4.0 MONITORING NETWORKS

4.1 **Monitoring Network Objectives**

The objective of the existing monitoring networks is to observe and record data on groundwater levels, quality, and related conditions, such as the interconnection of surface water and groundwater and subsidence. Wells included in the existing monitoring networks were selected with sufficient temporal frequency and spatial density to evaluate conditions related to the effectiveness of the GSP, specifically to detect short-term, seasonal, and long-term trends. Parameters that have been monitored provide historic baseline information for establishing the current status of relevant Sustainability Indicators (SI) that will be useful in tracking these SI as the GSP is being implemented. The complete list of SI is presented below:

1. Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued;
2. Significant and unreasonable reduction of groundwater storage;
3. Significant and unreasonable seawater intrusion;
4. Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies;
5. Significant and unreasonable land subsidence that substantially interferes with surface land uses; and,
6. Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.

The existing monitoring networks form a pool of monitoring locations that will serve as the backbone of the representative monitoring network used to assess SGMA compliance as discussed in Chapter 3. The existing network will support improved understanding of conditions in the Vina Subbasin, inform ongoing management of the subbasin, and contribute to future updates to the GSP. These objectives will be implemented in a manner that will:

- Demonstrate progress toward achieving Measurable Objectives (MO), Minimum Thresholds (MT), and Interim Milestones (IM);
- Monitor impacts to the beneficial uses or users of groundwater;

- Monitor changes in groundwater conditions; and
- Quantify annual changes in water budget components.

Data collected from the monitoring network will be used to track changes in groundwater elevations, water quality constituent concentrations, groundwater and surface water interactions and rates of subsidence at monitoring locations throughout the Vina Subbasin. At locations where MO differ substantially from current conditions, the monitoring data from the representative monitoring sites (RMS, discussed in Section 4.9) will be used to determine whether local projects and management actions are meeting IM presented in the GSP as indicators of progress toward attainment of MO. Measurable objectives will be monitored directly through measurement of groundwater levels and water quality constituents.

Groundwater elevations will be used as a proxy for evaluating reduction in groundwater storage, depletions of interconnected surface waters, and for land subsidence where either of these potential undesirable results is associated with declining groundwater elevations. In each of these instances, "significant and unreasonable" reductions are the guideposts used to warn of unsustainable groundwater conditions. For interconnected surface waters, the GSAs in the Vina Subbasin intend to further evaluate this SMC to avoid undesirable results to aquatic ecosystems and GDEs. To that end, an Interconnected Surface Water SMC framework has been developed for the GSP, as described in Section 3.8. This framework will guide future data collection efforts to fill data gaps, either as part of GSP projects and management actions or as plan implementation. As additional data are collected and evaluated, the Vina Subbasin commits to developing additional SMC, as appropriate, for specific stream reaches and associated habitat where there is a clear connection to groundwater pumping in the principal aquifer.

In addition to being central to SGMA compliance by enabling tracking of SI, data collected through the monitoring network will be used to update inputs to the water budget and to guide interpretation of water budget results. Monitoring data will also be used to assess impacts of groundwater management on various categories of beneficial uses and users and to monitor overall groundwater conditions from local and subbasin-wide perspectives.

The monitoring networks for groundwater levels, water quality, land subsidence, and depletions of interconnected surface water are described below. The Butte Basin Groundwater Model (BBGM) and / or groundwater level data will be used to estimate changes in groundwater storage based on observed changes in groundwater levels.

Seawater intrusion is not considered to be an SI relevant to the Vina Subbasin as seawater intrusion is not present and is not likely to occur in the Subbasin due to the distance from the Pacific Ocean, bays, deltas, or inlets. However, there is some evidence that connate groundwater of a quality characteristic of its ancient marine origins is present in the Subbasin and that this water has the potential to affect beneficial uses due to brackish characteristics. Ancient marine layers pose a water quality (saline) risk by contaminating groundwater from groundwater pumping. This GSP will address this risk through the water quality sustainability indicator.

The location of existing sites and the frequency of monitoring at each site are presented below as is the spatial density of locations in each of the monitoring networks. Data gaps and plans to fill these gaps are also discussed as part of the program for defining the representative monitoring network to be used in monitoring SI to ensure SGMA compliance. Explanations of how gaps identified in the monitoring network will be filled are provided in Section 4.11.

The goal of defining the existing monitoring network, identifying gaps in the network, and developing and implementing a program to fill those gaps is to develop a representative monitoring network capable of collecting information needed to address:

- Short-term trends in groundwater and related surface water conditions;
- Seasonal trends in groundwater and related surface water conditions;
- Long-term trends in groundwater and related surface water conditions; and
- Provide adequate coverage by establishing sufficient density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends listed above.

4.2 **Groundwater Level Monitoring**

Groundwater level monitoring is conducted through a network of monitoring wells used for observation of groundwater levels and calculation of flow directions and hydraulic gradients in the principal aquifer of the Vina Subbasin.The network also allows for characterization of the groundwater table or potentiometric surface of the principal aquifer.

The 78 wells included in the network were selected based on the degree to which data from these wells represents conditions in the area, use in existing monitoring programs, permission of the well owner to access the well, and the length and continuity of the monitoring record. Of the 78 wells, 25 are located in the Vina-North Management Area, 14 in the Vina-Chico Management Area,and 39 in the Vina-South Management Area. **Table 4-1** lists wells now used for monitoring in each Management Area and **Figure 4-1** shows the locations of these wells in their respective Management Areas. Multi-completion wells are sites where more than one monitoring well has been installed at a single location. The wells are drilled and screened at different depths with each well designed to measure groundwater levels at a selected depth in the underlying aquifer.

Table 4-1. Vina Subbasin Groundwater Level Monitoring Well Locations

State Well ID Number	Monitoring Frequency	Multi-Completion	Well Type
Vina - North Management Area			
22N01E20K001M	Quarterly	No	Residential
22N01W05M001M	Hourly	No	Irrigation
23N01E07H001M	Quarterly	No	Residential
23N01E29P002M	Quarterly	No	Irrigation
23N01E33A001M	Quarterly	No	Irrigation
23N01W03H002M	Hourly	Yes	Observation
23N01W03H003M	Hourly	Yes	Observation
23N01W03H004M	Hourly	Yes	Observation
23N01W09E001M	Quarterly	No	Irrigation
23N01W10E001M	Quarterly	No	Irrigation
23N01W10M001M	Hourly	No	Observation
23N01W14R002M	Quarterly	No	Irrigation
23N01W16E001M	Quarterly	No	Irrigation
23N01W25G001M	Quarterly	No	Irrigation
23N01W27L001M	Quarterly	No	Residential
23N01W28M002M	Hourly	Yes	Observation
23N01W28M003M	Hourly	Yes	Observation
23N01W28M004M	Hourly	Yes	Observation
23N01W28M005M	Hourly	Yes	Observation
23N01W31M001M	Hourly	Yes	Observation
23N01W31M002M	Hourly	Yes	Observation
23N01W31M003M	Hourly	Yes	Observation
23N01W31M004M	Hourly	Yes	Observation
23N01W36P001M	Quarterly	No	Residential
23N02W25C001M	Quarterly	No	Irrigation
Vina - Chico Management Area			
22N01E09B001M	Quarterly	No	Residential
22N01E28J001M	Quarterly	Yes	Observation
22N01E28J003M	Quarterly	Yes	Observation
22N01E28J005M	Quarterly	Yes	Observation
22N01E35E001M	Hourly	No	Irrigation

