Vina Subbasin
Groundwater Sustainability Plan
Draft Monitoring Network

1.0 Monitoring Networks

1.1.1 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 (SIs) that will be useful in tracking these SIs as the GSP is being implemented. The complete list of SIs 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. 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 (MOs), Minimum Thresholds (MTs), and Interim Milestones (IMs);

- 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 progress toward achieving locally-established MOs set for groundwater elevations, water quality constituent concentrations, groundwater/ surface water interactions and rates of subsidence at monitoring locations throughout the Vina Subbasin. At locations where MOs differ substantially from current conditions, the monitoring data will be used to determine whether local projects and management actions are meeting IMs presented in the GSP as indicators of progress toward attainment of MOs. Observations from the monitoring network will also be used to confirm that groundwater elevations, water quality constituent concentrations, subsidence rates and streamflow depletion do not breach locally-established MTs.

Most SIs will be monitored directly through measurement of groundwater levels, concentrations of key water quality constituents and observation of ground surface elevations and stream stages. However, the SI for reduction in ground water storage will use change in groundwater elevations as a proxy for reductions in storage with the volume of change in storage being estimated based on observed changes in elevations.

Groundwater elevations may also be used as proxies for stream depletion due to groundwater pumping 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.

In addition to being central to SGMA compliance by enabling tracking of SIs, 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, degraded water quality, land subsidence, and depletions of interconnected surface water are described below. The 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 a sustainability indicator relevant to the Vina Subbasin because 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. This will be addressed in the water quality discussions.

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 SIs to ensure SGMA compliance. Explanations of how gaps identified in the monitoring network will be filled to develop the representative networks are provided in **Section XX**. The schedule and costs associated with maintaining and improving monitoring networks is discussed in **Section XX** and monitoring protocols are presented in **Appendix X.**

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.

1.1.2 Groundwater Level Monitoring

1.1.2.1 Background

Groundwater level monitoring is conducted through a network of monitoring wells used for observation of groundwater levels and computation 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 1-1** lists wells now used for monitoring in each Management Area and **Figure 1-1** 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 1-1. 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

State Well ID Number	Monitoring Frequency	Multi-Completion	Well Type
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
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

State Well ID Number	Monitoring Frequency	Multi-Completion	Well Type
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
21N02E18C001M	Hourly	Yes	Observation
21N02E18C001M	Hourly	Yes	Observation
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

State Well ID Number	Monitoring Frequency	Multi-Completion	Well Type
21N03E32B001M	Hourly	No	Irrigation

