2.0 Plan Area and Basin Setting

2.1 Description of the Plan Area (Reg. § 354.8)

The Plan Area is the area within the SV Subbasin (DWR Groundwater Basin Number 5-012.01) as most recently defined in the Bulletin 118 February 2019 Update (following 2019 SV Subbasin Boundary Modification) and viewable on the SGMA Basin Prioritization Dashboard tool[1]. The SV Subbasin is located within Sierra Valley.

Sierra Valley is an irregularly shaped, complexly faulted valley with seismic influences located in southeastern Plumas County and northeastern Sierra County in northeastern California and is a valley renowned for its beauty, habitat as a nationally designated Important Bird Area and is the largest wetland in the Sierra Nevada Mountains (FRLT, 2018), biodiversity as one of the most biodiverse landscape in the United States; FRLT, 2018), and size (commonly regarded as the largest high-alpine valley in the United States; Vestra, 2005).

The outer boundaries of the SV Subbasin and adjacent Chilcoot Subbasin (excluding the straight-line boundary held in common) approximately parallel the boundaries of Sierra Valley (defined by the interface of the valley floor and surrounding mountains), with some minor exceptions.

The SV Subbasin has a surface area of 184 square miles (DWR, 2004a) and the Chilcoot Subbasin has a surface area of 12 square miles (DWR, 2004b). The hydrologic connection between the Sierra Valley Subbasin and the Chilcoot Subbasin is known to be significant, with some level of surface water hydrology and groundwater interaction but it is not well understood. The subbasins are to some extent discontinuous at depth due to a bedrock sill (DWR, 2004b).

2.1.1 Summary of Jurisdictional Areas and Other Features *(Reg. § 354.8 b)*

The Sierra Valley Watershed boundary is spread across three counties including: Plumas, Sierra, and a small portion in Lassen. The Sierra Valley Watershed area is located in California Assembly District 1, California Congressional District 1, Plumas County Supervisorial District 1, with a small portion in Plumas County Supervisorial District 5, and portions of Sierra County Supervisorial Districts 3, 4, and 5.

The SV Subbasin is shown in Figure 2.1.1-1, and the Plan Area is shown in Figure 2.1.1-2.

A relatively small portion (approximately 115-acre) of the northwest area of the SV Subbasin boundary is located outside of the SVGMD jurisdictional boundary. This area, commonly referred to as the sliver, is owned by the Forest Service and is the responsibility of Plumas County exclusively as an Agency, defined in Reg § 351, or GSA. SVGMD is the GSA for the remainder of the SV Subbasin boundary or Plan Area.

The two primary jurisdictional areas are therefore:

1. SVGMD's SGMA jurisdictional area, which is the portion of the Plan Area which is within the SVGMD boundary (see Figure 2.1.1-2), and
2. Plumas County's SGMA jurisdictional area, which is the portion of the Plan Area which is not within the SVGMD boundary (see Figure 2.1.1-2).

[1] https://gis.water.ca.gov/app/bp-dashboard/final/

The SV Subbasin, adjacent Chilcoot Subbasin, and other surrounding groundwater basins are shown on Figure 2.1.1-3.

Jurisdictional boundaries of federal, state, or local lands, state highways, and locations of the communities within the Plan Area, and other land ownership are displayed within the Sierra Valley Watershed boundary on Figure 2.1.1-4.

Land ownership by area and percent of watershed are listed in Table 2.1.1-1.

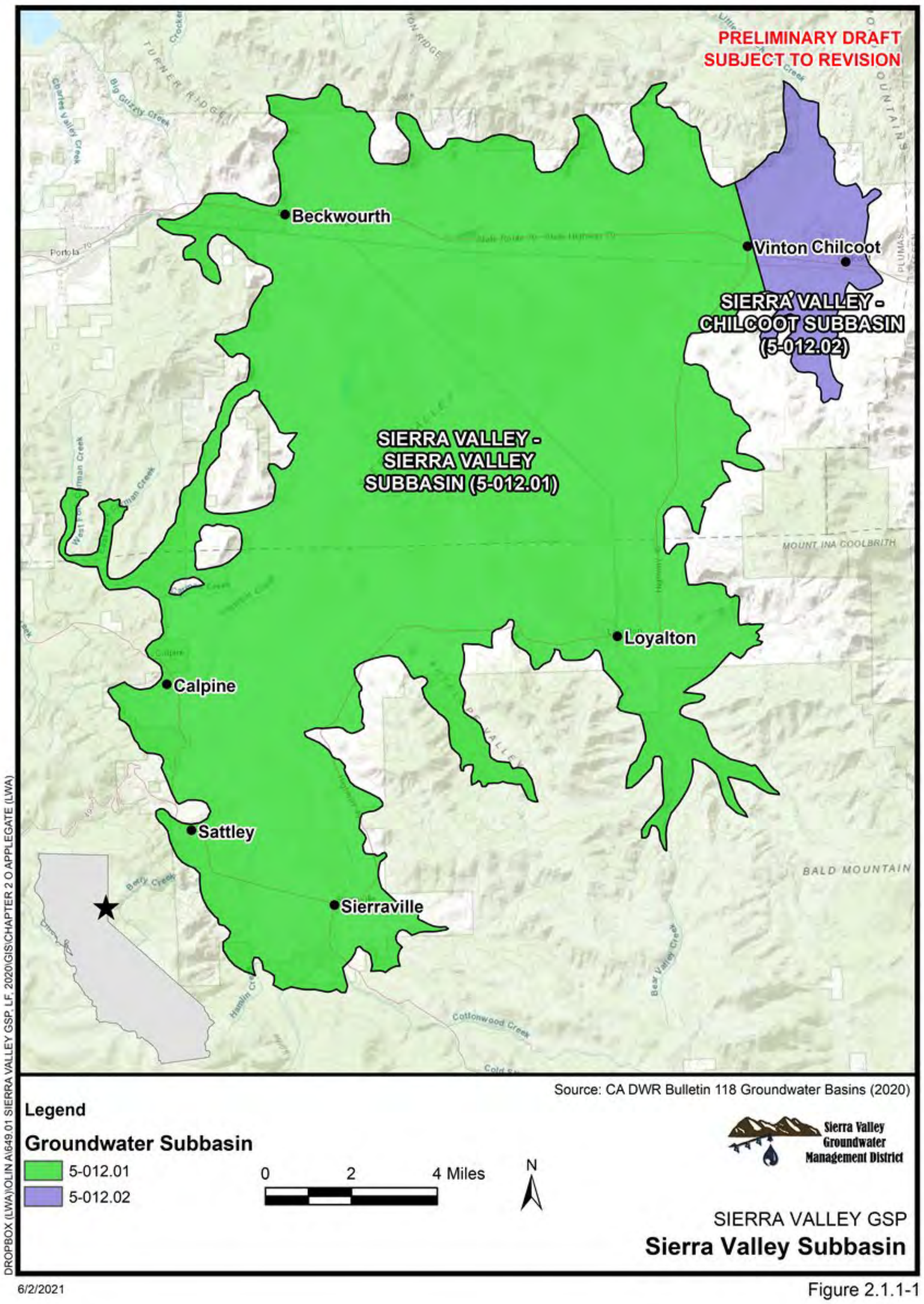
Water management agencies are presented in Figure 2.1.1-5.