Table 4-1. Vina Subbasin Groundwater Level Monitoring Well Locations

22N02E18J001M	Quarterly	No	Residential
22N02E30C002M	Quarterly	No	Observation
CWSCH01b	Quarterly	No	M&I
CWSCH02	Quarterly	No	M&I
CWSCH03	Quarterly	No	M&I
CWSCH04	Quarterly	No	M&I
CWSCH05	Quarterly	No	M&I
CWSCH06	Quarterly	No	M&I
CWSCH07	Quarterly	No	M&I
Vina - South Management Area			
20N01E02H003M	Hourly	No	Observation
20N01E10C002M	Quarterly	No	Irrigation
20N02E06Q001M	Quarterly	No	Irrigation
20N02E08C001M	Quarterly	No	Irrigation
20N02E08H003M	Quarterly	No	Residential
20N02E09G001M	Hourly	No	Observation
20N02E09L001M	Quarterly	No	Irrigation
20N02E24C001M	Hourly	Yes	Observation
20N02E24C002M	Hourly	Yes	Observation
20N02E24C002M	Hourly	Yes	Observation
20N03E31M001M	Hourly	No	Observation
20N03E33L001M	Hourly	No	Other
21N01E10B003M	Quarterly	No	Irrigation
21N01E12D001M	Quarterly	No	Irrigation
21N01E12K001M	Quarterly	No	Irrigation
21N01E13F001M	Quarterly	No	Irrigation
21N01E13L002M	Hourly	Yes	Observation
21N01E13L003M	Hourly	Yes	Observation
21N01E13L004M	Hourly	Yes	Observation
21N01E14Q002M	Quarterly	No	Irrigation
21N01E21C001M	Quarterly	No	Irrigation
21N01E25K001M	Quarterly	No	Residential
21N01E26K001M	Quarterly	No	Irrigation
21N01E27B001M	Quarterly	No	Residential
21N01E27D001M	Quarterly	No	Residential
21N01E28F001M	Quarterly	No	Irrigation
21N02E18C001M	Hourly	Yes	Observation
21N02E18C002M	Hourly	Yes	Observation
21N02E18C003M	Hourly	Yes	Observation

Table 4-1. Vina Subbasin Groundwater Level Monitoring Well Locations

21N02E20P001M	Quarterly	No	Irrigation
21N02E26E003M	Hourly	Yes	Observation
21N02E26E004M	Hourly	Yes	Observation
21N02E26E005M	Hourly	Yes	Observation
21N02E26E006M	Hourly	Yes	Observation
21N02E30L001M	Hourly	No	Residential
21N02E32E001M	Quarterly	No	Irrigation
21N03E22C001M	Quarterly	No	Residential
21N03E29J003M	Quarterly	No	Residential
21N03E32B001M	Hourly	No	Irrigation

Density of Monitoring Sites and Frequency of Measurement

Each of the wells in the existing network is monitored either by California Water Service (Cal Water), Butte County, DWR, or the associated California Statewide Groundwater Elevation Monitoring (CASGEM) collaborators in the subbasin. Of the wells in the existing network, 46 are measured manually on a quarterly basis, and 32 are measured continuously (hourly intervals) using dataloggers. Of the continuously monitored wells, 27 are multi-completion wells located at 8 different sites, which are monitored by DWR or Butte County using pressure transducers and data loggers. The 7 wells monitored by Cal Water are also reported quarterly.

For the purpose of SGMA compliance, water levels in all monitoring wells in the Vina Subbasin will be monitored at least quarterly. All wells will be measured within one calendar month following a schedule that will be developed for the subbasin in coordination with DWR, the County, and neighboring subbasins.

Groundwater pumping typically peaks during the summer growing season and slows in the fall and winter. Therefore, spring levels represent an annual high prior to summer irrigation demands while fall levels represent an annual low for static (non-pumping) conditions. In addition to the coordinated spring and fall elevation measurements made at all wells in the network, data will continue to be taken at wells now monitored at greater frequencies according to their existing monitoring schedules. For wells that cannot be observed on the regular monitoring schedule or for which readings are questionable, it will be noted in the standard data sheet that the well was unable to be measured.

Groundwater elevation data will be used to observe seasonal and annual changes and for analysis of short-term and long-term trends. Analysis of trends in groundwater levels together with data on surface water deliveries and groundwater extraction will be important tools for tracking the Subbasin's progress in meeting its MO and in determining the need for additional or modifications to management actions to meet MO.

A total of 59 monitoring sites (78 wells) are included in the network for monitoring groundwater levels. These wells are distributed over the 289 square-mile area of the Vina Subbasin with a distribution equivalent to a spatial density of 21 sites and 31 wells per 100 square miles, a network density that significantly exceeds those presented in the Best Management Practices (BMP) *Monitoring Networks and Identification of Data Gaps*. **Table 4-2** is taken from the BMP and shows a range of recommended monitoring network densities.

Table 4-2. Monitoring Well Density Considerations

Reference	**Well Density (wells per 100 square miles)**
Heath (1976)	0.2 – 10
Sophocleous (1983)	6.3
Hopkins (1984)	
Basins pumping more than 10,000 acre-feet/year (AFY) per 100 square miles	4.0
Basins pumping between 1,000 and 10,000 AFY per 100 square miles	2.0
Basins pumping between 250 and 1,000 AFY per 100 square miles	1.0
Basins pumping between 100 and 250 AFY per 100 square miles	0.7

Annual groundwater pumping presented in the water balance section of the GSP shows a historical rate of pumping in the Subbasin of 243,500 AFY (84,256 AFY per 100 square miles) and a current condition pumping rate of 209,200 AFY (72,388 AFY per 100 square miles).

Each monitoring point is located in one of the Subbasin's three Management Areas:

- Vina - North (17 sites [25 wells]) in an area of 112 square miles, spatial density of 15 sites and 22 wells per 100 square miles.
- Vina - Chico (12 sites [14 wells]) in an area of 46 square miles, spatial density of 26 sites and 30 wells per 100 square miles.
- Vina – South (30 sites [39 wells]) in an area of 130 square miles, spatial density of 23 sites and 30 wells per 100 square miles.

4.3 **Groundwater Storage Monitoring**

Background

The BMP for Groundwater Monitoring (DWR, 2017) notes:

> *While change in groundwater storage is not directly measurable, change in storage can be estimated based on measured changes in groundwater levels… and a clear understanding of the Hydrogeologic Conceptual Model…. The HCM describes discrete aquifer units and the specific yield values associated with these units. These data, together with information on aquifer thickness and connectivity, can be used to calculate changes in the volume of groundwater storage associated with observed changes in groundwater elevation.*

As suggested in the preceding passage from DWR's BMP on Groundwater Monitoring, measured changes in groundwater levels can serve as a proxy for changes in storage. For this reason, the network for monitoring changes in groundwater storage is the same as that used for monitoring changes in groundwater levels. Monitoring sites and wells included in this network are presented above in **Table 4-1** with well locations shown in **Figure 4-1.**

Frequency of Measurement

The data from the quarterly frequency of monitoring groundwater levels described above will enable observed changes in levels to serve as a proxy to indicate changes in groundwater storage. Data presented in the HCM on parameters such as aquifer layer composition and thickness and the specific yield and hydraulic conductivity of these layers are integrated in the BBGM, and allow the model to be used to estimate changes in groundwater storage that result from observed changes in groundwater elevations. As data on aquifer characteristics and modeling capabilities improve, the methodologies used to relate changes in groundwater elevations with corresponding changes in storage will be updated.

4.4 **Groundwater Quality**

Background

Assessment of groundwater quality in the Vina Subbasin focuses on annual observation of salinity (through monitoring of specific conductance), temperature, and pH in the principal aquifer. Each of these parameters is influenced by ambient conditions and the parent material of the principal aquifer. Specific conductance and pH are also influenced by human activity. While only salinity will be used to monitor attainment of MO and avoidance of breaches in MT, changes in pH and temperature may indicate shifting groundwater conditions that trigger additional investigation.

The groundwater quality monitoring network implemented for representative monitoring under SGMA will build upon the County's existing program. Additional monitoring will continue to be conducted by DWR and other agencies to track constituents not managed under this GSP including a variety of minerals, metals, pesticides, and herbicides. Data from the ongoing monitoring by various state and federal agencies will be available to the GSAs to augment local understanding of water quality in the Vina Subbasin and can be found on the State Board's Groundwater Ambient Monitoring and Assessment (GAMA) program at https://www.waterboards.ca.gov/gama/. Water quality programs conducted by other agencies are summarized in **Appendix 4-1**. The locations of all water quality monitoring wells are in **Figure 4-2**.