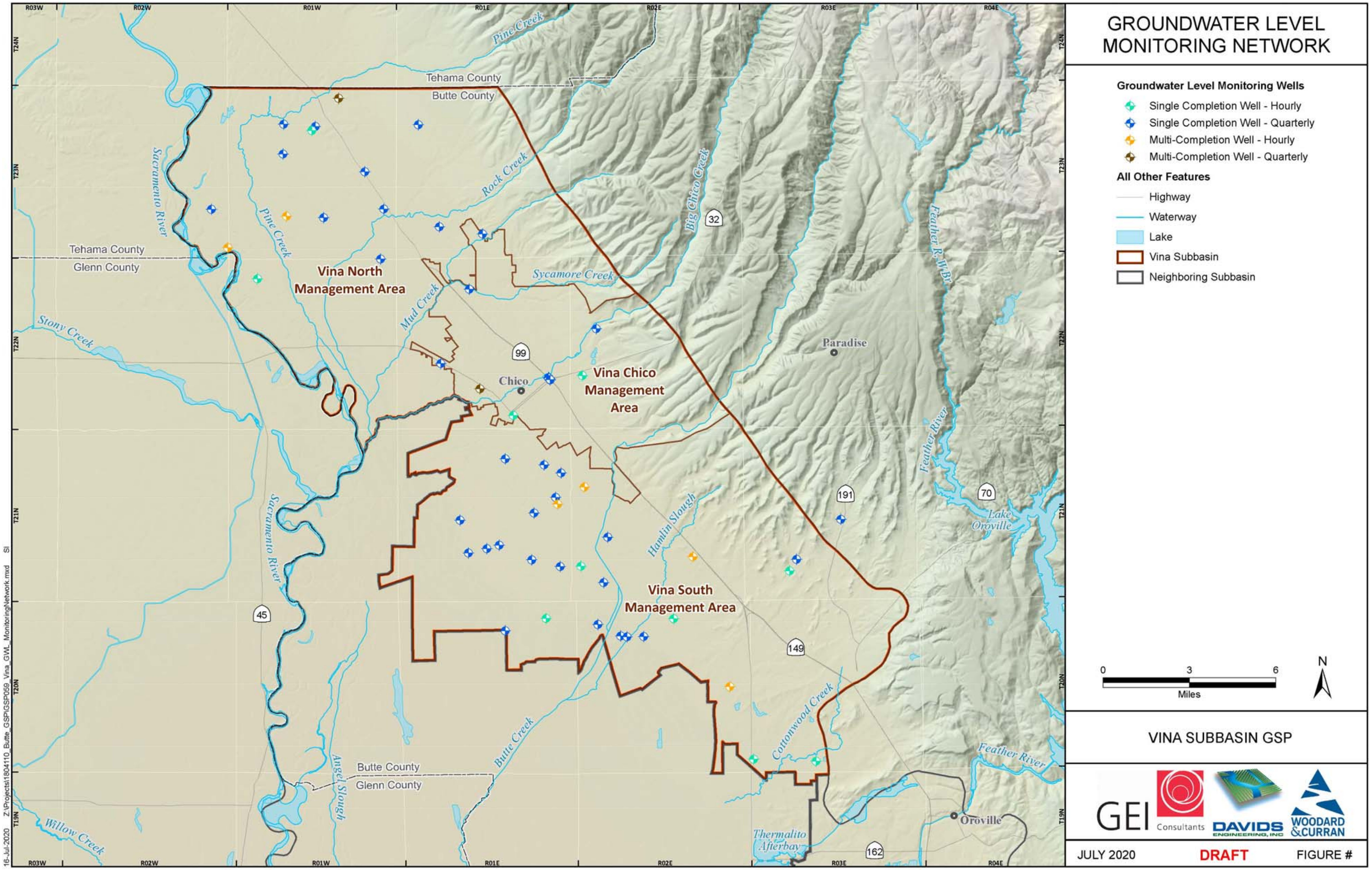

Figure 1-1. Groundwater Level Monitoring Wells

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1.1.2.2 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 data loggers. 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. (see **Figure 1-1**).

For the purpose of SGMA compliance, water levels in all monitoring wells in the Vina Subbasin will be monitored on at least a semi-annual basis – Spring (prior to the major irrigation season) and Fall (after the major irrigation season). All wells will be measured within one week of one another following a schedule that will be developed for the subbasin in coordination with DWR, the County and neighboring subbasins (see **Appendix X – Monitoring Protocol**).

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 MOs and in determining the need for additional or modifications to management actions to meet MOs.

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 BMP *Monitoring Networks and Identification of Data Gaps* (DWR. 2016). **Table 1-2** is taken from the BMP and shows a range of recommended monitoring network densities.

Table 1-2. 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 per 100 square miles	4.0
Basins pumping between 1,000 and 10,000 acre-feet/year per 100 square miles	2.0
Basins pumping between 250 and 1,000 acre-feet/year per 100 square miles	1.0
Basins pumping between 100 and 250 acre-feet/year 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 site 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.

1.1.3 Groundwater Storage Monitoring

1.1.3.1 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. This 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 1-2** with well locations shown on **Figures 1-1 and 1-2**.

1.1.3.2 Frequency of measurement

The data from the semiannual 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 aquifer layer composition and thickness and the specific yield and hydraulic conductivity of these layers are integrated in the Butte Basin Groundwater Model (BBGM), described in **Appendix Y**, 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.

1.1.4 Groundwater Quality

1.1.4.1 Background

Assessment of groundwater quality in the Vina Subbasin focuses on annual observation of salinity (through monitoring of EC), temperature, and pH in the principal aquifer. Each of these parameters is influenced by ambient conditions and the parent material of the principal aquifer. TDS and pH are also influenced by human activity. While only salinity will be used to monitor attainment of Measurable Objectives (MOs) and avoidance of breaches in Minimum Thresholds (MTs), 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 located on the State Board's Groundwater Ambient Monitoring and Assessment (GAMA) program at https://www.waterboards.ca.gov/gama/.

