CHAPTER 4
MONITORING NETWORKS

4.1 MONITORING NETWORK OBJECTIVES

The overall objective of the monitoring network in the Pleasant Valley Basin (PVB) is to track and monitor parameters that demonstrate progress toward meeting the sustainability goals. In order to accomplish this objective, the monitoring network in the PVB must be capable of the following:

- Monitoring changes in groundwater conditions (in six sustainability indicator categories)
- Monitoring progress toward minimum thresholds and measurable objectives
- Quantifying annual changes in water budget components

The existing network of groundwater wells includes both monitoring wells and production wells. This network is capable of delineating the groundwater conditions in the PVB and has been used for this purpose in the past. The current groundwater well network will be used to monitor groundwater conditions moving forward, to continue to assess long-term trends in groundwater elevation and groundwater quality in the PVB.

In the future, to the extent possible, additional dedicated monitoring wells will be incorporated into the existing monitoring network. These wells will provide information on groundwater conditions in geographic locations where data gaps have been identified, or where a dedicated monitoring well would better represent conditions in the aquifers than a production well currently used for monitoring.

4.2 DESCRIPTION OF EXISTING MONITORING NETWORK

The existing monitoring network for groundwater and related surface conditions in the PVB includes groundwater production wells, dedicated groundwater monitoring wells, stream gauges, and weather stations. The components of the monitoring network are discussed in Section 4.2.1, Network for Monitoring Groundwater, and Section 4.2.2, Surface Conditions Monitoring, in the context of their ability to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface conditions, as well as the ability of the network to provide representative conditions in the PVB. A discussion of how the monitoring network relates to each of the sustainability criteria follows this discussion in Section 4.3, Monitoring Network Relationship to Sustainability Indicators.

4.2.1 Network for Monitoring Groundwater

Data collected from 80 wells in the PVB have been used to demonstrate historical groundwater elevation conditions in the older alluvium and the Lower Aquifer System (LAS) (Appendix C, UWCD

Model Report). However, the current groundwater well monitoring network is much smaller (Figure 4-1, Monitoring and Non-Monitoring Wells Screened in the Oxnard, Mugu, and Hueneme Aquifers in the Pleasant Valley Basin, and Figure 4-2, Monitoring and Non-Monitoring Wells Screened in the Fox Canyon Aquifer in the Pleasant Valley Basin). A total of 12 wells in the PVB are designated as screened in a single aquifer (County of Ventura 2016). Of these, four are designated monitoring wells that belong to a single nested well cluster (02N21W34G02S-05S). The remaining eight wells are production wells. The majority of the wells in the PVB monitoring network are located in the Pleasant Valley Pumping Depression Management Area (PVPDMA). This management area has nine wells screened in a single aquifer, four of which are in the nested well cluster. In contrast, the North Pleasant Valley Management Area (NPVMA) has three wells screened in a single aquifer. There are no single-aquifer wells located in the East Pleasant Valley Management Area.

The United Water Conservation District (UWCD) collects groundwater elevation data from the nested well cluster, as well as from three agricultural wells that are screened in multiple aquifers in the PVB. The wells are monitored either monthly or bimonthly (once every 2 months). Water levels are measured both manually and with pressure transducers, which record the pressure of water (or height of the water column) above the transducer in the well. Pressure transducers have been installed in two of the wells in the nested well cluster and one of the agricultural wells the UWCD monitors in the PVB. These transducers record the height of the water column in the well every 4 hours, thereby providing high temporal resolution data on groundwater conditions in the aquifers. Data are downloaded from the transducers and the transducer records are subject to quality control review before being added to UWCD databases and reported to the Ventura County Watershed Protection District (VCWPD).

Manual groundwater elevation measurements are collected monthly or bimonthly from the groundwater wells in the PVB that are part of the UWCD monitoring network. These data are used to assess seasonal and long-term trends in groundwater elevation in the PVB, where groundwater elevations were first measured in the 1920s. Seasonal and long-term groundwater elevation trends have been assessed based on the data collected from the existing and historical network of groundwater monitoring wells, and are discussed in Section 2.3, Groundwater Conditions, of this Groundwater Sustainability Plan (GSP).

The spatial and temporal coverage of the existing groundwater monitoring network is sufficient to provide an understanding of representative conditions in the upper alluvium and LAS in the PVB and this network will be used to demonstrate progress toward the sustainability goals for the PVB. Although evaluation of the current network suggests that the network is sufficient to document groundwater conditions in the PVB areas for future improvement of the network are identified in Section 4.6, Potential Monitoring Network Improvements.

Groundwater Quality

Wells in the PVB that are currently monitored for groundwater quality include those in the nested monitoring well cluster (02N21W34G02S-05S) and an adjacent monitoring well (02N21W34G06S) that is screened in an aquitard, rather than in any of the primary aquifers. UWCD collects the samples from these wells. UWCD water quality monitoring is conducted in a rotating pattern such that each well is monitored at least one time per year. Annual monitoring of groundwater quality is sufficient to demonstrate long-term trends in groundwater quality. Water quality does not change as rapidly as groundwater elevation because the physical processes that drive changes in groundwater quality operate on a longer time-scale. Currently groundwater elevations are the primary metric by which progress toward sustainability will be measured. However, groundwater quality data will continue to be collected and analyzed in order to assess whether groundwater elevation thresholds are sufficiently protective of groundwater conditions in the PVB. Recommendations for improvement of the groundwater quality monitoring network are identified in Section 4.6.

Groundwater Extraction

The Fox Canyon Groundwater Management Agency (FCGMA) has required reporting of groundwater extraction from the PVB since 1983. Historically, groundwater extraction data from wells within the FCGMA jurisdictional boundary have been self-reported by the well owner semi-annually (Figure 2-5, Groundwater Extraction [acre-feet] in 2015 in the Las Posas Valley Basin). In 2018, FCGMA adopted an ordinance that required installation of advanced metering infrastructure (AMI) telemetry on wells that were equipped with flowmeters (FCGMA 2018). All agricultural wells were required to install AMI by December 31, 2018, municipal and industrial wells are required to install AMI by October 1, 2019, and all other metered wells are required to install AMI by October 1, 2020. Requiring AMI on all metered wells within FCGMA jurisdiction will provide for broader simultaneous reporting of groundwater extractions, improve FCGMA's ability to monitor and manage groundwater use, and facilitate implementation of this GSP.

4.2.2 Surface Conditions Monitoring

The primary surface conditions that impact groundwater conditions in the PVB are surface water flows and precipitation. The monitoring networks for both surface conditions are discussed in this section.

Surface Water

Surface flows in the PVB are monitored by a network of gauges that are maintained by VCWPD (Table 4-1; Figure 4-3, Active Surface Water Monitoring Network for the Pleasant Valley Basin). The network includes three types of gauges:

1. Recording Gauges (also known as Daily and Peak Stations). These stream gauges record daily average flowrates as well as "peak" flowrates during rain events.
2. Peak Only (Event) Gauges. This type of stream gauge records only "peak" flowrates during rain events (the threshold over which a flowrate is considered to be part of a rain event is site-specific).
3. ALERT Peak Gauges. These stream gauges serve only as a flood warning system. These gauges register high flows but are not used to measure numerical flow rates.