The only community in the Plan Area that is an incorporated city is Loyalton, with city limits generally corresponding to the City of Loyalton Water District's boundary. All of the communities within the Plan Area are to some extent groundwater dependent except for Campbell Hot Springs, which relies on a spring source. Campbell Hot Springs has plans for expansion which may necessitate supplementing the spring source with groundwater. In the event that such expansion occurs, this Plan will be revised accordingly.

There are no Tribal Trust Land Tracts (U.S. Department of Interior, Bureau of Indian Affairs) within the SV Subbasin based on information and data published by DWR.[2] Should any new information change this determination in the future, a figure showing Tribal Trust Land Tracts will be added to this Section.

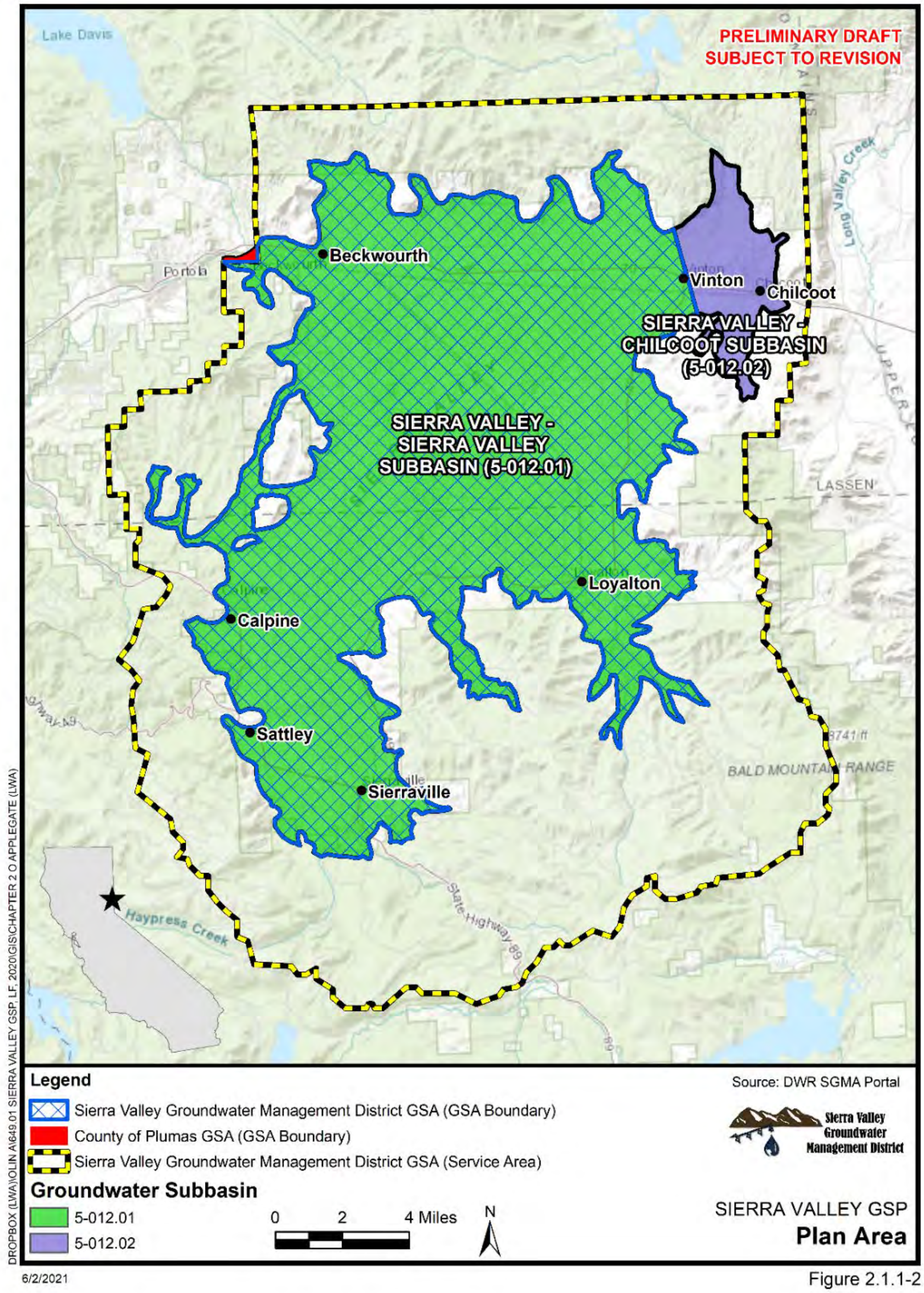
[2] https://gis.water.ca.gov/app/boundaries/ and DWR Guidance Document for the Sustainable Management of Groundwater, Engagement with Tribal Governments (January 2018)

Figure 2.1.1-1 Sierra Valley Groundwater Subbasin



58

Figure 2.1.1-2 Sierra Valley Groundwater Sustainability Plan Area



59

Areas covered by relevant general plans are:

1. portion of the Plan Area within Plumas County (Plumas County General Plan),
2. portion of the Plan Area within Sierra County (Sierra County General Plan),
3. area within the City of Loyalton (City of Loyalton General Plan).

The SV Subbasin contains federally owned lands of the U.S. Department of Agriculture, Forest Service within the Plumas National Forest and Tahoe National Forest. Associated Land and Resource Management Plans for Plumas (1988)[3] and Tahoe (1990)[4] are also relevant.

Existing land use designations in the Plan Area are shown in Figure 2.1.1-6.