A total of 7 sites are included in the County's ongoing water quality monitoring programs, with these wells having been selected based on the existing period of record, depth of well screens, and the quality of data reported and subject to permission of the well owner to monitor the well. Water quality monitoring has historically been conducted by Butte County during the summer. Of the 7 wells, one is located in the Vina-North Management Area, one is in the Vina-Chico Management Area, and five are in the Vina-South Management Area.

To study regional groundwater quality, DWR's Northern Region Office collects groundwater samples from DWR dedicated monitoring wells that are used exclusively for groundwater level and groundwater quality monitoring.

Table 4-3 presents information on each of the wells monitored by Butte County in the Vina Subbasin groundwater quality monitoring network. **Figure 4-2** shows the locations of the wells.

Table 4-3. Groundwater Quality Monitoring Locations

State Well ID Number	Local Name	Well Type
Vina – North Management Area		
23N01E29L03M	Vina	Irrigation
Vina – Chico Management Area		
n/a	Chico Urban	Domestic
Vina – South Management Area		
0N02E24Q01M	Cherokee	Irrigation
21N01E15E02M	Durham Dayton	Irrigation
20N02E09M02M	Esquon	Irrigation
22N01E15D02M	M & T	Irrigation
21N03E29J03M	Pentz	Irrigation

Density of Monitoring Sites and Frequency of Measurement

Following the County's ongoing water quality monitoring program, data will be collected annually for monitoring the groundwater quality sustainability in August which is near the peak season for groundwater demand. The groundwater quality monitoring sites are distributed over the 289 square- mile area of the Vina Subbasin resulting in a monitoring network with a spatial density of 2.4 sites per 100 square miles.

4.5 **Land Subsidence**

Background

Inelastic land subsidence has the potential to be of major concern in areas of active groundwater extraction due to infrastructure damage, permanent reduction in the storage capacity of an aquifer, well casing collapse, and increased flood risk in low lying areas. Inelastic subsidence typically occurs in the clay layers within aquifers and aquitards due to the withdrawal of water from storage within these layers. This water supports the structure of the clay layers, and dewatering permanently rearranges or collapses this structure, a process that cannot be reversed as groundwater cannot re-enter the clay structure after collapse.

Available data indicate that inelastic land subsidence due to groundwater withdrawal has not been an issue in the Vina Subbasin. This is likely due to relatively stable groundwater levels and subsurface materials that are not conducive to compaction.

The primary mechanism for subsidence monitoring in the Vina Subbasin is a group of GPS monuments established to create the Sacramento Valley GPS Subsidence Monitoring Network. This program has been developed jointly by DWR and Reclamation with cooperation and assistance from local entities, including Butte County. The locations of these monuments are shown in **Figure 4-3**. Monuments used to monitor subsidence in the Vina Subbasin network include 19 monuments located either in the interior of the Subbasin or on the boundary between Butte and Tehama counties or the boundary between the Vina and Butte subbasins. Data from this monitoring network is collected, analyzed, and reported by DWR as the data becomes available.

Data from monuments in the Vina Subbasin portion of the Sacramento Valley GPS Subsidence Monitoring Network have been used to monitor cumulative subsidence in the Vina Subbasin in 2008 and 2017, a period used to satisfy the SGMA requirement to evaluate historical subsidence.

Observations from the GPS Subsidence Monitoring Network will be supplemented by InSAR data released by DWR. This information reports vertical ground surface displacement using data collected by the European Space Agency Sentinel-1A satellite and processed by the National Aeronautics and Space Administration’s Jet Propulsion Laboratory (JPL). Data released to date from DWR’s InSAR program provides cumulative vertical ground surface displacements from June 2015 through September 2019 and is used in the GSP to fulfill the requirement to estimate the rate and extent of recent subsidence.

InSAR data collection and mapping is regional and is not based on a defined network of monitoring locations. Therefore, no InSAR sites are shown in **Figure 4-3**.

Location and Density of Monitoring Sites and Frequency of Measurement

The Sacramento Valley GPS Monitoring Network includes monuments that were measured in 2008 and 2017, while the InSAR program monitors subsidence on a continual basis. Data collected from both sources requires post processing and analysis, therefore the frequency of reporting is dependent on the work performed by DWR and by NASA’s JPL. There are no extensometers in the Vina Subbasin.

4.6 **Interconnected Surface Waters**

Background

Monitoring depletions of interconnected surface water is conducted by monitoring water levels (stage) in streams and groundwater levels to characterize spatial and temporal exchanges between surface water and groundwater and to calibrate and apply the tools and methods necessary to estimate depletions. The existing monitoring network incorporates data from active stream gages reported to the California Data Exchange Center (CDEC), the California Water Data Library (WDL), and the United States Geological Survey (USGS) National Water Information System and groundwater level monitoring, utilizing a subset of the locations described under the Vina Subbasin's groundwater level monitoring network.

The monitoring sites for the Vina Subbasin include the stream gages found in **Table 4-4** and **Figure 4-4** and the groundwater quality monitoring sites shown above in **Table 4-3** and **Figure 4-2**. The groundwater monitoring sites selected for observing groundwater and surface water interactions include the entire array of existing wells in the groundwater level monitoring network as described in Section 4.2, above, that form the pool of potential representative monitoring sites used to assess surface water and groundwater interactions. As discussed in Section 4.1, the GSAs in the Vina Subbasin intend to further evaluate the SMC for interconnected surface waters to avoid undesirable results to aquatic ecosystems and GDEs. As additional data are collected and evaluated, the Vina Subbasin commits to developing additional SMC and installation of monitoring points, as appropriate, for specific stream reaches and associated habitat where there is a clear connection to groundwater pumping in the principal aquifer.

As with locations used for monitoring of other Sustainability Indicators, the network of stream gages and wells used to monitor interactions between groundwater and streamflow includes sites selected for their period of record, the quality of data reported and subject to permission of the landowner to monitor the well.

In addition to being used to identify relations between groundwater levels and streamflow, data from the network of stream gages and monitoring wells may be used to update and refine the calibration of the Butte Basin Groundwater Model. This model will be used to combine data on groundwater levels and stream flows with data on aquifer parameters and water use to estimate the relation between groundwater conditions and stream flow and to identify instances where groundwater use depletes surface water.

Table 4-4. Vina Subbasin Surface Water Interaction Monitoring Sites

Stream Monitored	Gage ID	Gage Network	Measurement Frequency
Butte Creek Nr Durham	BCD	CDEC	hourly
Butte Creek Nr Chico	11390000	USGS	daily
Big Chico Creek Nr Chico	BIC	CDEC	hourly
Parrot Div From Butte Creek	BPD	CDEC	hourly
Lindo Canal Nr Chico	LCH	CDEC	event
Deer Creek Nr Vina	11383500	USGS	daily
Mud Creek Nr Chico	MUC	CDEC	event

A total of 78 monitoring wells and 7 stream gages are included in the Vina Subbasin's network for monitoring groundwater and streamflow interactions.

4.7 Monitoring Protocols for Data Collection

Monitoring Protocols and Frequency for Groundwater Levels

Each of the wells in the monitoring network is monitored either by Cal Water, Butte County, DWR, or the associated CASGEM entity. Access agreements, including written description of each site location, access instructions, and point of contact, will be arranged prior to initiation of field data collection.

Monitoring for purposes of the GSP will be conducted in accordance with DWR guidelines (BMP 1) to ensure groundwater level data are:

- Taken from the correct location, well ID, and screen interval depth.
- Accurate and reproducible.
- Representative of conditions that inform appropriate basin management data quality objectives.
- Recorded with all salient information to correct, if necessary, and compare data.
- Handled in a way that ensures data integrity.
- Taken using a CASGEM-approved water-level measurement method to ensure consistency across measurements. Methods include:
  - Establishing a reference point.
  - Using one of four approved methods (steel tape, electric sounding tape, sonic water-level meter, or pressure transducer) to measure groundwater levels.