The recording stations at Conejo Creek, near Highway 101 and at Ridgeview Street, and the recording station on Calleguas Creek, at California State University Channel Islands (CSUCI), are the gauges that provide the primary data on surface flows. These gauges collect daily data, while the other gauges in the PVB only record flows during precipitation events.

In addition to the surface flow monitoring network in the PVB, Camrosa Water District monitors diversions from Conejo Creek. These diversions are used to deliver surface water to agricultural users in lieu of groundwater production.

Surface water flows have been recorded in the PVB since the 1970s (Figure 1-4). There are currently gauges on the major surface water bodies in the PVB (Figure 4-3). The historical and existing spatial and temporal coverage from the surface water flow gauge network provides adequate coverage for the short-term, seasonal, and long-term surface flow conditions in the PVB. Although the current network is sufficient to document surface flow conditions in the PVB, areas for improvement are identified in Section 4.6.

Precipitation

Eight precipitation gauges currently monitor precipitation in the PVB (Table 4-2; Figure 4-4, Active Precipitation Monitoring Network for the Pleasant Valley Basin). The precipitation gauges are maintained, and data are collected, by VCWPD and the National Weather Service.

Precipitation in the PVB has been recorded for more than a century (Figure 1-5, Pleasant Valley Annual Precipitation). Although the locations of individual precipitation gauges have changed through time with some gauges being removed from service and others added, there is overlap between the records collected from the various gauges. Therefore a continuous precipitation record can be constructed for the PVB to demonstrate long-term trends. More recent data collected at higher frequencies can be used to demonstrate short term and seasonal trends in precipitation.

In addition to providing adequate temporal coverage of precipitation in the PVB, the current network of precipitation gauges includes sites in every management area of the PVB. This is sufficient spatial coverage to document precipitation in the PVB and to connect the precipitation measurements to both streamflow and groundwater conditions. Additional precipitation monitoring locations are not currently recommended for characterizing surface conditions in the PVB.

4.3 MONITORING NETWORK RELATIONSHIP TO SUSTAINABILITY INDICATORS

To document changes in groundwater conditions related to each of the six sustainability indicators, monitoring will be conducted, using the existing network of groundwater wells (Figures 4-1 and 4-2). This network includes a greater number of wells than the list of key wells provided in Chapter 3, Sustainable Management Criteria, of this GSP (see Tables 4-3 and 4-4). Minimum thresholds and measurable objectives have been selected for the set of key wells, but have not been selected for every well used to monitor groundwater conditions in the PVB. Conditions measured in the key wells will be used to document progress toward the sustainability goals. Groundwater conditions measured in the broader network of wells, which includes the key wells, will be used to document conditions in the PVB at a greater spatial coverage than is provided by the key wells. Recommendations and findings based on the key well data will be supported by the data collected by the broader well network.

4.3.1 Chronic Lowering of Groundwater Levels

To monitor conditions related to chronic lowering of groundwater levels, the groundwater monitoring network must be structured to accomplish the following:

- Track short-term, seasonal, and long-term trends in water elevation.
- Demonstrate groundwater elevations in mid-March and mid-October for each primary aquifer or aquifer system.
- Record groundwater elevations in key wells in which minimum thresholds and measurable objectives have been identified to track progress toward the sustainability goals for the PVB.

Spatial Coverage by Aquifer

The PVB monitoring well density for groundwater elevations varies by aquifer. There are no dedicated monitoring wells or production wells screened solely in the Shallow Alluvial Aquifer in the PVB. Currently the Shallow Alluvial Aquifer is not a major source of groundwater for agricultural or industrial use in the PVB. If future projects propose using water in the Shallow Alluvial Aquifer, a dedicated monitoring well will need to be added to the monitoring network to assess the potential impacts on the ability of the PVB to meet the sustainability goals.

In the older alluvium, there is one dedicated monitoring well that is screened in the age equivalent strata to what is referred to as the Oxnard Aquifer in the Oxnard Subbasin (Figure 4-1). In addition to the dedicated monitoring well in the older alluvium, there is also a production well that is screened in the age-equivalent strata to what is referred to as the Mugu Aquifer in the Oxnard Subbasin (Figure 4-1). The density of wells screened in the older alluvium is approximately 1 well per 16 square miles (the PVB area is approximately 31 square miles). Although there is no definitive rule for the density of groundwater monitoring points needed in a basin, for comparison the monitoring well density recommended by CASGEM Groundwater Elevation Monitoring Guidelines ranges from 1 to 10 wells per 100 square miles (DWR 2010). Additional DWR guidelines recommend a well network with a density of 1 observation per 16 square miles (DWR 2010, 2016b). Therefore, the density of wells in the older alluvium meets the criteria for adequate coverage to accomplish the objectives of the monitoring well network for determining chronic declines in groundwater elevation.

There is one dedicated monitoring well screened in the Upper San Pedro Formation (USP) in the PVB, which is the age equivalent of the Hueneme Aquifer in the Oxnard Subbasin (34G04; Figure 4-1). Thus, the density of monitoring network wells that are screened in the USP is approximately 1 well per 31 square miles. The USP is not a major water-producing aquifer in the PVB (see Section 2.4, Water Budget). Because the well density fits within the CASGEM Groundwater Elevation Monitoring Guidelines and the USP is not a primary aquifer in the PVB, the density of wells in the USP is adequate to accomplish the objectives of the monitoring well network for determining chronic declines in groundwater elevation.

The Fox Canyon Aquifer (FCA), which is the primary groundwater aquifer in the PVB, has the highest density of wells in the monitoring network. There is one dedicated monitoring well screened solely within the FCA, and there are six production wells screened solely in the FCA (Figure 4-2). These production wells are included in the network of wells that is used to monitor groundwater conditions in the PVB. The density of wells in the monitoring network for the FCA is approximately 1 well per 4 square miles. Therefore, the density of wells in the FCA meets the criteria for adequate coverage to accomplish the objectives of the monitoring well network for determining chronic lowering of groundwater levels.

Although the active network of wells used to document chronic lowering of groundwater levels in the PVB has sufficient spatial density on the scale of the entire PVB, there are local areas in which coverage can be improved. Potential improvements in local coverage are discussed in Section 4.6.

Temporal Coverage by Aquifer

Groundwater elevation data will be collected from the network of groundwater wells to provide groundwater elevation conditions in the spring and fall of each year. Further discussion of the monitoring schedule is provided in Section 4.4, Monitoring Network Implementation.

4.3.2 Reduction of Groundwater Storage

To monitor conditions related to reduction of groundwater storage, the groundwater monitoring network must be structured to accomplish the following:

- Demonstrate groundwater elevations in mid-March and mid-October for each primary aquifer or aquifer system.
- Calculate year-over-year (mid-March to mid-March) change in storage by aquifer.
- Provide data from which lateral and vertical hydraulic gradients within and between aquifers can be calculated.
- Record groundwater elevations in key wells in which minimum thresholds and measurable objectives have been identified to track progress toward the sustainability goals for the PVB.

The requirements for documenting reduction in groundwater storage are similar to those for chronic lowering of groundwater levels (see Section 4.3.1), because these two sustainability indicators are interrelated. The primary difference between the two sets of requirements is the need to document potential gradients between aquifers. These gradients influence the movement of water between aquifers, which in turn influences storage in the aquifer.