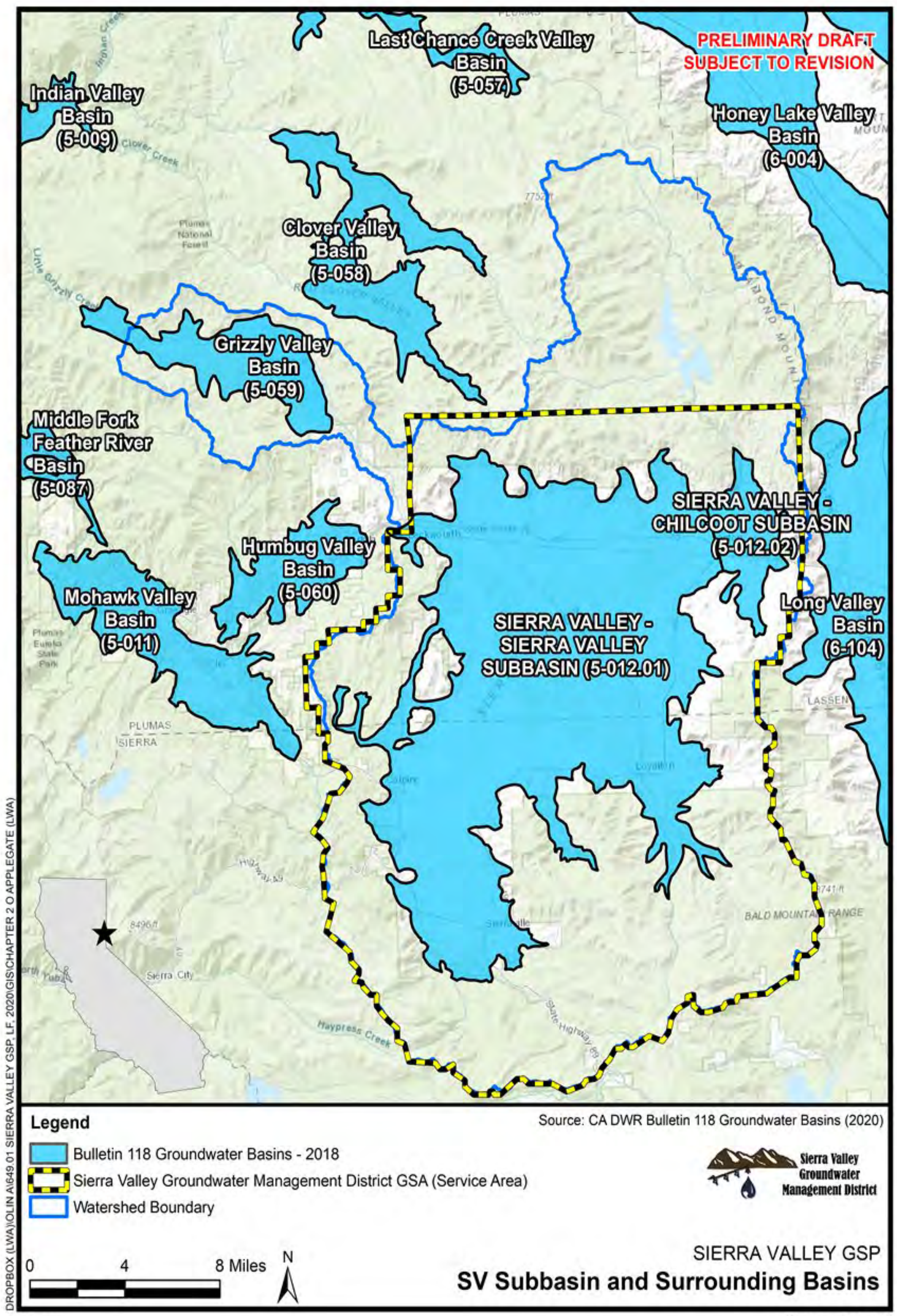
The approximate number of domestic and municipal wells per square mile, agricultural wells per square mile, and unknown wells per square mile, are shown in Figure 2.1.1-7, Figure 2.1.1-8, and Figure 2.1.1-9, respectively (source: DWR Well Completion Report Map[5]). The numbers of wells per type are listed in Table 2.1.1-2.

[3] https://www.fs.usda.gov/main/plumas/landmanagement/planning

[4] https://www.fs.usda.gov/main/tahoe/landmanagement/planning

[5] Available from: https://dwr.maps.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37

Figure 2.1.1-3 Sierra Valley Groundwater Basin (SV Subbasin) and Adjacent Groundwater Basins



6/2/2021

Figure 2.1.1-3

Figure 2.1.1-4 Sierra Valley Watershed Boundary, State Highways, Locations of the Communities within the Plan Area, and Land Ownership