A total of 7 sites are included in the County's on-going water quality monitoring programs, with these wells having been selected based on the existing period of record, 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, 1 located in the Vina-North Management Area, 1 is in the Vina-Chico Management Area, and 5 are in the Vina-South Management Area.

Sites which discharge agricultural runoff are regulated under the Irrigated Lands Regulatory Program (ILRP) by the State Water Resources Control Board or one of the nine Regional Water Quality Control Boards. Many ILRP sites in the Central Valley operate under general orders (broad-based WDRs) or commodity-specific orders designed to prevent discharges of agricultural runoff from causing or contributing to exceedances of water quality objectives. The Vina Subbasin falls within the Butte-Yuba-Sutter Watershed of the Sacramento Valley Water Quality Coalition, which implements the Irrigated Lands Regulatory Program (ILRP) in the Sacramento Valley. The Butte-Yuba-Sutter Subwatershed encompasses all of Butte and Yuba Counties and the majority of Sutter County. A large portion of the subwatershed is located on the Sacramento Valley floor, where the majority of agricultural production occurs, however the subwatershed extends into the upper watershed as far as Lake Oroville. Groundwater quality monitoring within this subwatershed is largely conducted by DWR and local agencies and reported through the GAMA program.

The first groundwater technical report for the Coalition was the Groundwater Quality Assessment Report (GAR), conditionally approved by Central Valley Regional Water Quality Control Board (CVWQCB) in September 2016. This document identified High Vulnerability Areas (HVAs) susceptible to nitrate contamination and assigned priority rankings to these areas. No HVAs are located within the Vina Subbasin, however, further reviews of HVAs may be conducted through the Trend Monitoring Program and will be documented in the GAR 5-year update (SVWQC 2016). Wells in the SVWQC's program are typically monitored for pH, nitrates, EC, temperature, dissolved oxygen, oxidation-reduction potential and turbidity (SVWQC 2019). One well monitored by this program lies in the in the Wyandotte Creek Subbasin and is listed in **Table 1-4**.

The California Rice Commission (CRC) operates a second coalition in the Sacramento Valley that reports groundwater quality data for compliance with the ILRP. Wells monitored by this coalition are shallow “rice" wells that are typically 35 feet deep with screened intervals extending from 25 to 30 feet below ground surface. While the coalition’s 2019 Annual Monitoring Report listed no monitoring wells within Butte County, the 2018 report lists three wells within Butte County including two within the Vina Subbasin (CRC 2019).

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.

Although DWR’s program for monitoring groundwater quality reports data on wells in adjacent subbasins, there are no dedicated monitoring wells currently in the Wyandotte Creek Subbasin as part of their program. The first installation of a dedicated monitoring well was approved by DWR in 2020 through the Technical Support Services program.

Table 1-3 presents information on each of the wells monitored by Butte County in the Vina Subbasin groundwater quality monitoring network. **Table 1-4** presents information on wells reported to the GAMA program that are monitored for water quality in the Vina Subbasin and includes 3 wells monitored by the SVWQC. The table also presents information on 2 wells monitored by the California Rice Commission as part of their program for compliance with the ILRP. These wells are not reported to GAMA. **Figure 1-2** shows the locations of wells noted in both tables.

The GAMA database consolidates data provided by a number of agencies and, as noted above, is used as a source of data by the Sacramento Valley Water Quality Coalition for implementation of the ILRP. Constituents monitored under this program include:

- Arsenic;
- Chromium 6;
- Dibromo chloropropane (DBCP);
- PCATE;
- TCPR123;
- Total dissolved solids (TDS), and
- Uranium.