Historically, the change in groundwater stored in freshwater aquifers in the PVB has been modeled by UWCD. After GSP adoption, modeled volumes of annual change in storage will be reported by aquifer and by year in annual reports. A standardized method to calculate the change in storage that relies solely on water elevations within each aquifer, rather than a numerical model, may also be developed as a check on the model predictions.

The spatial and temporal density of groundwater elevation data necessary to document groundwater storage changes in the aquifers of the PVB is the same as that necessary to document groundwater elevation changes. The current network of wells is capable of documenting changes to both sustainability indicators. Specific recommendations for potential improvements to local coverage are discussed in Section 4.6.

4.3.3 Seawater Intrusion

Direct seawater intrusion does not impact the PVB. To monitor groundwater conditions related to seawater intrusion in the Oxnard Subbasin, groundwater elevations will be measured in the PVB in such a way as to accomplish the following:

- Track short-term, seasonal, and long-term trends in water elevation.
- Demonstrate groundwater elevations in mid-March and mid-October for each primary aquifer or aquifer system.
- Record groundwater elevations in key wells in which minimum thresholds and measurable objectives have been identified to track progress toward the sustainability goals for the Subbasin.

These goals are the same as those for chronic lowering of groundwater levels and the spatial density of monitoring network wells required to meet these goals is also the same as the density requirement for documenting chronic lowering of groundwater levels. The current monitoring network provides adequate spatial coverage to accomplish these goals (see Section 4.3.1).

4.3.4 Degraded Water Quality

To monitor conditions related to degraded water quality, water quality samples will be collected in such a way as to track long-term trends in water quality that may impact beneficial uses and users of groundwater in the PVB. Specifically, these water quality samples should be targeted to constituents of concern and areas of the PVB that have documented or potential degradation related to groundwater production from the PVB.

Spatial Coverage by Aquifer

The network of wells currently used to monitor groundwater elevation conditions in each aquifer is sufficient to determine trends in groundwater quality as well. The primary area of concern for groundwater quality degradation relating to groundwater elevations in the PVB is the PVPDMA. Seven wells in the monitoring network are located in the PVPDMA. Four of these wells are screened in the FCA, while the other three are screened in the Older Alluvium and the USP. This provides an adequate spatial density for the PVPDMA, although it should be noted that all of the monitoring network wells in this management area are located north of 5th Street (Figures 4-1 and 4-2). Consequently, recommendations for potential improvements to local coverage in the PVPDMA are discussed in Section 4.6.

In the NPVMA, the primary concern with groundwater quality is related to infiltration of surface water along Arroyo Las Posas. This concern occurs from both direct surface water infiltration in the PVB and from infiltration of surface water in the Las Posas Valley Basin that migrates into the PVB as subsurface flow in the Shallow Alluvial Aquifer (see Section 2.3). There is one well in the PVB monitoring network adjacent to the boundary with the Las Posas Valley Basin and close to Arroyo Las Posas. Data from this well will be used to constrain groundwater conditions and groundwater quality related to infiltrating surface water in the NPVMA.

Water Quality Constituents

Monitoring and annual reporting has occurred for constituents that are associated with a water quality threshold adopted by the FCGMA Board of Directors or by the Los Angeles Regional Water Quality Control Board. These constituents are TDS, chloride, nitrate, sulfate, and boron. The network of existing wells is capable of providing an adequate assessment of groundwater quality trends for these constituents.

Temporal Resolution

Degradation of groundwater quality occurs on a longer time scale than changes in groundwater elevation. Historically, UWCD has collected water quality samples on a quarterly basis, and VCWPD has collected samples annually, although more frequent sampling can occur in some wells. These samples have provided information on trends in groundwater quality throughout the PVB. The temporal resolution of the data collection is adequate to document trends in groundwater concentration for the constituents identified by the FCGMA Board of Directors and the Los Angeles Regional Water Quality Control Board.

4.3.5 Land Subsidence

To monitor conditions related to land subsidence, groundwater elevations will be measured to determine if water levels fall below historical lows. Groundwater elevations are being used as a proxy for land subsidence in the PVB. The minimum thresholds identified at the key wells are above the historical low groundwater elevation. Therefore, it is not anticipated that specific land subsidence monitoring will be required for the PVB. Instead, the network of groundwater monitoring wells discussed in Sections 4.2.1 and 4.3.1 will be used to determine if land subsidence related to groundwater production may occur.

4.3.6 Depletions of Interconnected Surface Water

To monitor conditions related to depletions of interconnected surface water, surface water flows and shallow groundwater will be measured in such a way as to accomplish the following:

- Track short-term, seasonal, and long-term trends in groundwater elevation in the Shallow Alluvial Aquifer adjacent to Arroyo Las Posas, Conejo Creek, and Calleguas Creek.

- Demonstrate groundwater elevations in mid-March and mid-October for the Shallow Alluvial Aquifer adjacent to Arroyo Las Posas, Conejo Creek, and Calleguas Creek.
- Record groundwater elevations in key wells in which minimum thresholds and measurable objectives have been identified to track progress toward the sustainability goals for the PVB.

The existing network of wells used to document groundwater conditions in the PVB does not include a well screened solely in the shallow aquifer. Historical data indicate that groundwater elevations are typically lower than the bottom of the ephemeral stream channels in the PVB, and have been lower than typical riparian vegetation rooting depths as recently as the 1980s along Arroyo Las Posas (see Section 2.3.7, Groundwater-Dependent Ecosystems). Portions of lower Arroyo Las Posas, Calleguas Creek, and Conejo Creek have been identified as potential groundwater dependent ecosystems because riparian communities have developed adjacent to the stream bed. However, these streams are losing streams and the degree to which the vegetation is reliant on groundwater versus unsaturated soil water is unknown (see Section 2.3.7). To characterize the relationship between the riparian vegetation and water levels in the Shallow Alluvial Aquifer, shallow monitoring wells could be installed in the Shallow Alluvial Aquifer. These potential improvements to the monitoring well network are discussed further in Section 4.6.

4.4 MONITORING NETWORK IMPLEMENTATION

4.4.1 Groundwater Elevation Monitoring Schedule

To reduce uncertainty associated with hydraulic gradients and to follow guidance documents produced by DWR (DWR 2016b), water level measurements used in the evaluation of seasonal high and seasonal low groundwater conditions should collected in a 2-week window in mid-March and mid-October (specifically, March 9–22 and October 9–22 of any given calendar year).

Short-term trends in groundwater elevation are currently, and will continue to be, monitored using transducers that are operated and maintained by UWCD. Data from these transducers are downloaded quarterly and are stored in a central database.

Seasonal and long-term trends in groundwater elevation are monitored using the transducer data and manual measurements made by UWCD on a monthly or bimonthly basis, and manual measurements made by VCWPD on a quarterly basis. Additional manual water level measurements made by other partner agencies (e.g., the City of Camarillo or mutual water districts) are typically sent to VCWPD annually.

4.4.2 Groundwater Storage Monitoring Schedule

Groundwater storage is directly related to, and calculated from, groundwater elevations. Consequently, the schedule for monitoring groundwater storage is the same as that for monitoring groundwater elevations.

4.4.3 Seawater Intrusion Monitoring Schedule

No monitoring schedule is required for seawater intrusion because the PVB does not experience direct seawater intrusion.