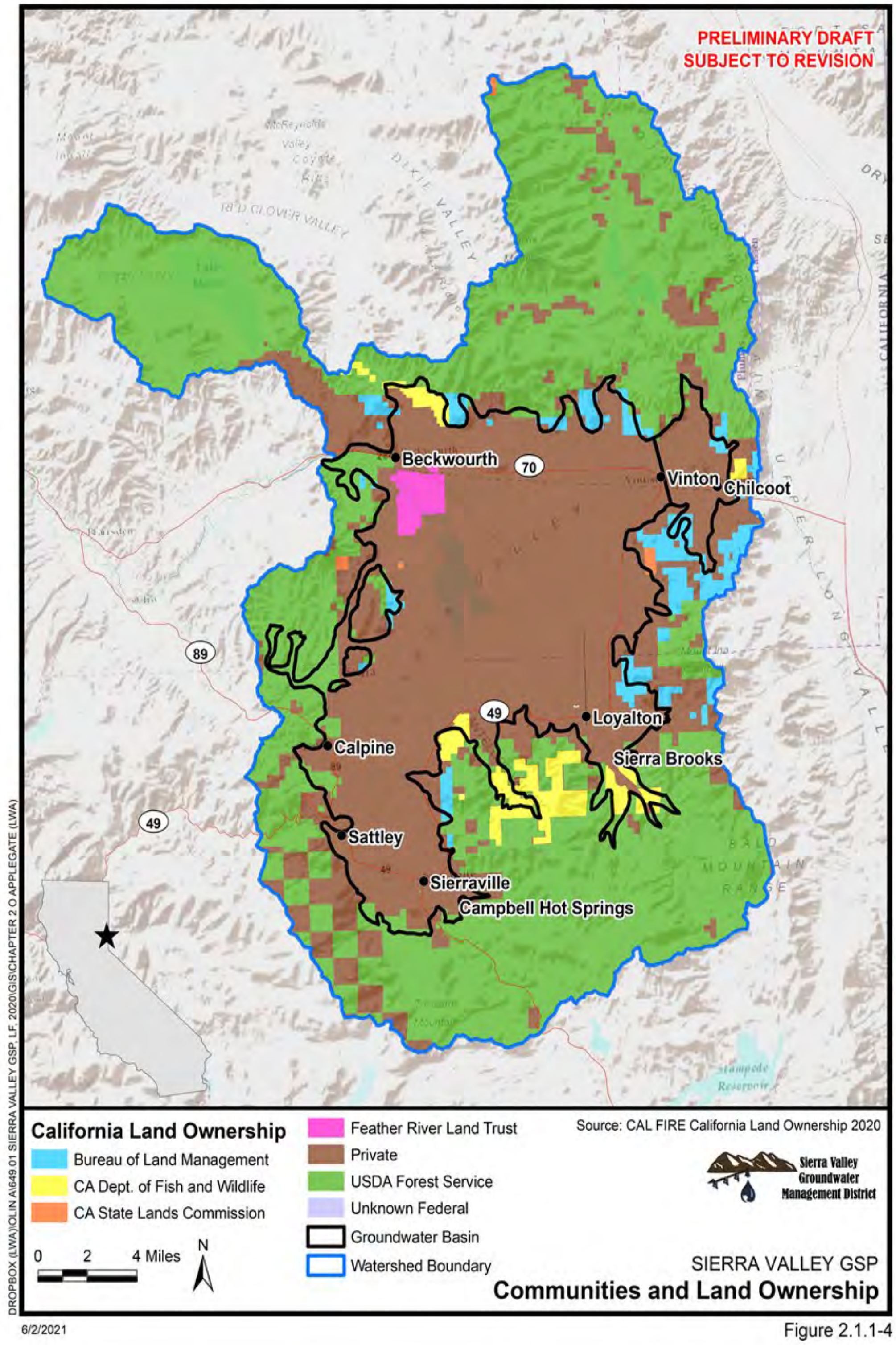


Table 2.1.1-1 Sierra Valley Watershed Land Ownership

Owner	Total Acres	Percent of Watershed
Bureau of Land Management	11,733	3.9
California Department of Fish and Game	8,389	2.8
State Lands Commission	591	0.2
United States Forest Service	127,351	42.8
Plumas National Forest	*31,681*	*10.6*
Tahoe National Forest	*95,418*	*32.1*
Toiyabe National Forest	*252*	*0.1*
Subtotal Federal Acres	**148,064**	**49.7**
Unclassified Private Ownership	142,751	48.0
Sierra Pacific Industries	6,841	2.3
Subtotal Other Acres	**149,592**	**50.3**
Total	**297,656**	**100%**
Source: California Spatial Information Library, The Legacy Project, 2003 California Forestry Association, Private Timber Company Land Holdings Data, 1995		

(Vestra, 2005)

Figure 2.1.1-5 Plan Area Agencies with Water Management Responsibilities shown atop Groundwater Basin Boundaries

