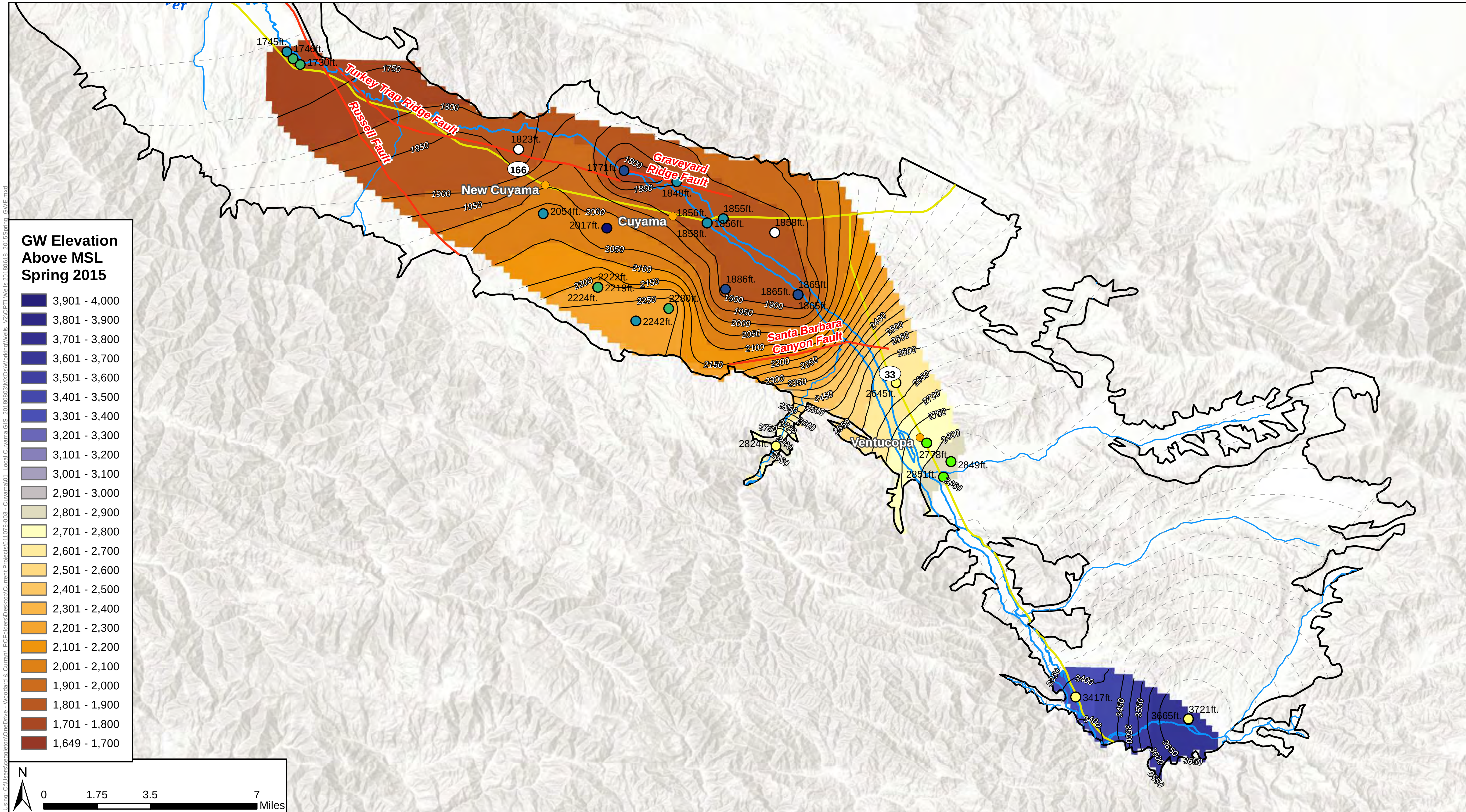

Figure 2-45: Spring 2015 Groundwater Elevation

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

September 2019

WOODARD & CURRAN

Legend

- Cuyama Basin
- Cuyama River
- Faults
- Groundwater Elevation Above MSL
- Inferred Groundwater Elevation Above MSL

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 2/1/2015 - 4/30/2015 due to limitated data availability.

Contours Interval: 50 ft.