4.4.4 Water Quality Monitoring Schedule

UWCD conducts annual monitoring of groundwater quality in the dedicated nested monitoring well cluster in the PVB. Groundwater quality monitoring should continue on the same schedule in order to document groundwater quality trends in the PVB. Annual reviews of the groundwater quality trends will be used to assess whether sampling frequency needs to be adjusted.

4.4.5 Groundwater Extraction Monitoring Schedule

Monitoring of groundwater extraction rates will take place continuously, using flow meters and telemetry equipment installed on individual wellheads, and monthly totals of pumped water will be transmitted to a central database maintained by FCGMA.

4.5 PROTOCOLS FOR DATA COLLECTION AND MONITORING

Protocols for collecting groundwater level measurements and water quality samples, as well as downloading transducers and logging the borehole of newly drilled wells, are included in the Monitoring Protocols Best Management Practices (BMPs) produced by DWR (DWR 2016a). The FCGMA plans to work with agency partners to ensure that future data collection is conducted according to relevant protocols in the BMPs. Current practices used by VCWPD and UWCD are described in this section.

VCWPD Protocols

VCWPD technicians collect water levels using steel tapes. For a well that is too deep for the tape, an acoustical sounder or an air pressure gauge is used, and the measurement is stored in the database with a Questionable Measurement Code indicating that alternate equipment was used.

VCWPD technicians collect water quality samples from production wells using the installed pump equipment. A three-volume purge, or a testing of groundwater parameters including pH, temperature, and electrical conductivity, is conducted to determine whether the water at the wellhead is representative of groundwater in the aquifer. Water quality samples are then sent to an analytical laboratory, where they are filtered and preserved.

UWCD Protocols

UWCD technicians collect water levels using a variety of equipment, including dual wire and single wire sounders and metal tapes. In the event that the well contains a pump, the technician manually tests the approximate temperature of the pump housing. If the pump housing is warm, the water level that is entered into the database is qualified with a Questionable Measurement Code, indicating recent pumping. UWCD also considers other indicators, such as wet conditions at wells and in nearby fields, to evaluate if water levels may not be static.

UWCD technicians collect water quality samples using the three-volume purge method, and follow U.S. Geological Survey guidelines for groundwater quality sampling. For shallow wells, a Grundfos Redi-Flo pump is used to purge and sample the groundwater. For deeper wells, a compressor is used to airlift the groundwater for purging and sampling. On rare occasions, a bailer is used to purge and sample.

4.6 POTENTIAL MONITORING NETWORK IMPROVEMENTS

The existing monitoring network in the PVB is sufficient to document groundwater and can be used to document progress toward the sustainability goals for the PVB. However, analysis of the monitoring network also indicates that there are areas in which data coverage and monitoring efforts can be improved in the future. Areas for improvement of the existing monitoring network and data infrastructure system are described in the following sections.

4.6.1 Water Level Measurements: Spatial Data Gaps

Additional monitoring wells could be used to improve spatial coverage for groundwater elevation measurements in all three management areas of the PVB. Wells that are added to the network should be dedicated monitoring well clusters, with individual wells in the cluster screened in a single aquifer. The potential improvements to the monitoring network in each aquifer are shown on Figure 4-5, Approximate Locations and Screened Aquifers for Proposed New Monitoring Wells in the Pleasant Valley Basin.

In the PVPDMA, the groundwater monitoring network in the PVB could be improved by adding a monitoring well or wells to the south of 5th Street (Figure 4-5). An additional well, or wells, in this area would provide aquifer specific groundwater elevations in an area that does not have a well screened in any of the primary aquifers in the PVB that is suitable for inclusion in the monitoring network. Groundwater elevation measurements in this area would help constrain groundwater gradients across the boundary between the PVB and the Oxnard Subbasin. FCGMA has applied for funding through a DWR Technical Support Services (TSS) monitor well funding grant to add a monitoring well in the PVPDMA.

In the NPVMA, the groundwater monitoring network could be improved by adding a monitoring well or wells. Currently, there are no dedicated monitoring wells screened in any of the primary aquifers in this NPVMA. Adding a monitoring well would provide for aquifer-specific water levels that would improve the understanding of groundwater gradients between the PVPDMA and the NPVMA.

There are no monitoring wells in the East Pleasant Valley Management Area (Figures 4-1 and 4-2). Addition of a monitoring well in the vicinity of Calleguas Creek, downstream of the junction between Lower Arroyo Las Posas and Conejo Creek, would improve understanding of groundwater conditions in this management area. It would also provide data to help constrain the relationship between groundwater elevations in the East Pleasant Valley Management Area and groundwater conditions in the adjacent PVPDMA.

In the shallow alluvial aquifer a dedicated shallow monitoring well adjacent to Calleguas Creek, Conejo Creek, and Lower Arroyo Las Posas could be used to help understand the relationship between surface water and groundwater along these stream courses. These wells would be used to help assess whether riparian vegetation is accessing groundwater in the Shallow Alluvial Aquifer, or is reliant on soil moisture from infiltrating surface water.

New wells will be constructed to applicable well installation standards set in California DWR Bulletin 74-81 and 74-90, or as updated (DWR 2016b). It is recommended that, where feasible, new wells be subjected to pumping tests in order to collect additional information about aquifer properties in the vicinity of new monitoring locations.

Proposed locations are approximate and subject to feasibility review (accounting for infrastructure, site acquisition, and site access among other factors), after GSP submittal. The schedule for new well installation will be developed in conjunction with feasibility review.

4.6.2 Water Level Measurements: Temporal Data Gap

The DWR Monitoring Protocols BMP (DWR 2016a) states the following:

> Groundwater elevation data … should approximate conditions at a discrete period in time. Therefore, all groundwater levels in a basin should be collected within as short a time as possible, preferably within a 1 to 2 week period.

The DWR Monitoring Networks BMP (DWR 2016b) states the following:

> Groundwater levels will be collected during the middle of October and March for comparative reporting purposes.

Currently, groundwater elevation measurements are not scheduled according to these criteria. To minimize the effects of this type of temporal data gap in the future, it will be necessary to coordinate the collection of groundwater elevation data so it occurs within a 2-week window during the key reporting periods of mid-March and mid-October. The recommended collection windows are October 9–22 in the fall and March 9–22 in the spring (see Section 4.4).

Additionally, as funding becomes available, pressure transducers should be added to wells in the groundwater monitoring network. Pressure transducer records provide the high-temporal-resolution data that allows for a better understanding of water level dynamics in the wells related to groundwater production, groundwater management activities, and climatic influence.

4.6.3 Groundwater Quality Monitoring

Improvements to the groundwater quality monitoring network include increasing the spatial density of samples by collecting water quality samples from all wells in the monitoring network, and ensuring that water quality samples are collected at least annually from each well. Annual groundwater quality samples should also be collected from wells that are added to the groundwater elevation monitoring network in the future.

Additionally, the current analyte list should be expanded to include a full general minerals suite so that Stiff or Piper diagrams can be created to fully characterize the geochemical characteristics of the groundwater and track changes over time.