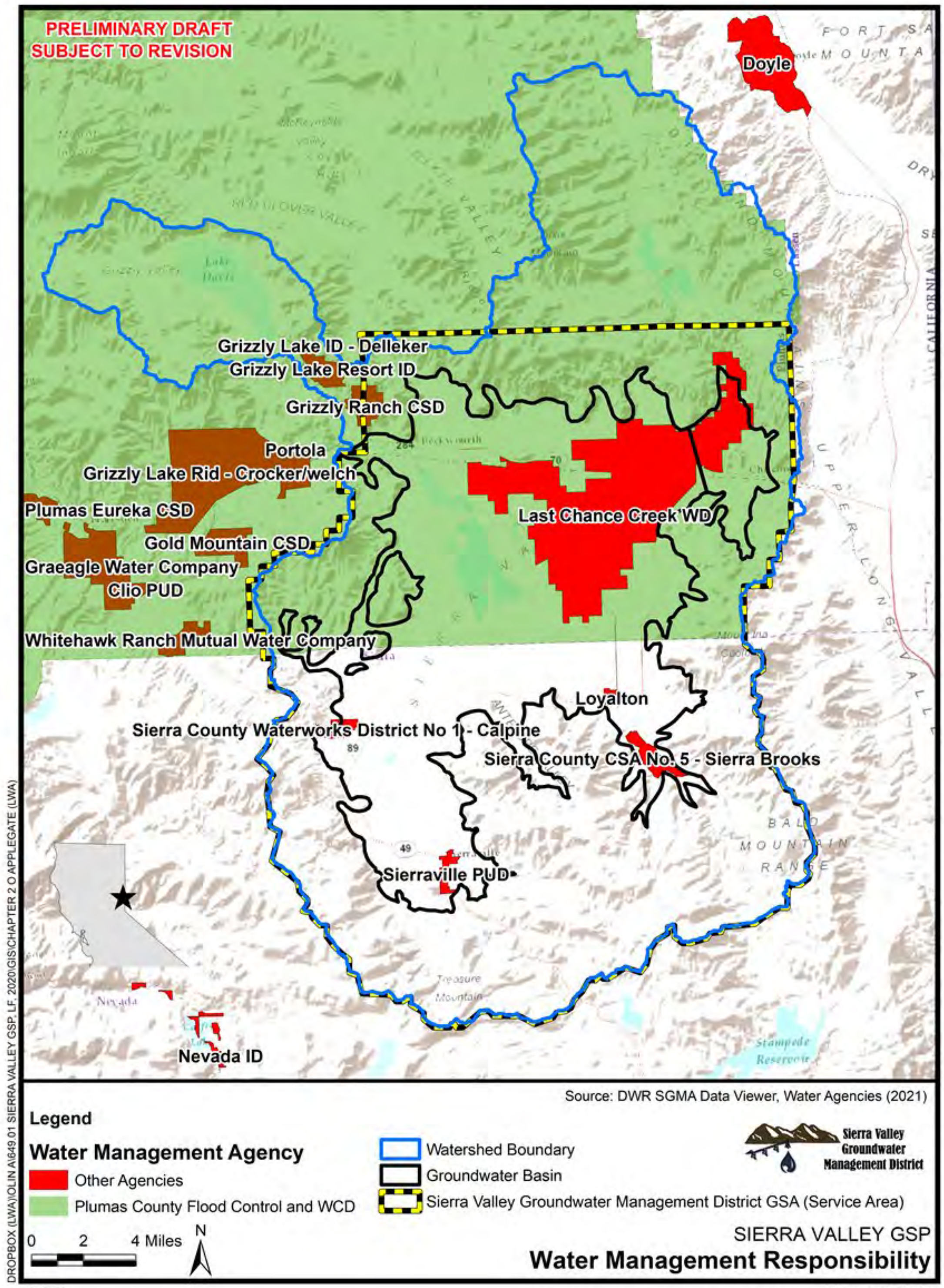


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Figure 2.1.1-5

84

Figure 2.1.1-6 Existing Land Use Designations in the Plan Area

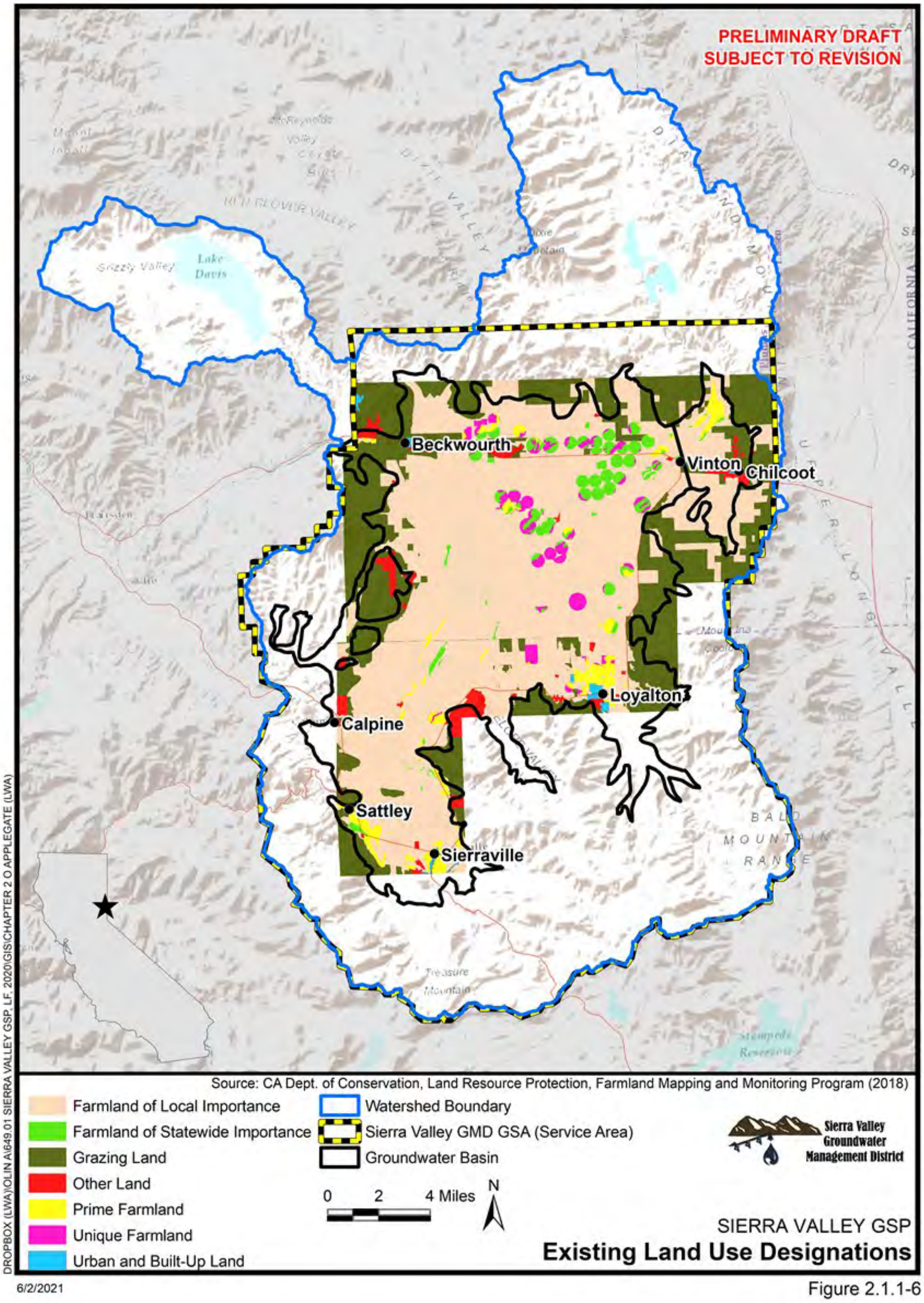

Figure 2.1.1-6

85

Figure 2.1.1-7 Approximate Number of Domestic Wells and Municipal Wells per Square Mile within the Plan Area (source: DWR Well Completion Report Map Application)

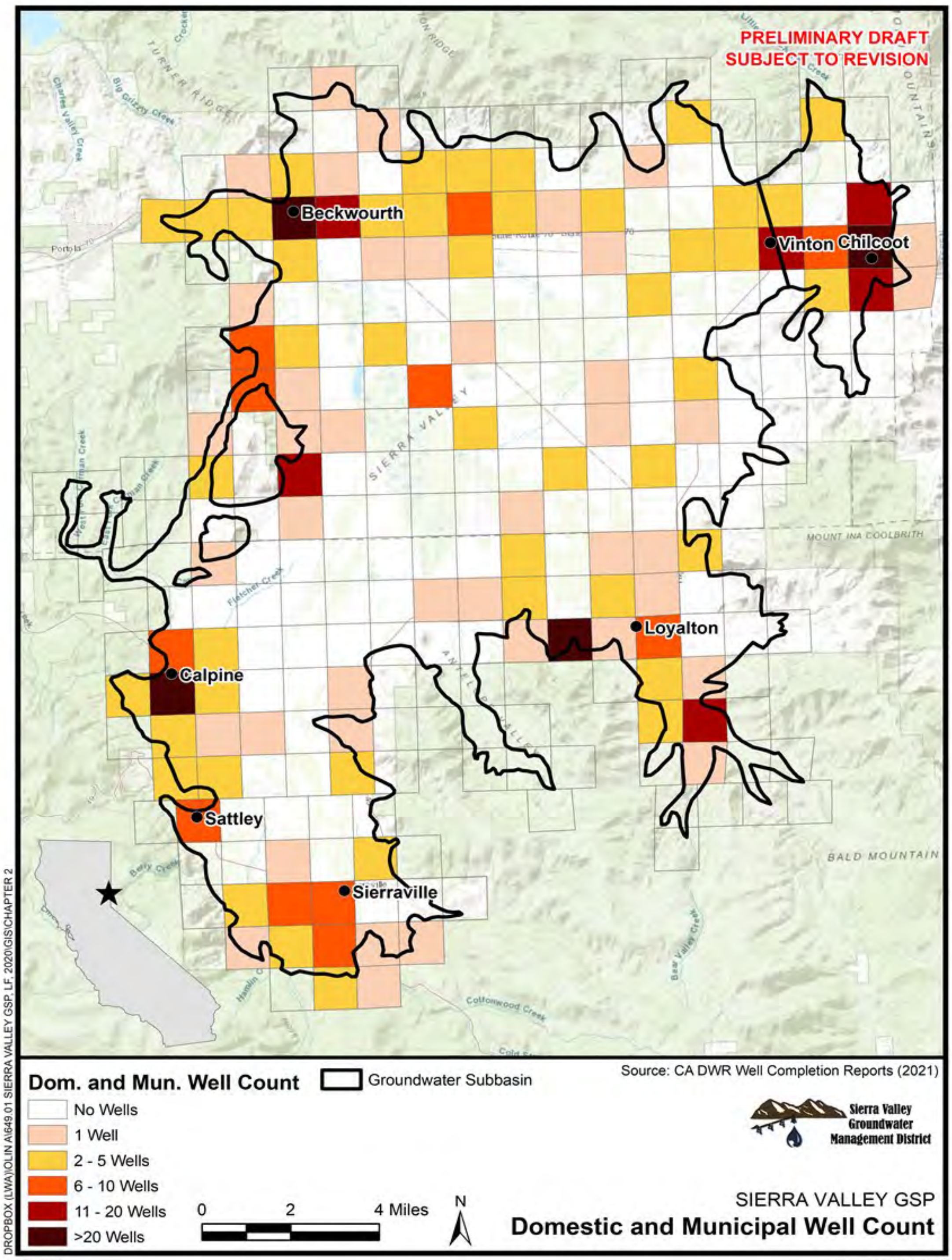

Figure 2.1.1-8 Approximate Number of Agricultural Wells per Square Mile within the Plan Area (source: DWR Well Completion Report Map Application)