Table 1-3. Groundwater Quality Monitoring Locations

State Well ID Number	Local Name	Well Type	X Coordinates	Y Coordinates
Vina - North Management Area				
23N01E29L03M	Vina	Irrigation	594899.9235	4408256.961
Vina - Chico Management Area				
n/a	Chico Urban	Domestic	604657.9129	4402146.872
Vina - South Management Area				
0N02E24Q01M	Cherokee	Irrigation	611817.0885	4381319.6
21N01E15E02M	Durham Dayton	Irrigation	598415.4614	4392314.278
20N02E09M02M	Esquon	Irrigation	606971.9689	4384471.562
22N01E15D02M	M & T	Irrigation	595121.5054	4395448.542
21N03E29J03M	Pentz	Irrigation	614558.8602	4389448.647

Table 1-4. Groundwater Quality Monitoring Locations Reported by GAMA

Well ID	Latitude	Longitude	Well Type	Source *	Active
103007	39.7308	-121.869	MUNICIPAL	LLNL	Y
0400007-002	39.67615	-121.771955	MUNICIPAL	DDW	Y
0400154-001	39.706416	-121.799805	MUNICIPAL	DDW	Y
0410002-077	39.770767	-121.819416	MUNICIPAL	DDW	Y
21N01E25A001M	39.6489	-121.809	UNKNOWN	DWR	Y
21N02E18C002M	39.6819	-121.797	UNKNOWN	DWR	Y
21N02E30M001M	39.6453	-121.805	UNKNOWN	DWR	Y
21N02E31M001M	39.6367	-121.803	UNKNOWN	DWR	Y
SVWQC00018	39.5619	-121.7078	DOMESTIC	SVWQ	Y
SVWQC00023	39.6466	-121.7703	DOMESTIC	SVWQ	Y
SVWQC00027	39.7804	-121.9549	PUBLIC	SVWQ	Y
L10004555712-MW-3	39.6745004	-121.7284057	REMEDIATION SITE	EDF	Y
L10004555712-MW-6	39.67333	-121.7334982	REMEDIATION SITE	EDF	Y
L10004555712-U-11	39.6719886	-121.7343211	LYSIMETER	EDF	Y
T0600776104-MW-1	39.714616	-121.7948847	REMEDIATION SITE	EDF	Y
T0600776104-MW-10	39.7138921	-121.7951469	REMEDIATION SITE	EDF	Y
T0600776104-MW-11	39.7140965	-121.7955739	REMEDIATION SITE	EDF	Y
T0600776104-MW-12	39.7142853	-121.7951267	REMEDIATION SITE	EDF	Y
T0600776104-MW-13	39.7145517	-121.7951691	REMEDIATION SITE	EDF	Y
T0600776104-MW-3	39.7144747	-121.7951672	REMEDIATION SITE	EDF	Y
T0600776104-MW-4	39.7141922	-121.7950444	REMEDIATION SITE	EDF	Y
T0600776104-MW-5	39.7143302	-121.7955589	REMEDIATION SITE	EDF	Y
T0600776104-MW-7	39.7145131	-121.795095	REMEDIATION SITE	EDF	Y
T0600776104-MW-8	39.7143906	-121.7949391	REMEDIATION SITE	EDF	Y

Well ID	Latitude	Longitude	Well Type	Source *	Active
T0600776104-MW-9	39.7143378	-121.7951044	REMEDIATION SITE	EDF	Y
020N002E35J002M	39.54156	-121.708	RICE WELL	CRC	Y
020N002E08A001M	39.60825	-121.766	RICE WELL	CRC	Y

* EDF – Water Board Groundwater Monitoring from Cleanup Sites (Electronic Data Format), DDW – Division of Drinking Water, DWR – Department of Water Resources, SVWQC – Sacramento Valley Water Quality Coalition (ILRP); California Rice Commission (ILRP).