Groundwater level data will include at a minimum the well identification number, measurement time and date, depth to water (to the nearest 0.01 foot) from the established reference point, total depth, measurement method, measurement quality descriptors (for no measurement or questionable measurement), and observations on well and/or site conditions (including modifications to the well). The equipment used to collect groundwater level data will be recorded to include the equipment manufacturer, model, and serial number, as applicable. Equipment used for data collection will be operated and maintained according the manufacturer's recommendations.

Each well in the network has an established reference point in NAVD88.

The general procedure for groundwater level monitoring is as follows:

- The well port (cap, plug or lid) for access will be removed. Pressure inside the well casing will be allowed to equalize to ambient conditions prior to data collection.
- Non-dedicated equipment will be decontaminated by washing with a non--phosphate soap solution and triple rinse of distilled water.
- Groundwater level data (described above) will be recorded.
- Groundwater elevation will be recorded (Groundwater elevation = reference point elevation – depth to water).
- The well port (and lock, if applicable) will be replaced.

Groundwater level data will be entered into the data management system (DMS) as soon as possible following collection.

Monitoring frequency for each well will occur at a minimum of once per quarter. Monitoring will be conducted in October, March, July and August. Select wells are monitored more frequently via dataloggers, at an hourly basis, but will only be reported quarterly. Each representative monitoring site (RMS) will be monitored within one calendar month to ensure consistency for comparability over time. This monitoring frequency will achieve the goal of obtaining sufficient data to evaluate the seasonal, short-, and long-term trends in groundwater.

Monitoring Protocols and Frequency for Water Quality

Each of the wells in the existing network is monitored for water quality by DWR and other agencies, both private and public, including Butte County.

Monitoring for purposes of the GSP will be conducted in accordance with DWR guidelines (BMP 1) to ensure water quality data:

- Are taken from the correct location
- Are accurate and reproducible
- Represent conditions that inform appropriate basin management and are consistent with the data quality objectives
- Are handled in a way that ensures data integrity
- Include pertinent information that is recorded to normalize, if necessary, and compare data

Water quality will be measured for compliance through monitoring of specific conductance. However, pH and temperature will also be recorded for informational purposes. Water quality samples will be assessed in the field and will not require laboratory analysis.

Groundwater quality data will include at a minimum the well identification number, sample time and date, groundwater elevation data (as described in Section 4.2), water quality values for pH, specific conductance, and temperature, sample quality descriptors (for no measurement or questionable measurement), and observations on well and/or site conditions (including modifications to the well). The equipment used to collect groundwater quality data will be recorded to include the equipment manufacturer, model and serial number, as applicable. Equipment used for data collection will be operated and maintained according to the manufacturer’s recommendations.

The general procedures for groundwater quality sampling include:

- For wells with dedicated pumps, the sample will be collected near the wellhead.
- The sampling port and/or sampling equipment will be decontaminated by washing with a non-phosphate soap solution and triple rinse of distilled water prior to sample collection.
- The well will be purged of 3 well casing volumes prior to sampling (if not equipped with dedicated low-flow or passive equipment).
- Samples will be collected under laminar flow conditions.
- Field calibration of equipment to assess drift.

Monitoring for water quality for each well will occur annually in August. Select wells may be monitored more frequently but will only be reported annually. Each RMS will be monitored within one calendar month to ensure consistency for comparability over time. This monitoring frequency will achieve the goal of obtaining sufficient data to evaluate the seasonal, short-, and long-term trends in groundwater.

4.8 Representative Monitoring Sites

RMS are wells that are selected to represent conditions in the three specified management areas (North, Chico and South) within the Vina Subbasin. They are a subset of the 78 Monitoring Network wells (across 59 sites) shown in **Figures 4-1** and **4-2**. The monitoring objectives, protocols, and data reporting requirements for the RMS wells are the same as the Monitoring Network wells. The RMS wells are designated as the compliance points at which the five sustainability indicators (groundwater levels, groundwater storage, water quality, land subsidence, and interconnected surface water) are monitored, and for the quantitative values for MT, MO, and IM as defined in the sustainable management criteria in Chapter 3.

Selection Criteria for Representative Monitoring Sites

RMS wells are intended to be representative of general conditions within the area. This approach allows for a focused and specific monitoring location to effectively represent a larger geographical area. The data gathered from the RMS will be used to quantify the management areas groundwater conditions for the five sustainability indicators and evaluate GSP implementation.

RMS wells were selected using the following criteria:

1. Adequate Spatial Distribution – Representative monitoring site were selected from the monitoring network to maximize the geographical coverage across each of the three management areas and avoid overlapping or redundant coverage.

2. Existing Data – Representative monitoring sites with a longer period of record and a greater number of historical measurements were selected to provide insight into long-term trends that can provide information about groundwater conditions through varying climatic periods such a droughts and wet periods. Historical data may also show changes in groundwater conditions through anthropogenic effects as well. While some sites chosen may not have extensive historical data, they may still be selected because there are no wells nearby with longer records.

3. Increased Density in Heavily Pumped Areas – Selection of additional wells in heavily pumped areas such as within urban residential areas in the city of Chico will provide additional data where high groundwater use occurs.

4. Multi-Completion Wells – The utilization of wells with different screen intervals is important to collect data on the groundwater conditions at different elevations within the aquifer. This can be achieved by using wells with different screen depths that are

close to one another, or by using multi-completion wells.

5. Consistency with BMPs – The BMPs provided by DWR encourage consistency across subbasins and compliance with established regulations.
6. Well Construction Data – Well data such as perforation depths, construction date, and well depth was considered for selection.
7. Accessibility – Consideration for accessibility to the physical well location and to the existing data was incorporated into the selection of RMS wells. RMS in the network include residential, municipal, agricultural, and governmental wells that are owned and operated by various private and public entities.
8. Professional Judgement – Professional judgement was used to make the final decision about each well, particularly when more than one suitable well exists in an area of interest.

4.9 Representative Monitoring Sites for Sustainability Indicators

Each of the associated Sustainable Management Criteria for each Sustainability Indicator described in Chapter 3 have RMS wells identified for monitoring and evaluation with the exception of seawater intrusion as it is not applicable to the Vina Subbasin. The selected RMS wells for each Sustainability Indicator are discussed in the following sections.

Groundwater Levels

The RMS wells will be used as compliance points to record groundwater elevations for the evaluation of chronic lowering of groundwater levels. SGMA allows groundwater elevations to be used as proxy for monitoring other SI if a significant correlation exists between groundwater elevations and the other SI and if the MO for groundwater elevation include a reasonable margin of operational flexibility to avoid undesirable results.

Groundwater storage is directly connected to groundwater elevation, and therefore the MO for groundwater levels will adequately serve as proxy for groundwater storage. Land subsidence occurs when compressible subsurface soils are dewatered. Soil units in the Vina Subbasin have not historically been susceptible to compression during periods of declining groundwater elevations. Therefore, the MO for groundwater levels will adequately serve as proxy for land subsidence.

Surface waters may manifest a depletion in volume if groundwater levels fall below the established MO. Such depletion is not evident in the historical records available, however more information may be required to adequately characterize interactions. See Chapter 3.8

for a discussion of interconnected surface water assessment. As indicated in this Section, an Interconnected Surface Water SMC framework has been developed for the GSP. This framework will guide future data collection efforts to fill data gaps, either as part of GSP projects and management actions or plan implementation. As additional data are collected and evaluated, the Vina Subbasin commits to developing additional SMC and installation of RMS as appropriate, for specific stream reaches and associated habitat where there is a clear connection to groundwater pumping in the principal aquifer.

For the purposes of this GSP, groundwater elevations will be used as a proxy for monitoring of SMCs of groundwater storage, land subsidence, and interconnected surface water.

A total of 17 RMS wells were selected as compliance points for monitoring of groundwater levels (**Figure 4-5**). Six RMS were selected from the 25 Monitoring Network wells for the North management area, 5 RMS from the 14 Monitoring Network Wells for the Chico management area, and 6 RMS from the 39 Monitoring Network wells for the South Area. **Table 4-5** summarizes the well construction details and **Table 4-6** summarizes the well location details.