4.6.4 Subsidence Monitoring

Currently, neither FCGMA nor its partner agencies in the region monitor land subsidence. UNAVCO monument CSCI is located immediately adjacent to the southern boundary of PVB in the foothills of the Santa Monica Mountains (see Section 2.3.5). There has been no net subsidence at this monument since its installation in November 2000. Because of the placement of this monument in the foothills of the Santa Monica Mountains, elevations measured there reflect tectonic forces rather than the influence of groundwater withdrawals. Subsidence related to groundwater production is not anticipated to occur in the PVB in the future as groundwater elevations recover to levels that are above the minimum thresholds, which are above historical low groundwater elevations. Preexisting GPS-based benchmarks are not well suited for monitoring land subsidence in the event that groundwater elevations drop below historical low levels for an extended period of time and the potential for land subsidence to substantially interfere with surface land uses is determined (see Section 3.3.5, Land Subsidence). If this occurs, subsidence monitoring would have to be added to the monitoring network.

4.6.5 Shallow Groundwater Monitoring near Surface Water Bodies and GDEs

As discussed in Section 4.6.1 (Water Level Measurements: Spatial Data Gaps), there are no dedicated monitoring wells that can be used to monitor shallow groundwater that may be interconnected with surface water bodies, or sustain potential GDEs in the PVB. Additionally, historical records of shallow groundwater elevations are limited. Water level records in the younger alluvium are available from shallow wells associated with groundwater remediation cases and made available on GeoTracker. Because these shallow wells were installed for specific remediation cases and are not controlled by FCGMA or its partner agencies, these wells may be destroyed after the cases are closed. Therefore, the possibility of using them for future monitoring is uncertain.

To fill the existing data gap and to assist with understanding the potential connectivity between shallow groundwater and potential GDEs, shallow dedicated monitoring wells can be added within the boundaries of the potential GDE along the Arroyo Las Posas, Conejo Creek, and Calleguas Creek.

4.6.6 Surface Water: Flows in Agricultural Drains in the PVB

Discharge flows are currently unmeasured in the drainage system, frequently referred to as the “tile drains,” that was installed in order to develop land in the western PVB, which was formerly affected by high soil salinity levels, for agriculture (Isherwood and Pillsbury 1958). The tile drains are typically located 6 to 7 feet below ground surface, though the depth varies and is not well documented in most areas. Shallow groundwater entering the drains discharges to central drainage ditches, and from there flow into local surface waters.

Metering flow in the tile drains would provide an important check on numerical groundwater results and would also provide valuable information about the water resource potential of the semi-perched aquifer. A feasibility study is recommended to identify the best locations in the drainage system for installing flowmeters.

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Table 4-1
Network of Stations Monitoring Surface Flows in the Vicinity of the Pleasant Valley Basin

Station Number	Station Name	Latitude	Longitude	Elevation (ft msl)	Gauge Type	USGS ID
800	Conejo Creek by Highway 101	34.236528	−118.964583	145	Recording Stream Gauge	11106400
800A	Conejo Creek at Ridge View Street	34.205828	−118.998789	105	Recording Stream Gauge	—
805	Calleguas Creek at CSUCI	34.179028	−119.039528	58	Recording Stream Gauge	11106550
806A	Calleguas Creek at Highway 101	34.215374	−119.01554	152	Peak Only (Event) Gauge	11106000
835	Camarillo Hills Drain by Highway 101	34.216361	−119.068556	84	Peak Only (Event) Gauge	-

Notes: CSUCI = California State University Channel Islands; ft msl = feet above mean sea level; USGS = U.S. Geological Survey.
Table shows results from active gauges only, as of August 2016.

Table 4-2
Network of Stations Monitoring Precipitation in the Vicinity of the Pleasant Valley Basin

Station Number	Station Name	Latitude	Longitude	Elevation (ft msl)	Gauge Type	USGS ID
194A	Camarillo–Adohr (Sanitation Plant)	34.196769	−119.00241	110	Recording Precipitation Gauge	—
219A	Camarillo–Hauser	34.237126	−119.027131	192	Standard Precipitation	—
259	Camarillo–PVWD	34.213014	−119.069475	80	Recording Precipitation Gauge	—
263A	Camarillo–Leisure Village CIMIS 152	34.219553	−118.992344	115	CIMIS Site	—
500A	Camrosa Water District	34.238726	−118.967411	200	Recording Precipitation Gauge	—
505	Camarillo–CSUCI (Type B)	34.179028	−119.039528	58	Non-Standard Recorder	—
509	Spanish Hills–Las Posas Res (Type B)	34.226355	−119.086301	300	Non-Standard Recorder	—
512	Camarillo–Upland (Type B)	34.239469	−119.007585	0	Non-Standard Recorder	—

Notes: CIMIS = California Irrigation Management Information System; CSUCI = California State University Channel Islands; ft msl = feet above mean sea level; USGS = U.S. Geological Survey.
Table shows results from active gauges only, as of August 2016.

Table 4-3
Current VCWPD Monitoring Schedule for Wells in the Pleasant Valley Basin

State Well Number	Main Use	Screened Aquifer	Screened Aquifer System	Manual Water Levels Monitored by VCWPD[a]	Water Quality Samples Collected by VCWPD[a]	Twice-Yearly Water Quality Sampling Required after GSP Adoption
01N21W01B05S	Agricultural	Unassigned	Unassigned		Yes	Yes
01N21W02J02S	Agricultural	Multiple	UAS	Yes		
01N21W02P01S	Domestic	Multiple	Unassigned	Yes		Yes
01N21W03C01S	Agricultural	FCA	LAS	Yes		
01N21W03D01S	Agricultural	Multiple	Both		Yes	Yes
01N21W03K01S	Agricultural	Mugu	LAS		Yes	Yes
01N21W03R01S	Agricultural	Multiple	LAS		Yes	Yes
01N21W04K01S	Agricultural	Multiple	LAS	Yes	Yes	Yes
01N21W09J03S	Agricultural	Multiple	LAS	Yes		
01N21W10A02S	Domestic	Unassigned	UAS		Yes	Yes
01N21W10G01S	Agricultural	Multiple	LAS	Yes	Yes	Yes
01N21W12D02S	Agricultural	Unassigned	Unassigned		Yes	Yes
01N21W14A01S	Agricultural	Unassigned	Unassigned	Yes		
01N21W15D02S	Agricultural	Multiple	LAS		Yes	Yes
01N21W15H01S	Domestic	Multiple	UAS	Yes	Yes	Yes
02N20W19M05S	Monitoring	Multiple	Unassigned	Yes		
02N20W28G02S	Agricultural	Multiple	Unassigned	Yes		
02N20W29B02S	Municipal	Unassigned	Unassigned		Yes	Yes
02N21W33P02S	Agricultural	Multiple	LAS	Yes		
02N21W34C01S	Municipal	FCA	LAS		Yes	Yes
02N21W34G01S	Agricultural	Multiple	LAS		Yes	Yes
02N21W35M02S	Agricultural	Multiple	LAS	Yes		
02N21W36N01S	Agricultural	Multiple	UAS	Yes		

Notes: FCA = Fox Canyon Aquifer; GSP = Groundwater Sustainability Plan; LAS = Lower Aquifer System; UAS = Upper Aquifer System; VCWPD = Ventura County Watershed Protection District.
Table shows monitoring schedule and status as of October 2017.
[a] As of October 2017.