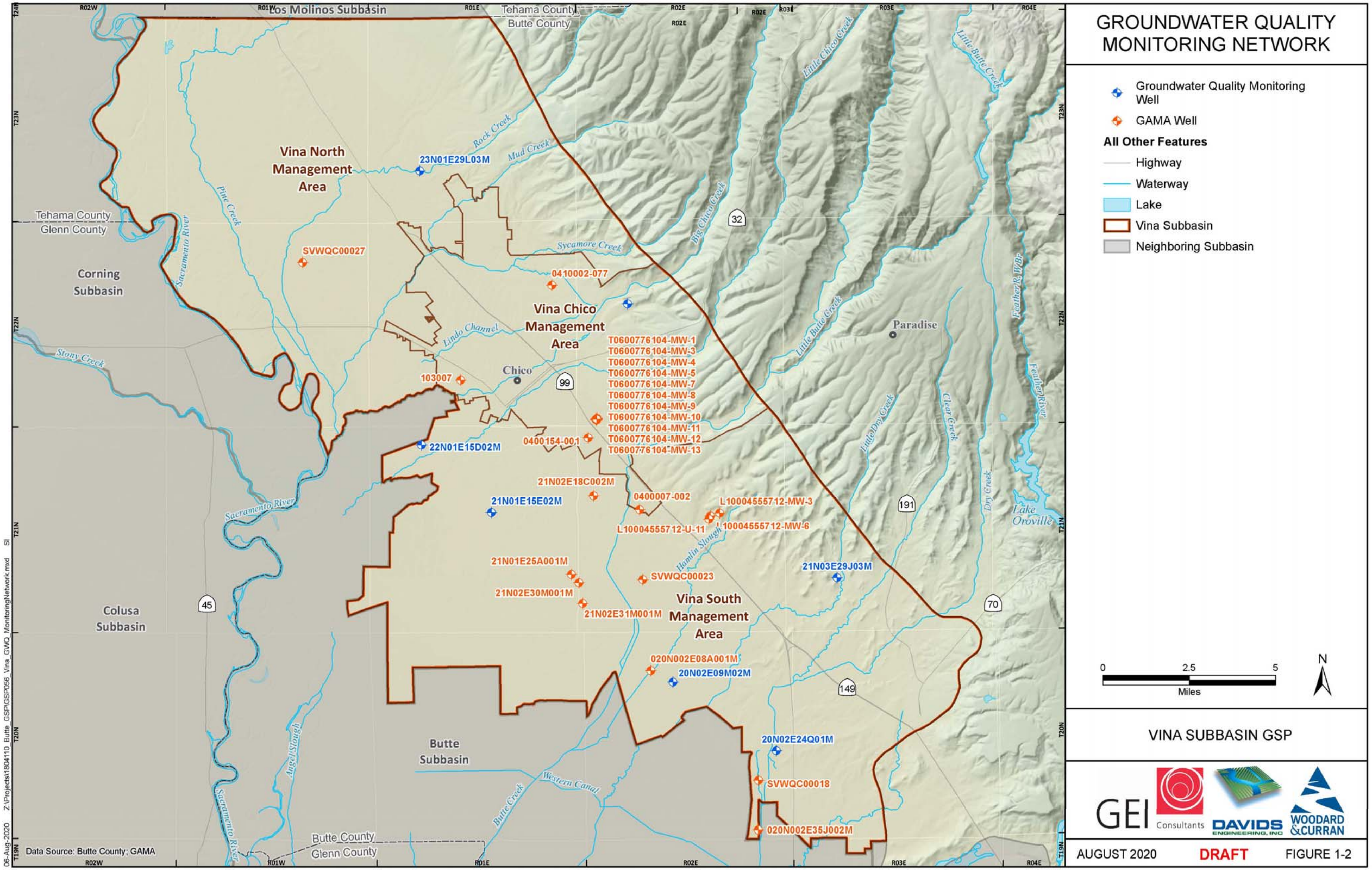

Figure 1-2. Groundwater Quality Monitoring Wells

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1.1.4.2 Density of monitoring sites and frequency of measurement

Following the County's ongoing water quality monitoring program, data will be collected for monitoring the groundwater quality sustainability indicator on an annual basis.

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.

1.1.5 Land subsidence

1.1.5.1 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 subsurface materials that are not conducive to compaction and stable groundwater levels.

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 on **Figure 1-3.** 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 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 on **Figure 1-3**.

1.1.5.2 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.