Table 4-5. Groundwater Levels RMS Well Construction Details

RMS Well ID	State Well Number (Site Name)	Total Depth (feet bgs)	Screened Interval (feet bgs)	Reference Point Elevation[1] (feet)	Reference Point Description	Ground Surface Elevation[1] (feet)
Vina Subbasin – North Management Area						
	23N02W25C001M	243	N/A	161.2	Hole cut in side of casing	157.4
	23N01W10E001M	668	600-668	190.68	One inch hole inside pump base	189.38
	23N01E07H001M	195	115-195	283	Top of casing, remove blue cap	282
	22N01W05M001M	200	N/A	153.28	Hole in pump south side	151.48
	23N01W36P001M	165	N/A	164.35	Top of casing crack in north side	162.75
	23N01E33A001M	506	53-506	252.34	One inch hole in top of casing	252.34
Vina Subbasin – Chico Management Area						
	(CWSCH01b)	>600	---	200	N/A	---
	(CWSCH07)	<600	---	270	N/A	---
	(CWSCH03)	>600	---	258	N/A	---
	(CWSCH02)	>600	---	183	N/A	---
	22N01E28J005M	>600	---	179.79	Top of casing easterly 1" casing	178.89
Vina Subbasin – South Management Area						
	21N01E21C001M	565	240-300 448-508	133.64	Hole in pump base west side	133.34
	21N02E18C003M	240	130-140 160-170 190-200	191.15	Top of shortest PVC casing	189.07
	20N01E10C002M	210	20-120	128.35	Top of casing south side	127.35
	20N02E24C001M	155	124-134	159.65	Top of casing, northern-most piezo	157.75
	20N02E09L001M	710	460-710	143.83	Hole in pump base, southeast side	139.33
	21N02E26E005M	315	265-275 280-290	184.44	Top of next to shortest PVC casing	182.26

Note:
1 – North American Vertical Datum 1988 (NAVD88)
N/A – Not available
PVC – polyvinyl chloride

--- Details of public supply wells not disclosed

Table 4-6. Groundwater Levels RMS Well Location Details

RMS Well ID	State Well Number (Site Name)	Latitude[1]	Longitude[1]
Vina Subbasin – North Management Area			
	23N02W25C001M	39.8222	-122.0401
	23N01W10E001M	39.864	-121.972374
	23N01E07H001M	39.864821	-121.904936
	22N01W05M001M	39.787113	-122.010001
	23N01W36P001M	39.7972	-121.9297
	23N01E33A001M	39.809696	-121.863054
Vina Subbasin – Chico Management Area			
	(CWSCH01b)	---	---
	(CWSCH07)	---	---
	(CWSCH03)	---	---
	(CWSCH02)	---	---
	22N01E28J005M	39.731678	-121.864995
Vina Subbasin – South Management Area			
	21N01E21C001M	39.665471	-121.878004
	21N02E18C003M	39.682	-121.797
	20N01E10C002M	39.609653	-121.848763
	20N02E24C001M	39.5812	-121.7026
	20N02E09L001M	39.6066	-121.7586
	21N02E26E005M	39.6468	-121.7263

Note:
1 – North American Datum 1983 (NAD83)
--- Location of public supply wells not disclosed

Water Quality

A total of 8 RMS wells were selected as compliance points for monitoring of water quality (**Figure 4-5**). They will be monitored for the SMC listed in Chapter 3.5. These wells were selected independently of the wells discussed in Section 4.5 and are not listed in **Table 4-3**. **Table 4-7** summarizes the well construction details and **Table 4-8** summarizes the well location details.

Table 4-7. Water Quality RMS Well Construction Details

RMS Well ID	State Well Number (GSP Number)	Total Depth (feet bgs)	Screened Interval (feet bgs)	Reference Point Elevation[1] (feet)	Reference Point Description	Ground Surface Elevation[1] (feet)
Vina Subbasin – North Management Area						
	23N01W28M002M	1044	791-801 881-891 951-961 1011-1021	160.33	Top of shortest PVC casing	159.02
	23N01W03H002M	553	510-540	218.84	Top of shortest PVC casing	216.88
	23N01W31M001M	1200	969-979 1020-1030	162.86	Top of highest PVC casing	154.75
Vina Subbasin – Chico Management Area						
	22N01E28J005M	948	740-800	179.79	Top of casing easterly 1″ casing	178.89
Vina Subbasin – South Management Area						
	21N02E18C001M	914	770-780 800-810 830-840 870-880	191.56	Top of tallest PVC casing	189.07
	21N01E13L002M	771	735-760	181.9	Top of casing	179.85
	21N02E26E003M	660	610-620	184.97	Top of tallest PVC casing	182.27
	20N02E24C003M	520	484-505	159.14	Top of casing, middle (shortest) piezo	157.75

Note:
1 – North American Vertical Datum 1988 (NAVD88)

Table 4-8. Water Quality RMS Well Location Details

RMS Well ID	State Well Number	Latitude[1]	Longitude[1]
Vina Subbasin – North Management Area			
	23N01W28M002M	39.818773	-121.991188
	23N01W03H002M	39.878215	-121.95712
	23N01W31M001M	39.8028	-122.0294
Vina Subbasin – Chico Management Area			
	22N01E28J005M	39.731678	-121.864995
Vina Subbasin – South Management Area			
	21N02E18C001M	39.682	-121.797
	21N01E13L002M	39.67348	-121.8144
	21N02E26E003M	39.6468	-121.7263
	20N02E24C003M	39.5812	-121.7026

Note:
1 – North American Datum 1983 (NAD83)

4.10 Network Assessment and Improvements

An assessment of the monitoring network is required to determine uncertainty and identify data gaps that could affect the achievement of sustainability goals. Improvements to the network to address data gaps will be planned and implemented to manage, focus, and prioritize monitoring.

Data gaps can result from monitoring information that is not of sufficient quantity or quality. Monitoring network data gaps can influence the development and understanding of the basin setting, including the hydrogeologic conceptual model, groundwater conditions, and water budget; and proposed minimum thresholds and measurable objectives. Updates to the data gaps will be included with the annual reporting and 5-year assessment of the GSP.

The following data gaps and proposed resolutions have been identified in the Vina Subbasin:

- **Domestic Well Depths –** The MT for groundwater levels is based on total depths of domestic wells. The dataset used for this assessment is poor and may include wells no longer in use or poorly maintained. To resolve this data gap, the GSAs will conduct surveys of active domestic wells to assess the actual total depth of these wells within the Subbasin. The GSAs will also maintain a record of verifiable domestic wells that go dry during the implementation period that will include depth of these wells, screen intervals, and available maintenance records. These data will be used to modify the MT over the implementation period, as appropriate.

- **Water Quality –** Temporal data gaps exist for water quality samples collected within the RMS wells. However, existing data from other sites indicate that water quality in the Subbasin is significantly below the MO. The frequency of sampling proposed in GSP is anticipated to provide consistent and comparable data to fill this data gap.
- **Interconnected Surface Water/Associated impacts on GDEs –** There is a lack of sufficient data to analyze interaction of streams and pumping within the primary aquifer system. Additional wells and other monitoring networks will be installed, as appropriate, following the framework discussed in Chapter 3.8.