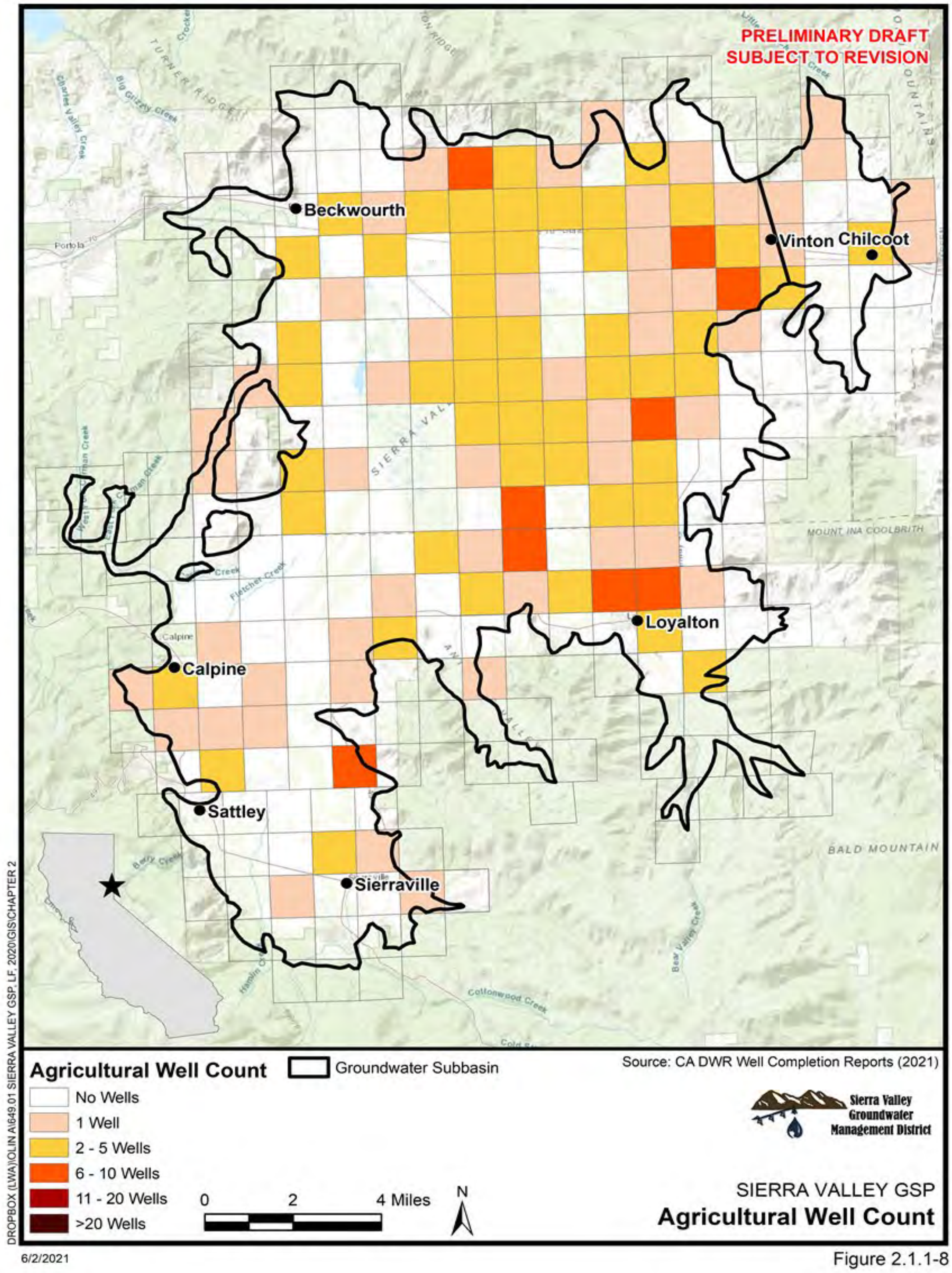

Figure 2.1.1-9 Approximate Unknown Wells per Square Mile within the Plan Area (source: DWR Well Completion Report Map Application)