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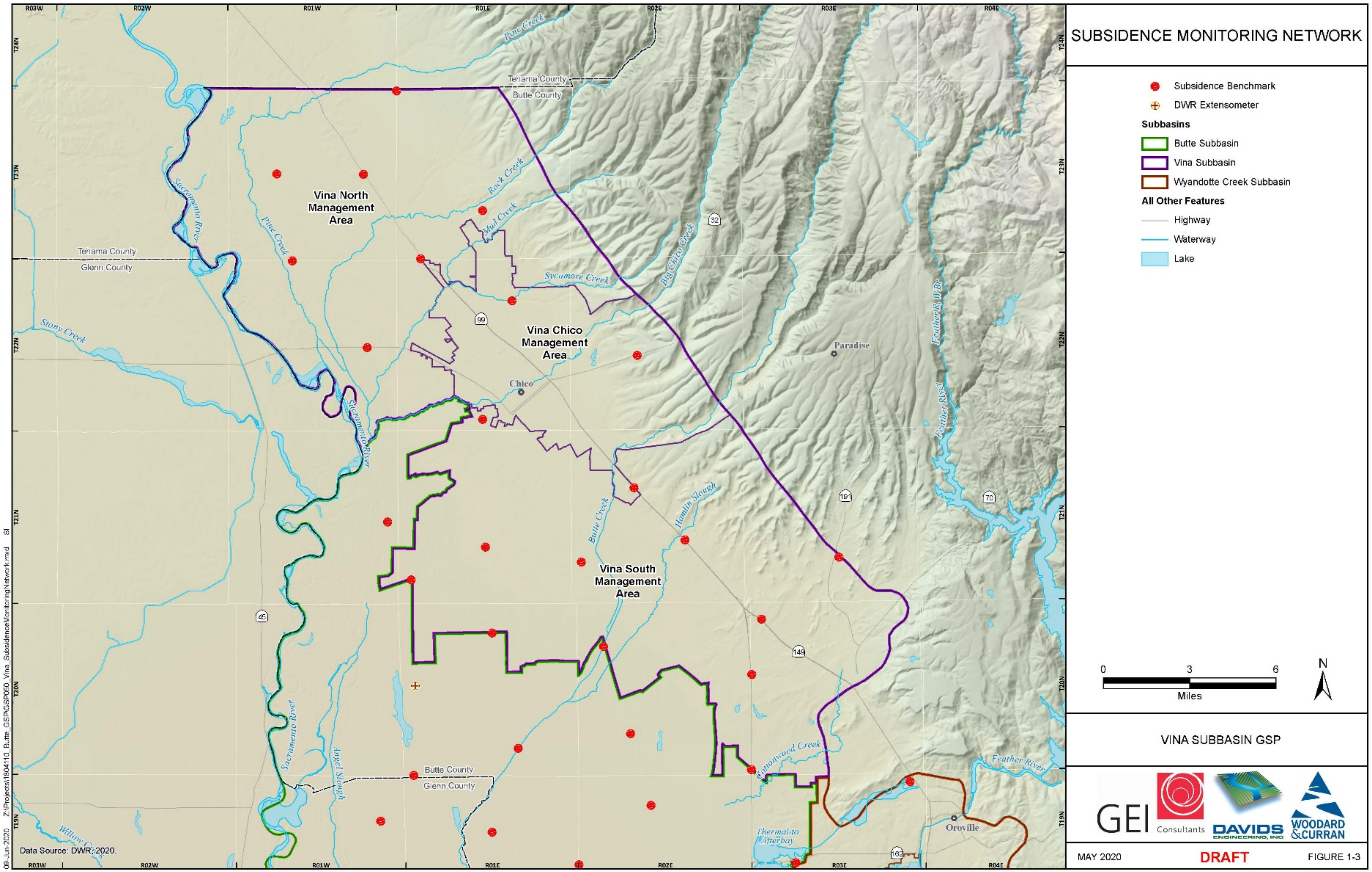

394 **Figure 1-3. Subsidence Monument Locations**

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1.1.6 Groundwater/ Surface Water Interaction

1.1.6.1 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 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 1-4** and **Figure 1-4** and the groundwater monitoring sites shown above in **Table 1-1** and **Figure 1-1**. The groundwater monitoring sites selected for observing groundwater/ surface water interactions include the entire array of existing wells in the groundwater level monitoring network as described in Section 1.1.2 above which will form a pool of potential representative monitoring sites used to assess surface water and groundwater interactions.