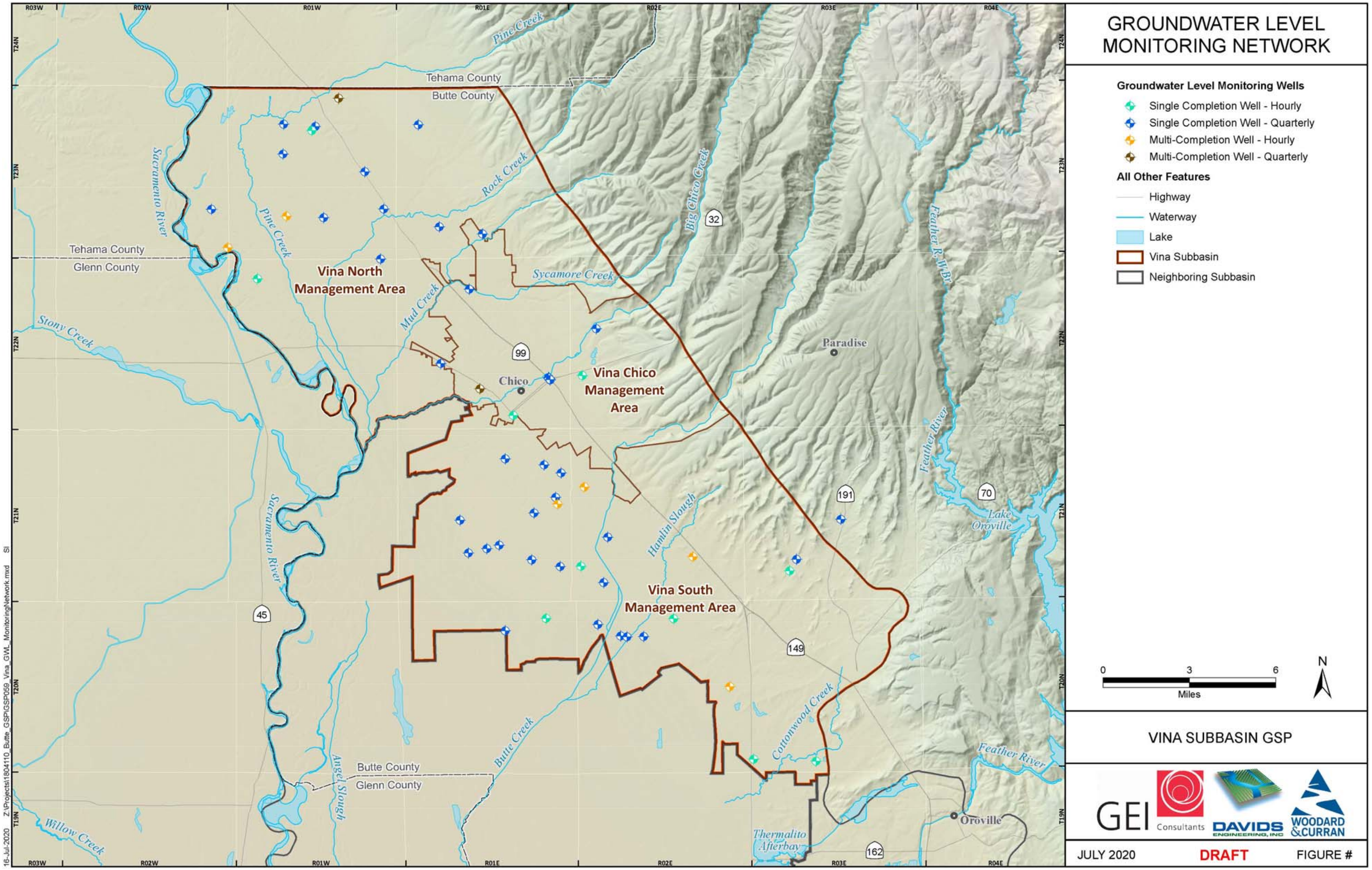
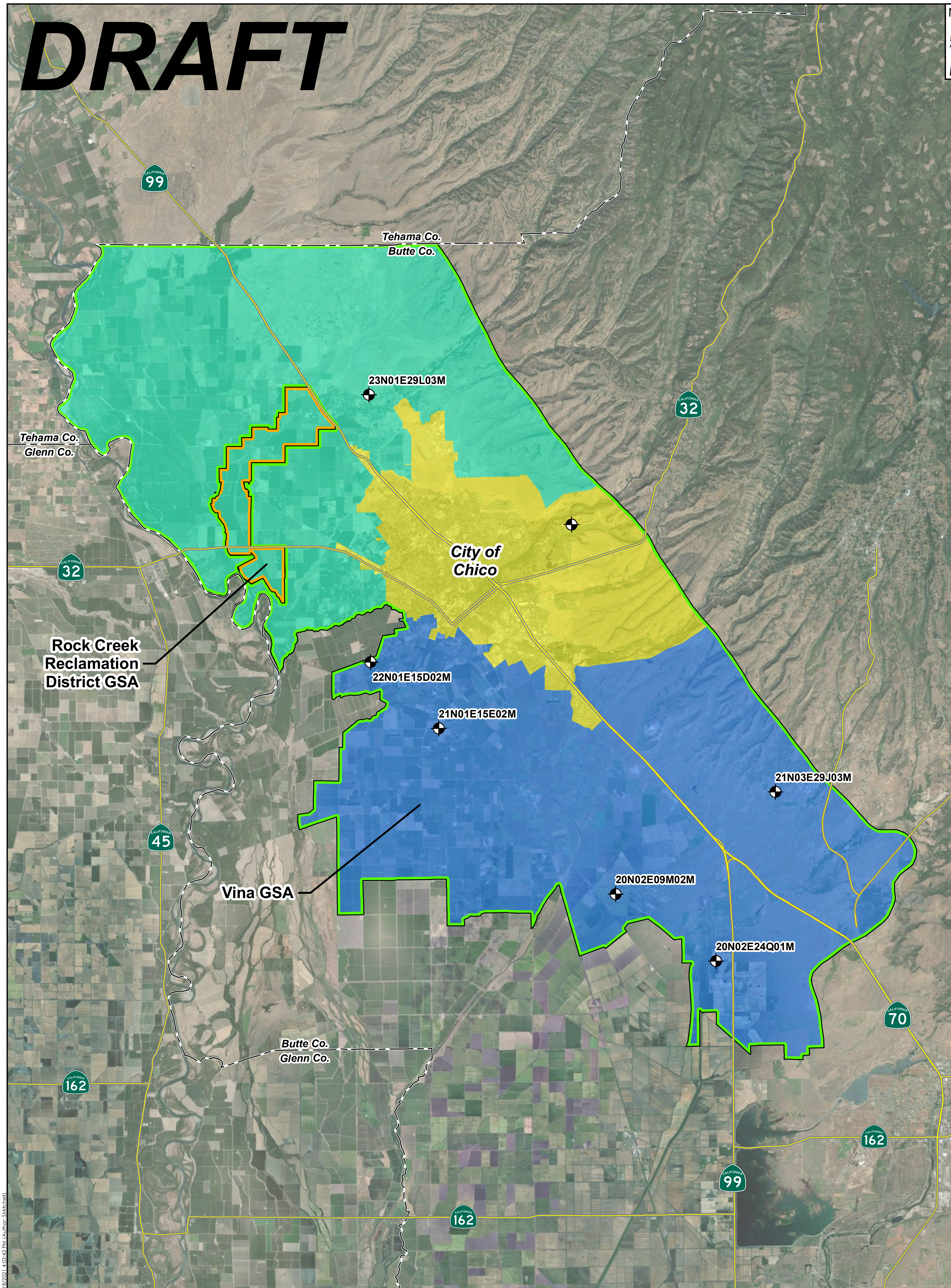


Figure 4-1. Groundwater Level Monitoring Wells



Legend

- Groundwater Quality Monitoring Well
- Highways
- County boundaries

Groundwater Sustainability Agency (GSA)