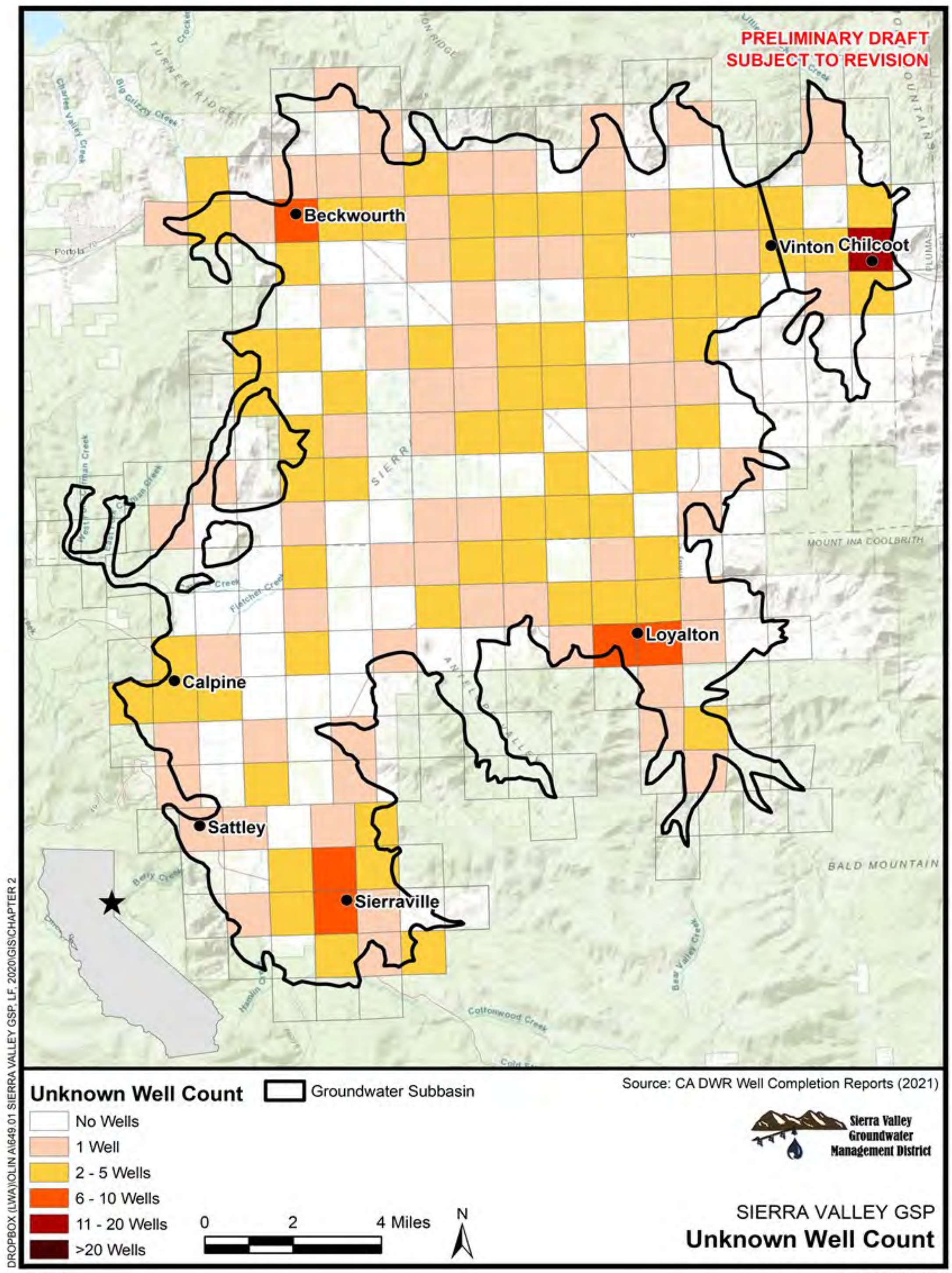

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Figure 2.1.1-9

Table 2.1.1-2. Well Count in Sierra Valley by Type[1]

Well Type	Well Status				
	Active	Inactive	Destroyed	Unknown	Abandoned
Municipal	32	1	2	19	1
Agricultural	59	60	14	54	
Domestic	32	2	3	438	
Monitoring	77		12	47	
Spring/Seep	7				
Stockwater	24	2	3	22	
Unknown	101		7	186	
Exploratory Boring		5		6	
Heat Exchange				1	
Industrial				8	
Production				5	
Total	**332**	**70**	**41**	**786**	**1**

1. Well information obtained from DWR, United States Geological Survey (USGS), and SVGMD. Methods detailed in DMS Technical Memorandum, Appendix ##.

2.1.1.1 Plan Area, Exclusive Agencies, and Adjacent Basins

The Sierra Valley (SV) Subbasin was characterized as a medium priority basin in DWR Bulletin 118, therefore, it is the primary focus of this Plan in compliance with SGMA (DWR, 2018). Although the Plan Area is technically the area within the SV Subbasin only, much of the descriptions, data assessment, monitoring, and management actions and projects included in this Plan include areas beyond the SV Subbasin. The reasoning for this is that there are areas within SVGMD boundaries, but outside of the SV Subbasin boundary, which are significant from a groundwater sustainability perspective and for which SVGMD's enabling legislation gives legal authority to monitor and manage groundwater. For example, the northeastern corner of the valley (defined as the Chilcoot Subbasin - DWR Groundwater Basin Number 5-12.02) is within the SVGMD boundary but not within the SV Subbasin and has significant hydrologic connection with the SV Subbasin. Additionally, critical recharge areas in the higher elevation areas surrounding Sierra Valley are within the SVGMD boundary but not within the SV Subbasin boundary. The "management areas" that arise from these and other distinctions are explicitly defined in Section 2.2.4 of this Plan.

All groundwater basins adjacent to the SV Subbasin are very low priority basins, including the Chilcoot Subbasin (DWR, 2018). Adjacent groundwater basins, as shown in Figure 2.1.1-3, include:

- Long Valley Groundwater Basin (DWR Groundwater Basin Number 6-104) to the east,
- Clover Valley Groundwater Basin (DWR Groundwater Basin Number 5-058) to the north,
- Grizzly Valley Groundwater Basin (DWR Groundwater Basin Number 5-059) to the northwest,

- Humbug Valley Groundwater Basin (DWR Groundwater Basin Number 5-060) to the west, and
- Mohawk Valley Groundwater Basin (DWR Groundwater Basin Number 5-011) to the west south of the Humbug Valley Groundwater Basin.

2.1.1.2 Adjudicated Areas, Other Agencies, and Areas Covered by Alternative

The Plan Area currently has no adjudicated groundwater areas and there are no areas within the Plan Area that are covered by an Alternative. In the event that any groundwater areas become adjudicated in the future, or any areas become covered by an Alternative, a figure will be added to Section 2.1 identifying such areas and descriptions will be added here. The only Agency (as defined in Reg. § 351. of the California Code of Regulations) within the Plan Area other than SVGMD is Plumas County. The area within the Plan Area for which Plumas County is the exclusive GSA is identified in Figure 2.1.1-2. SVGMD is the GSA for the remainder of the Plan Area.

2.1.1.3 Jurisdictional Boundaries

Other jurisdictional areas (federal, state, and water agencies) and areas covered by relevant general plans within the Plan Area include the following:

1. Bureau of Land Management lands, California Department of Fish and Wildlife lands, State Lands Commission lands, and National Forest lands (see Figure 2.1.1-4);
2. The portion of the Plan Area within Plumas County (Plumas County jurisdictional area, the portion of the Plan Area within Sierra County (Sierra County jurisdictional area), and the area within the City of Loyalton (City of Loyalton jurisdictional area), see Figure 2.1.1-2 and Figure 2.1.1-3; and
3. The portion of the Plan Area within the following agencies with water management responsibilities: Plumas County Flood Control and Water Conservation District, Last Chance Creek Water District shown, City of Loyalton Water District, Sierra Brooks Water System, Sierraville PUD, and Sierra County Waterworks District No. 1 Calpine, see Figure 2.1.1-5.

2.1.1.4 Land Use and Water Sources

Land use is generally characterized by incremental intensities of human use by various types such as residential, commercial, industrial, agricultural, mineral resources, recreational, or natural resources and is typically controlled directly by local regulations and indirectly by other state and federal laws intended for public safety, public welfare, or to protect natural resources (Vestra, 2005). Demographics are often described in conjunction with land use to provide spatial information about population patterns in specific areas for factors such as density, race, age, and income. Demographics are generally reflective of current land use while land use plans, such as general plans, represent a desired blueprint for future development. Demographics and other land use data is described here. Land use elements of applicable general plans are described in Section 2.1.3. Much of the information provided here was excerpted from Vestra (2005) and is watershed-scale data.