Table 4-4
Current UWCD Monitoring Schedule for Wells in the Pleasant Valley Basin

State Well Number	Main Use	Screened Aquifer	Screened Aquifer System	Manual Water Levels Measured Bimonthly or Monthly	Transducer in Well	Water Quality Samples Collected Quarterly	Twice-Yearly Water Quality Sampling Required after GSP Adoption
01N21W10G01S	Agricultural	Multiple	LAS	Yes	Yes		
01N21W12D01S	Agricultural	Multiple	UAS	Yes			
01N21W15J04S	Agricultural	Multiple	LAS	Yes			
02N21W34G02S	Monitoring	FCA	LAS	Yes		Yes	Yes
02N21W34G03S	Monitoring	FCA	LAS	Yes	Yes	Yes	Yes
02N21W34G04S	Monitoring	Hueneme	LAS	Yes	Yes	Yes	Yes
02N21W34G05S	Monitoring	Oxnard	UAS	Yes		Yes	Yes
02N21W34G06S	Monitoring	Unknown	Aquitard	Yes		Yes	Yes

Notes: FCA = Fox Canyon Aquifer; GSP = Groundwater Sustainability Plan; LAS = Lower Aquifer System; UAS = Upper Aquifer System; VCWPD = Ventura County Watershed Protection District.
Table shows monitoring schedule and status as of October 2017.
[a] As of October 2017.

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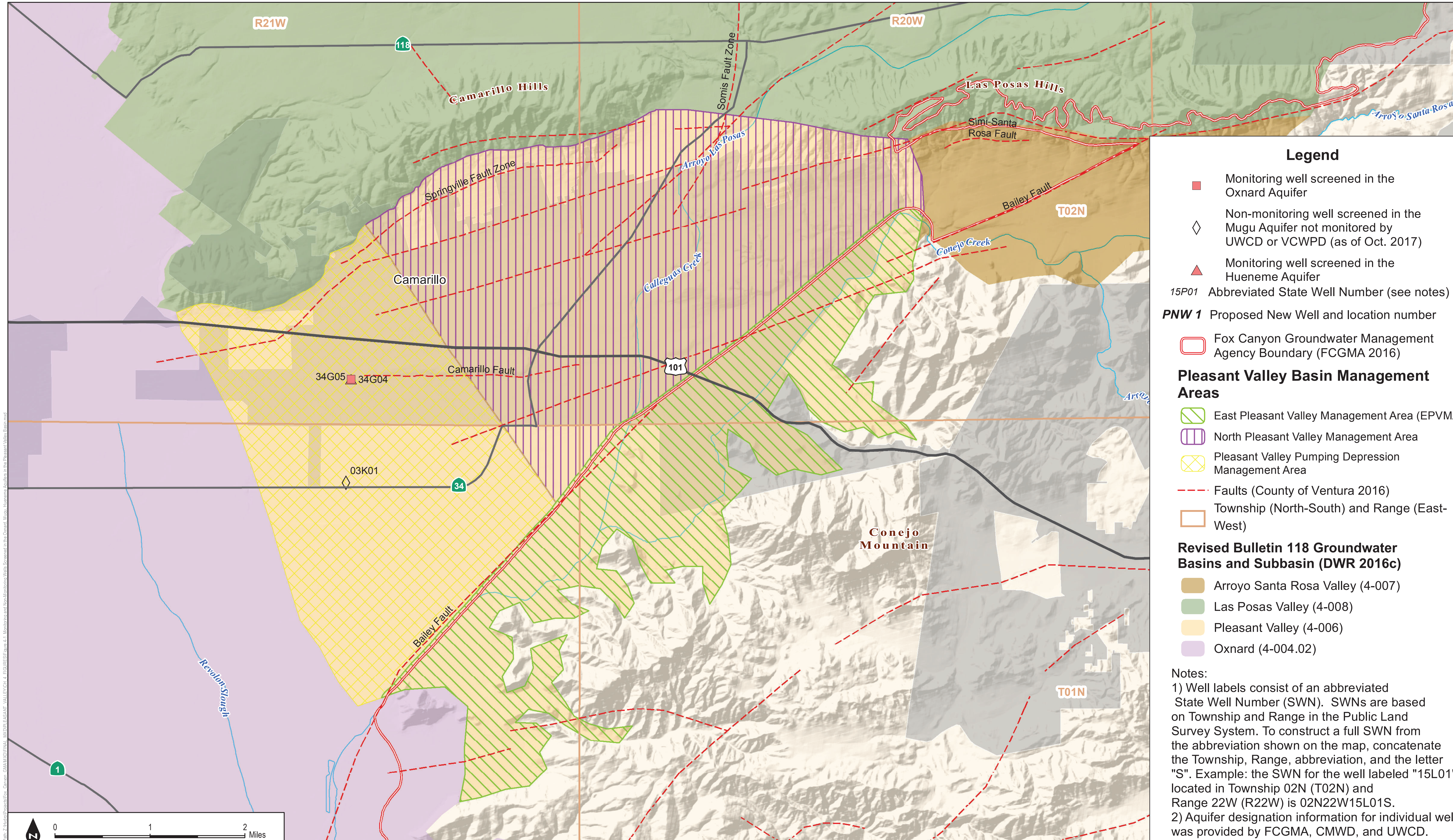

DUDEK

SOURCE: DWR; County of Ventura; UWCD; CMWD

FIGURE 4-1

Monitoring and Non-Monitoring Wells Screened in the Oxnard, Mugu, and Hueneme Aquifers in the Pleasant Valley Basin