- Vina GSA
- Rock Creek Reclamation District GSA

Vina Subbasin Management Areas

- North
- Chico
- South

4 2 0 4 Miles

Water Quality Monitoring Wells

Vina GSP

Geosyntec consultants

Figure

4-2

Project No.: SAC282

May 2021

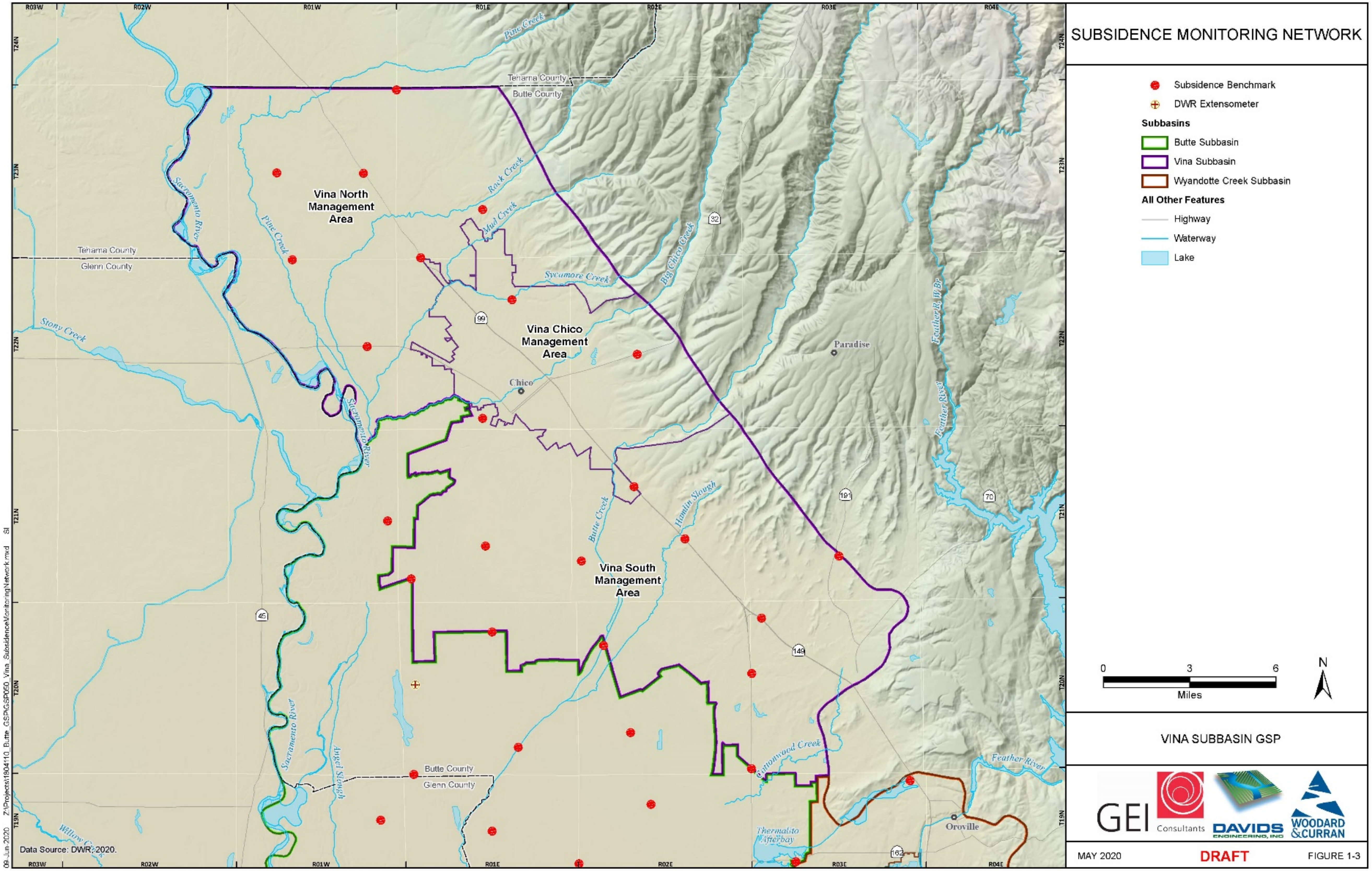


Figure 4-3. Subsidence Monument Locations

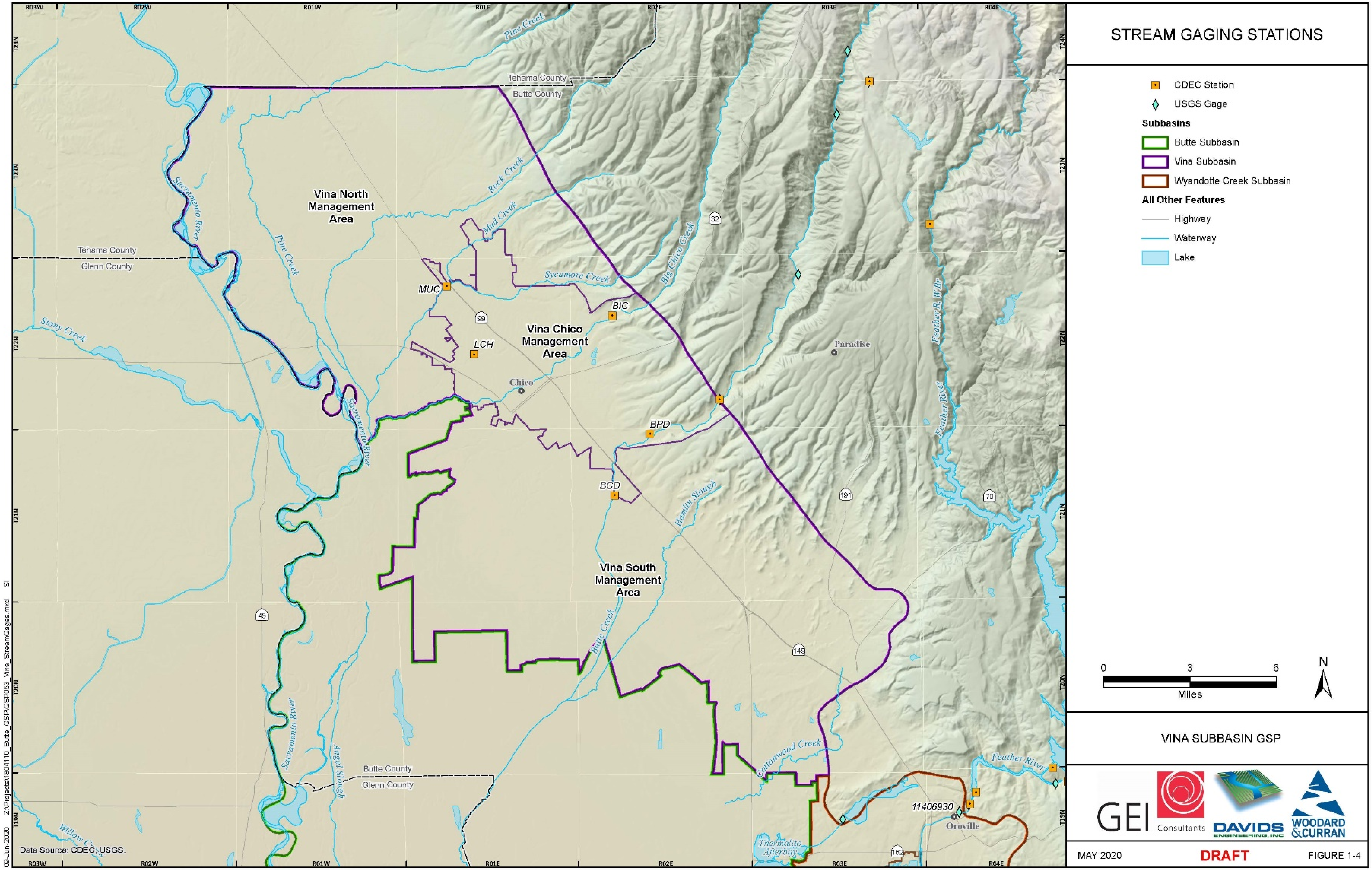
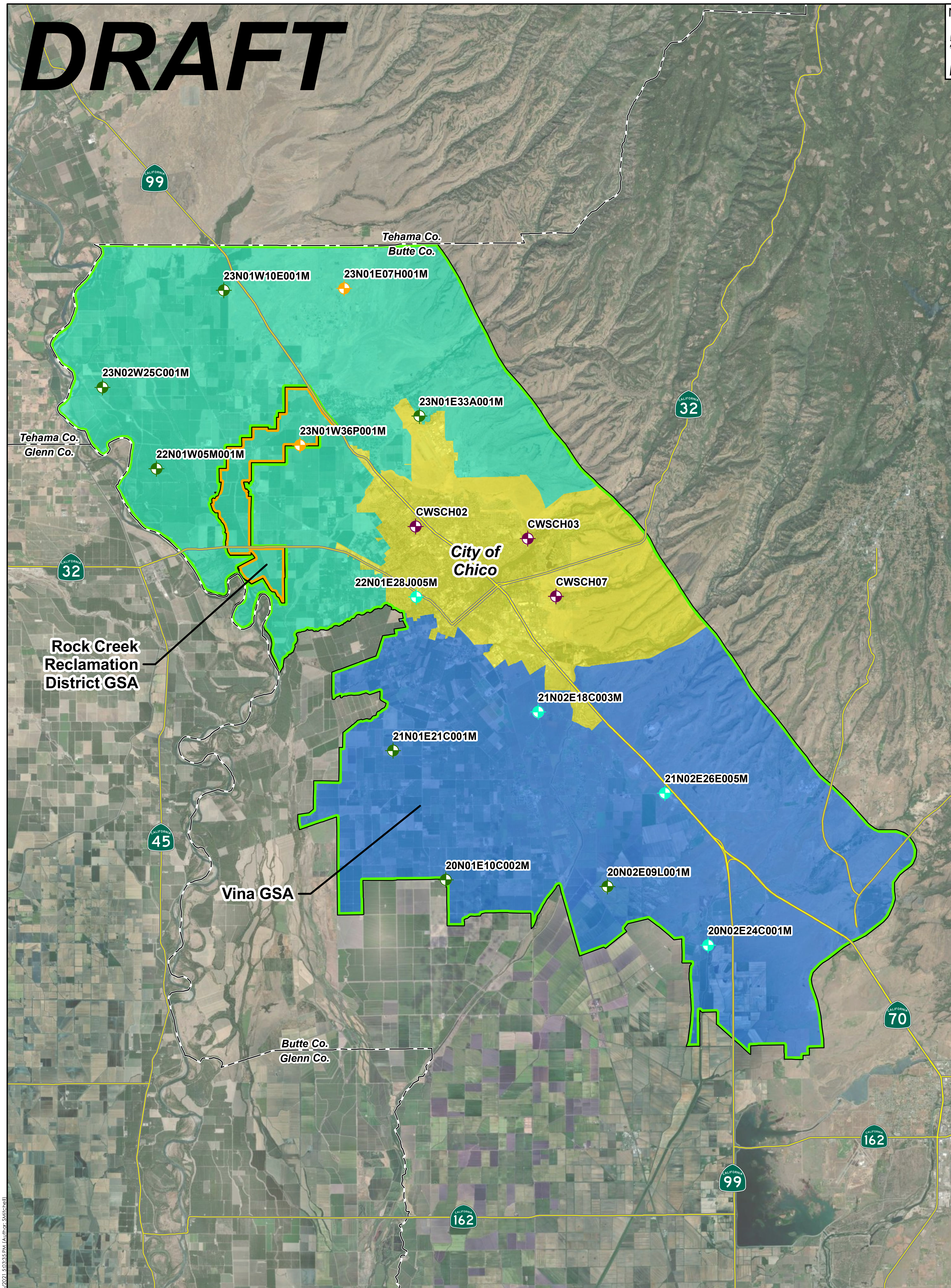