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 1-4. 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/ streamflow interactions. Once further analysis of the well data is conducted to determine representative well monitoring sites, the density of monitoring locations and frequency of their measurements will be addressed in the Representative Monitoring section of this GSP.

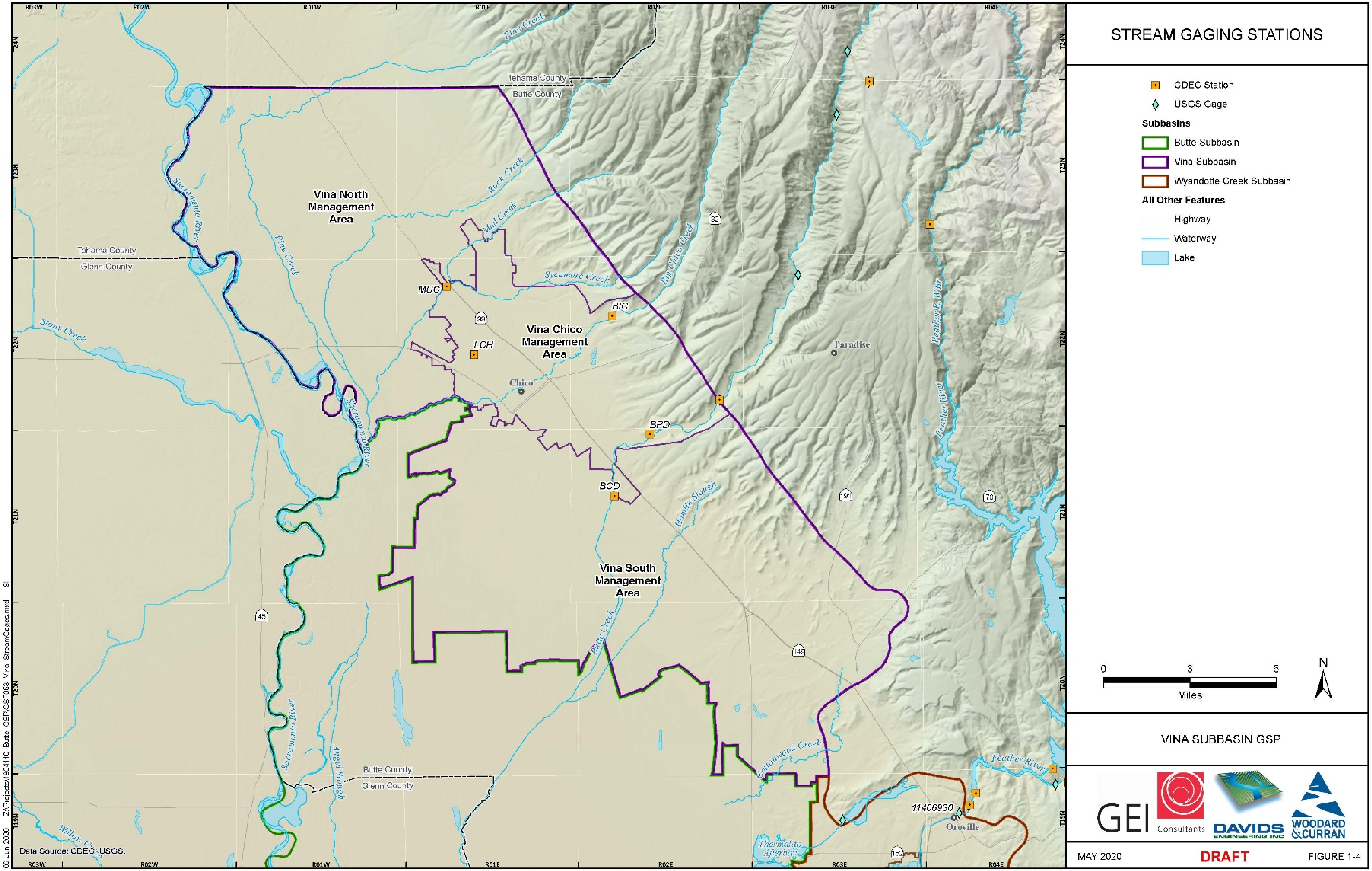

Figure 1-4 Stream Gage Locations

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