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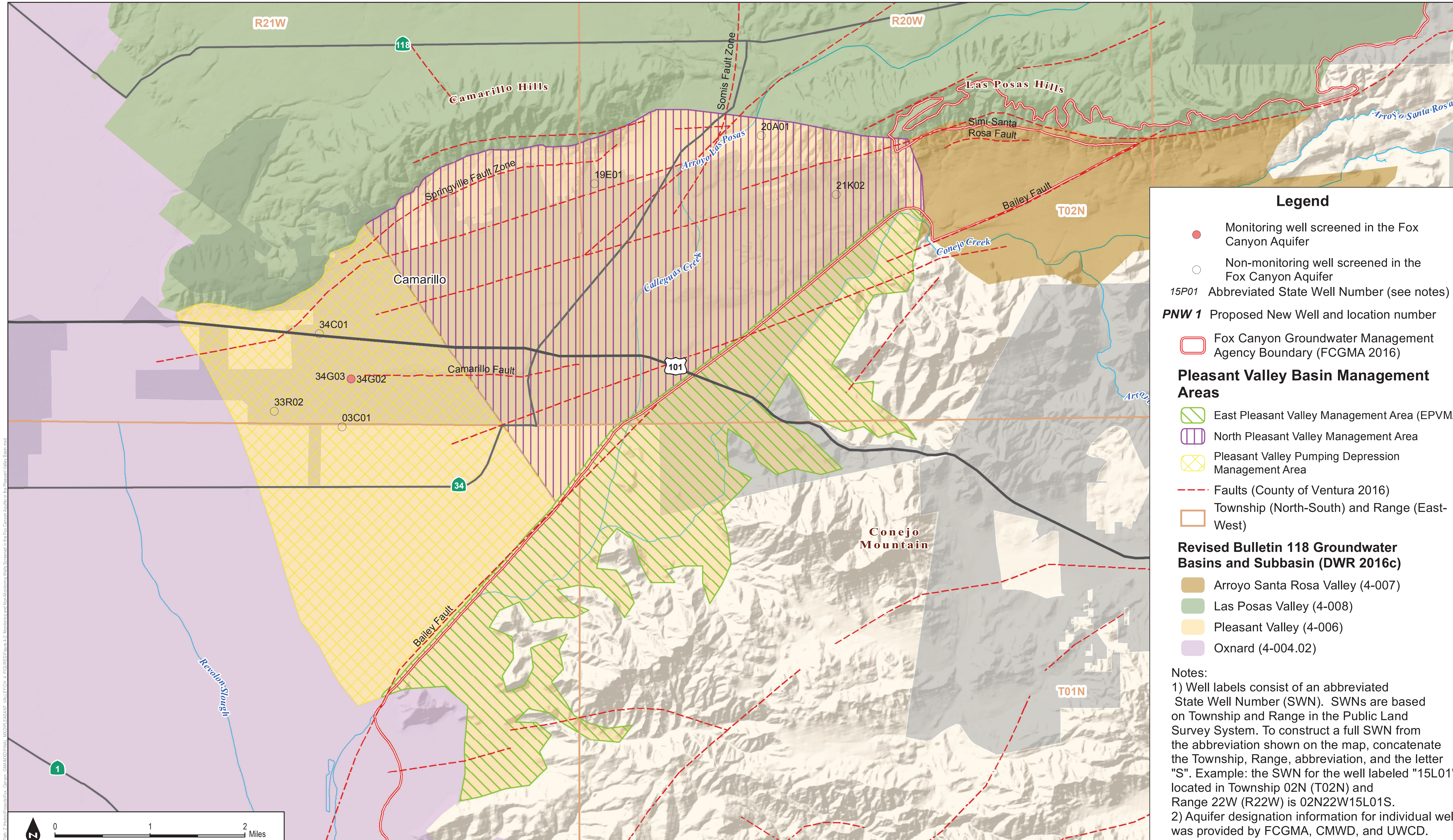

SOURCE: DWR; Ventura County; UWCD; CMWD

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FIGURE 4-2

Monitoring and Non-Monitoring Wells Screened in the Fox Canyon Aquifer in the Pleasant Valley Basin

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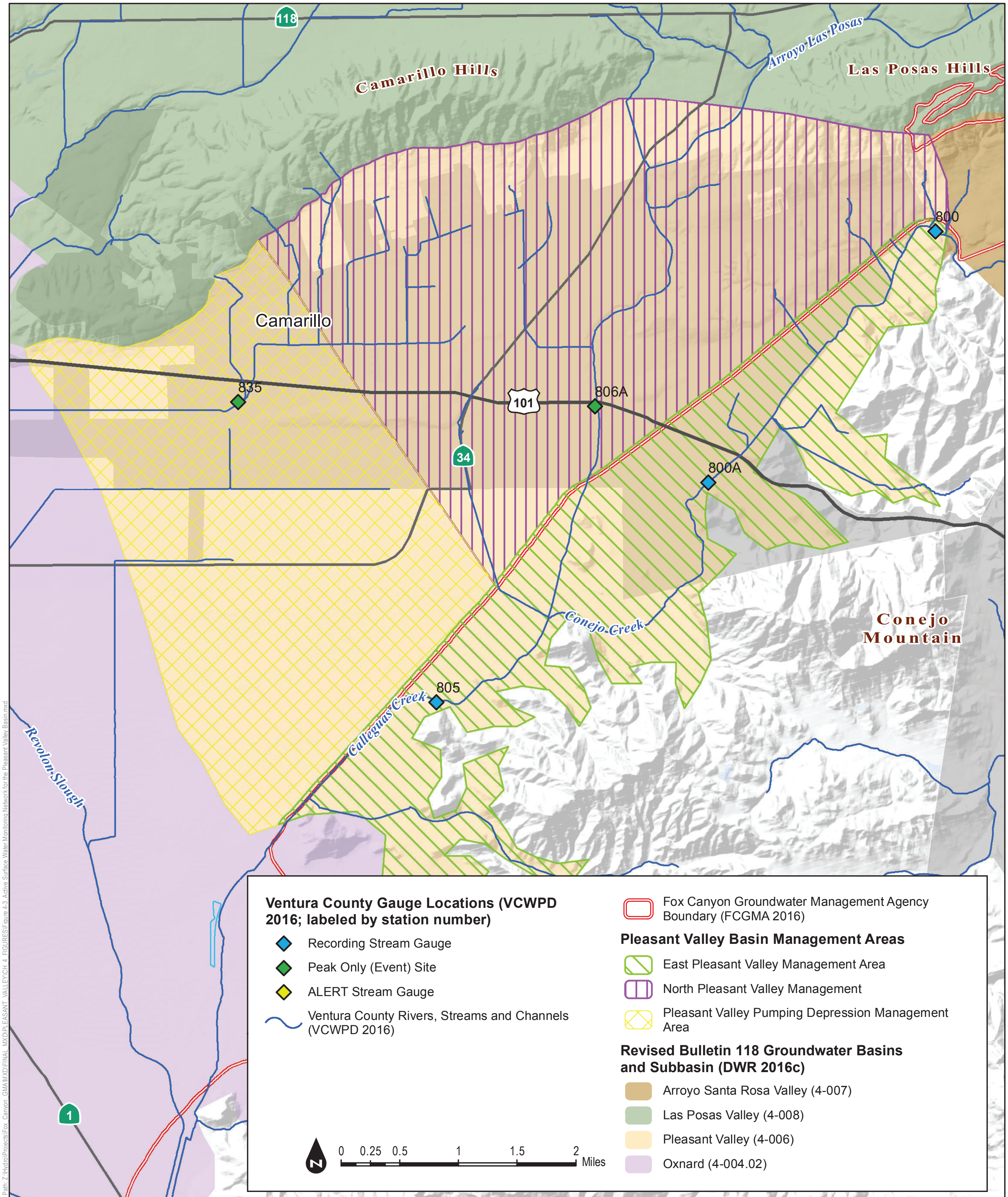

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SOURCE: DWR; County of Ventura; VCWPD