Figure 4-4 Stream Gage Locations



P:\GIS\SAC282 - Butte County\Project\202010_GSP_Maps\20210420\RMS_GWE_Vina.mxd 5/6/2021 5:03:35 PM (Author: SMitchell)

Legend

RMS GWE Monitoring Wells

- Residential
- Irrigation
- Observation
- Municipal and Industrial

- Highways
- County boundaries

Groundwater Sustainability Agency (GSA)

- Vina GSA
- Rock Creek Reclamation District GSA

Vina Subbasin Management Areas

- North
- Chico
- South

4 2 0 4 Miles

Groundwater Level RMS Wells

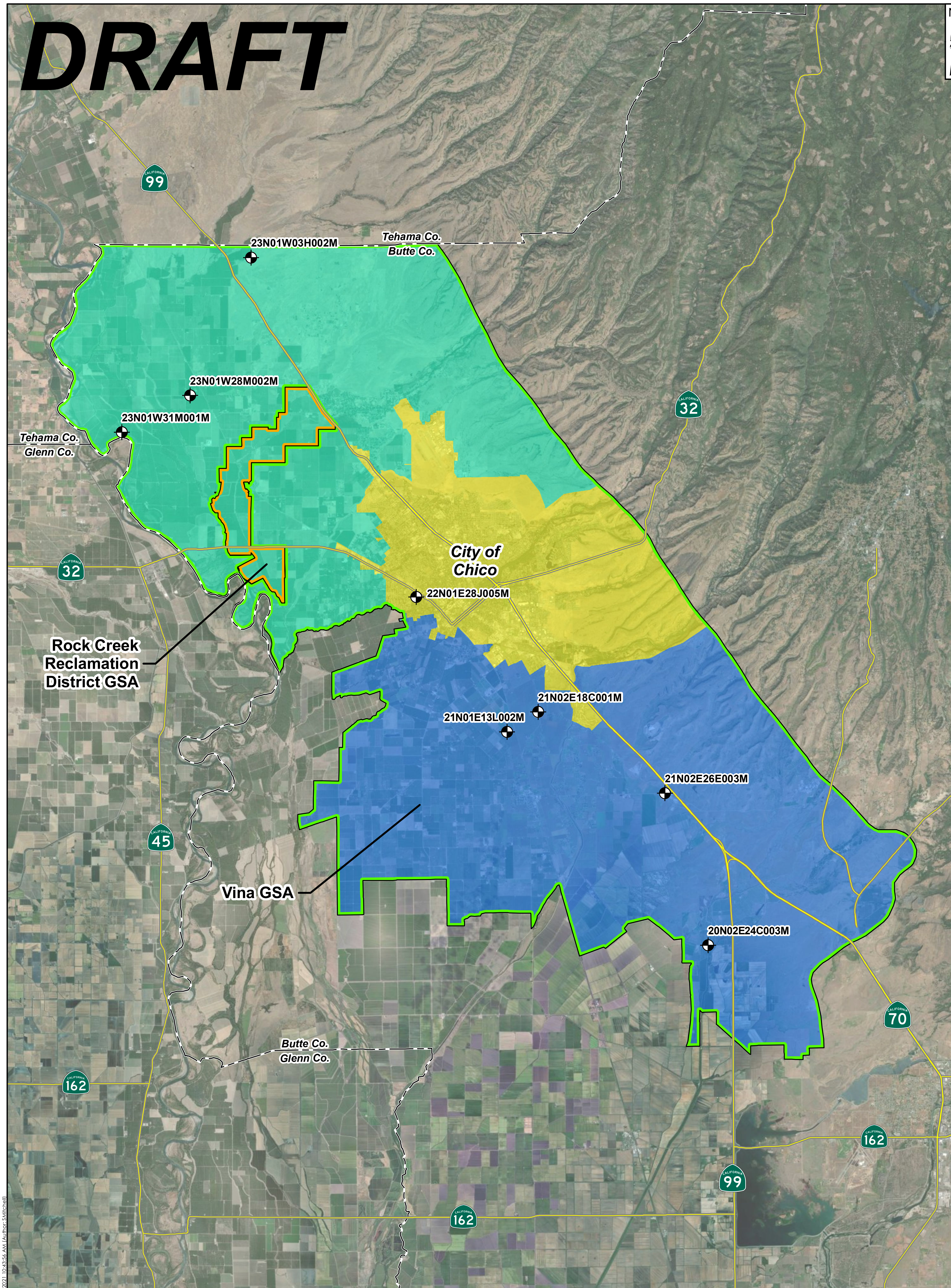
Vina GSP

Geosyntec consultants

Figure 4-5

Project No.: SAC282

May 2021



Legend

RMS WQ Monitoring Wells

Observation

Highways

County boundaries

Groundwater Sustainability Agency (GSA)

Vina GSA

Rock Creek Reclamation District GSA

Vina Subbasin Management Areas

North

Chico

South

4 2 0 4 Miles

Water Quality RMS Wells

Vina GSP

Geosyntec consultants

Figure **4-6**

Project No.: SAC282

May 2021