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Figure 2-46 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. These depths are in general less severe than those shown for the spring of 2017, reflecting deepening depth to groundwater conditions in the central portion of the Basin. Interpretation from New Cuyama to monitoring points in the northwest is hampered by a limited set of data points.

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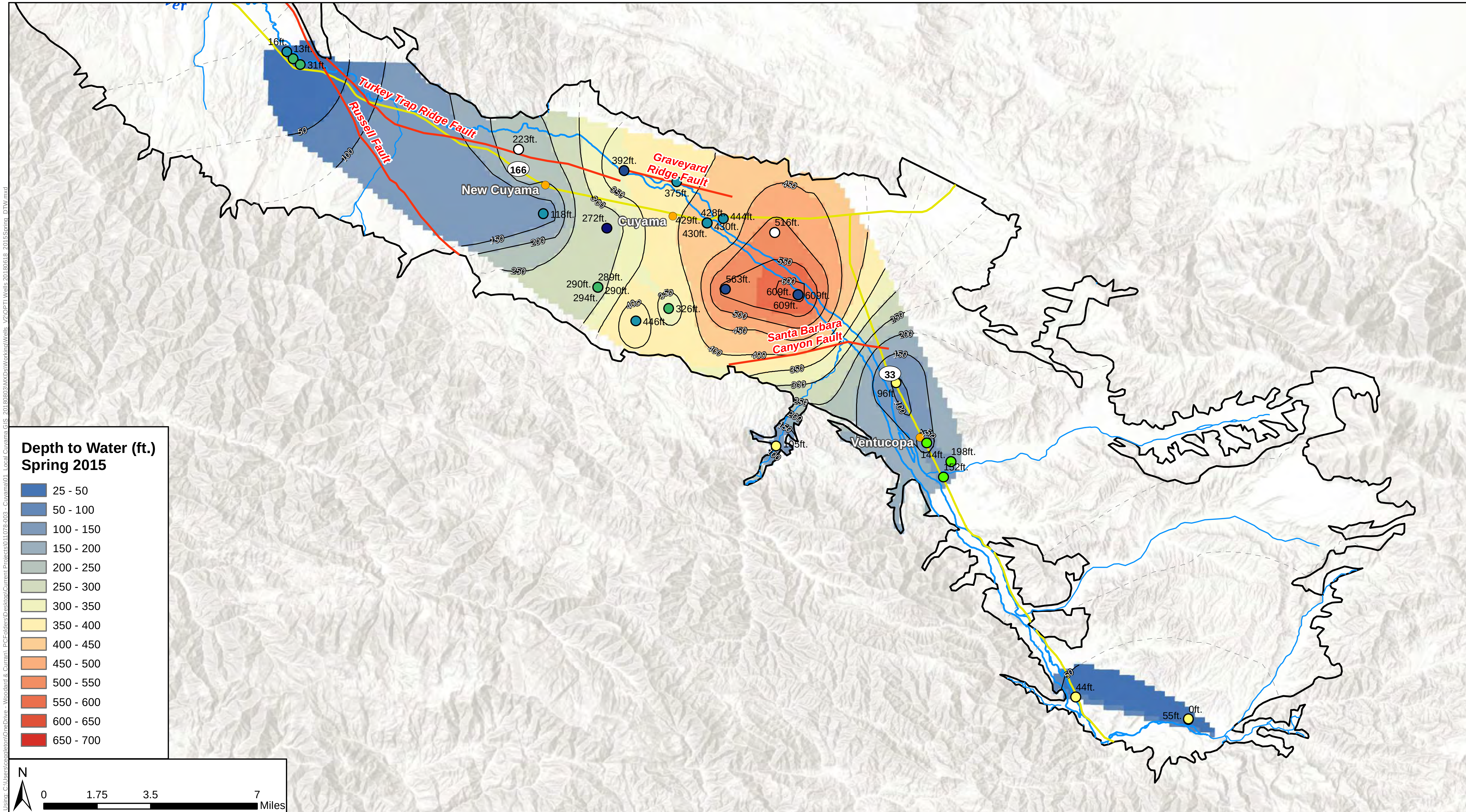

Figure 4-46: Spring 2015 Depth to Water

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

September 2019

WOODARD & CURRAN

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
- 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 2/1/2015 - 4/30/2015 due to limitated data availability.

Contours Interval: 50 ft.

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Figure 2-47 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 across the SBCF and flows to an area of lowered groundwater elevation northeast of the town of Cuyama.