FIGURE 4-3

Active Surface Water Monitoring Network for the Pleasant Valley Basin

Groundwater Sustainability Plan for the Pleasant Valley Basin

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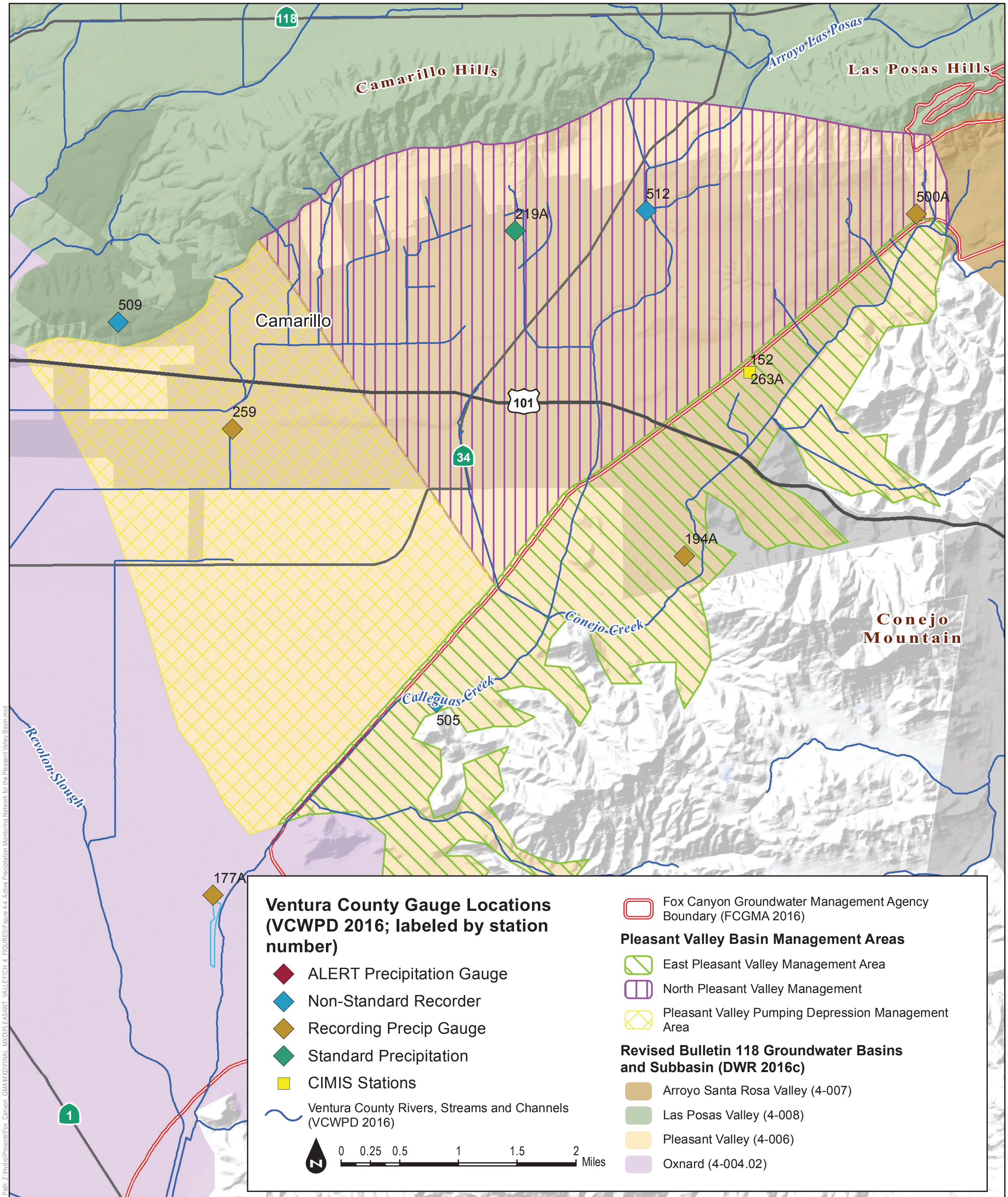

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SOURCE: DWR; County of Ventura; VCWPD

FIGURE 4-4

Active Precipitation Monitoring Network for the Pleasant Valley Basin

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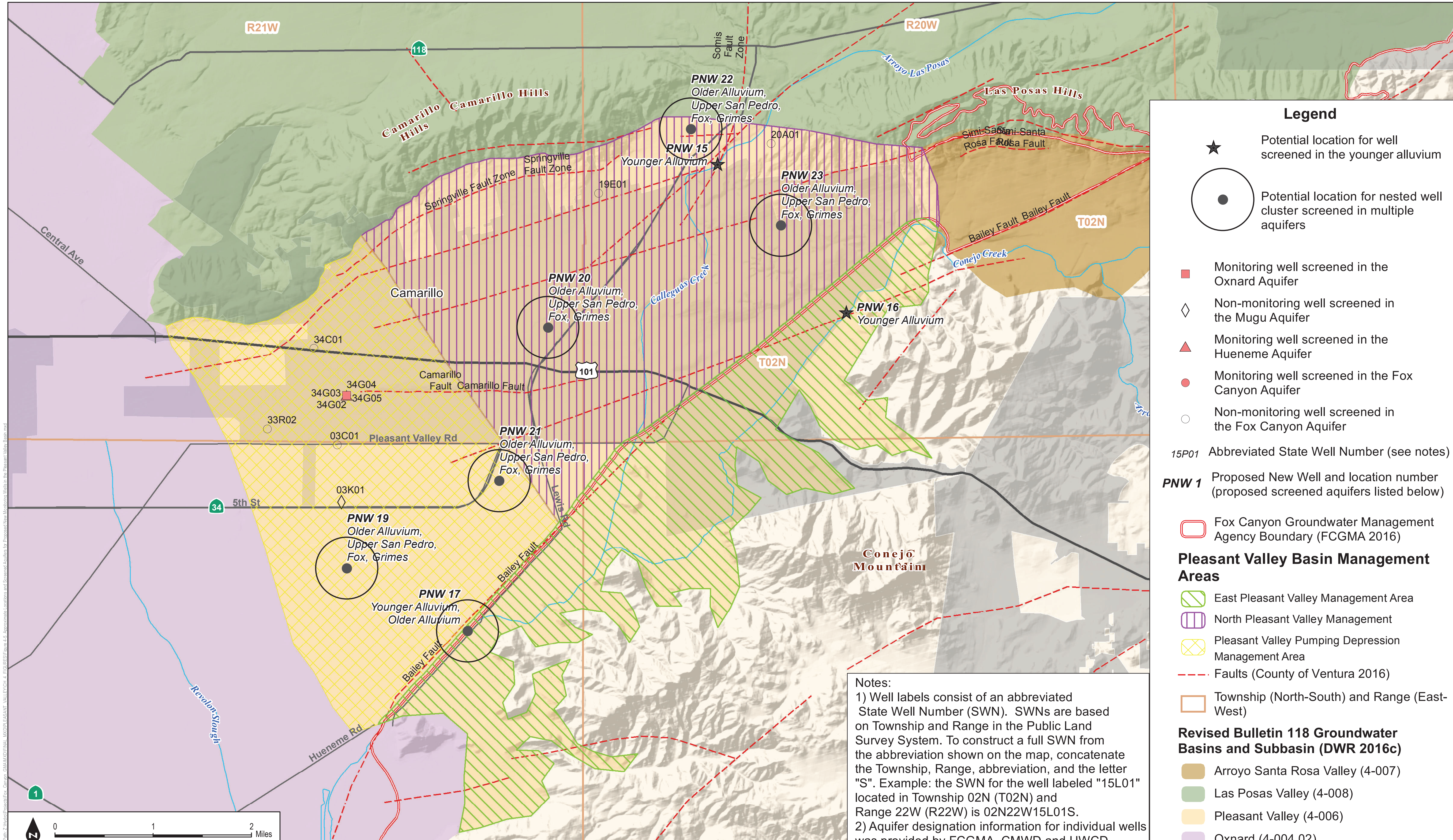

SOURCE: DWR; Ventura County; UWCD; CMWD

FIGURE 4-5

Approximate Locations and Screened Aquifers for Proposed New Monitoring Wells in the Pleasant Valley Basin

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Groundwater Sustainability Plan for the Pleasant Valley Basin

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