There are several small communities in the Sierra Valley, mostly near the valley edges. The communities, clockwise (roughly) from northwest to southwest, are: Beckwourth, Vinton, Chilcoot, Sierra Brooks, Loyalton, Campbell Hot Springs (a.k.a. Sierra Hot Springs), Sierraville, Sattley, and Calpine. The Sierra Valley watershed boundary, shown in Figure 2.1.1-5, fully encompasses the Plan Area and extends slightly into Lassen County to the northeast. The communities of Sierra Valley with state highways and county lines are also shown on the

Figure. Beckwourth is a census-designated place (CDP) in Plumas County located near the northwest corner of the valley. The population of Beckwourth from the 2010 census was 432 at the 2010 census, up from 342 from the 2000 census. Vinton is an unincorporated community in Plumas County located near the northeast corner of the valley. For census purposes, Vinton is included in the CDP of Chilcoot-Vinton. Chilcoot is an unincorporated community in Plumas County located near the northeast corner of the valley, also included in the CDP of Chilcoot-Vinton. The population of the Chilcoot-Vinton from the 2010 census was 454, up from 387 from the 2000 census. Sierra Brooks is a CDP community in Sierra County located near the southeast corner of the valley. The population of Sierra Brooks from the 2010 census was 478. Loyalton is an incorporated city in Sierra County located near the southeast corner of the valley. The population of Loyalton from the 2010 census was 769, down from 862 from the 2000 census. Campbell Hot Springs, also known as Sierra Hot Springs, is a small resort community located near the southern boundary of valley. There is no population data for the community of Campbell Hot Springs. The year-round population is minimal, but the community hosts a considerable number of tourists annually in its lodge, hotel, and camping area. Campbell Hot Springs is the only community in Sierra Valley with such accommodations for tourism. Sierraville is a CDP community in Sierra County located near the southern boundary of the valley. The population of Sierraville from the 2010 census was 200. Sattley is a CDP community in Sierra County located near the southwest corner of the valley. The population of Sattley from the 2010 census was 49. Calpine is a CDP community in Sierra County located near the southwest corner of the valley. The population of Calpine from the 2010 census was 205.

The cumulative population of these communities from the 2010 census comes to about 2,600 people. The remainder of the population in the valley (likely less than 500 people) is spread out on rural parcels, mostly R-20 (20-acre), R-40 (40-acre), and R-160 (160-acre) parcels, many of which are family ranches. Based on population growth trends and anecdotal data, it is expected that the population of the communities of Sierra Valley will remain relatively stable, with the most significant changes expected to occur in the northeast and southeast portions of the valley (i.e., Chilcoot and Sierraville) as a side-effect of rapid population growth in the nearby Reno and Truckee areas.

Land ownership in the Sierra Valley Watershed is approximately 50 percent public and 50 percent private. The USFS, BLM, California Department of Fish and Game (CDFG), and State Lands Commission hold approximately 58 percent of the watershed. Of the 50 percent of the land held by federal agencies, the USFS is the biggest landholder with approximately 43 percent. There are three national forests in the Sierra Valley Watershed. Approximately 32 percent of the USFS is in the Tahoe National Forest; 11 percent is in the Plumas National Forest, and less than one percent is in the Toiyabe National Forest.

The primary existing land use designation is agriculture/cropland and grazing. As shown on Figure 2.1.1-6, there are numerous farmland designations in the Sierra Valley defined by the California State Farmland Mapping and Monitoring Program. These include urban and built-up land (783 acres), grazing land (35,845 acres), farmland of local importance (90,187 acres), prime farmland (8,515), farmland of statewide importance (4,718 acres), unique farmland (2,642 acres), water (45 acres), and other land (3,281 acres). Although water makes up a relatively small portion of the estimated land use/cover, it should be noted that FEMA floodplain (area with a 1% annual chance of flooding of up to 12”) comprises a significant portion of the valley.

A wide variety of crops are grown throughout Sierra Valley, including alfalfa, improved pasture, meadow pasture, grain, Christmas trees, and specialty crops. The majority of crops are pasture or production of hay. The top five crops in Plumas and Sierra County for 2002 listed by value were timber products, cattle, irrigated and dryland pasture and rangeland pasture, alfalfa hay, and other hay (CFBF, 2004).

Others land uses include various forms of recreation. Large areas of open space that are publicly and privately owned accompany relatively low density of human settlement in the Sierra Valley Watershed. Much of the land remains generally accessible for informal public recreational activities of a dispersed, low-intensity nature. These activities include camping, hunting, fishing, running, walking, mountain biking, cross-country skiing, snowmobiling, and nature study. Water Rights law and existing water rights in Sierra Valley (described in Section 2.1.2) also play a major role in dictating land use (crop production, grazing).

Water sources for domestic, commercial, industrial and irrigation water supply are both surface water and groundwater. DWR basin prioritization (DWR, 2019a) states that groundwater makes up 36% of the total water supply in the SV Subbasin. See Section 2.2.1.5 for additional information on water sources and delivery. Because of the surplus of surface water during the wet season and lack of surface water during the dry season, conjunctive use of surface and groundwater is a critical component of water supply management in Sierra Valley. Conjunctive use programs and practices are described in Section 2.1.2.3 of this Plan.

2.1.1.5 Groundwater Well Density and Groundwater Dependent Communities

All of the communities within the Plan Area are to some extent groundwater dependent except for Campbell Hot Springs, which relies on a spring source. Campbell Hot Springs has plans for expansion which may necessitate supplementing the spring source with groundwater. In the event that such expansion occurs, this Section will be revised accordingly. Of the remainder of the communities, Sierraville and Calpine are the most likely to be capable of securing alternative water sources (i.e., springs, creeks) due to the relative wetness/higher precipitation averages and surface water inputs along the southern edge of the valley.

The density of wells per square mile, showing the general distribution of agricultural, domestic, municipal, and unknown water supply wells in the basin, including de minimis extractors, utilizing data provided by DWR, as specified in Reg. § 353.2, are shown in Figure 2.1.1-7, Figure 2.1.1-8, and Figure 2.1.1-9.The density of domestic wells and municipal wells, agricultural wells, and unknown wells in the Plan Area range from 0 to 80, 0 to 10, and 0 to 17 per square mile, respectively, with the majority of domestic and municipal wells located around the communities of Sierra Valley, the majority of the agricultural wells located in the central and eastern portions of the valley, and unknown wells primarily located within/around the communities of Beckwourth, Chilcoot, Loyalton and Sierraville. A comprehensive review of existing wells which included locating wells based on well log information was performed during the development of the hydrogeologic conceptual model for this Plan. Agricultural wells make up the majority of pumping, as subsequently described (see Section 2.1.2.1.3). Industrial wells are limited to the American Renewable Power Plant Supply Well near Loyalton and a number of smaller wells providing water to industrial facilities near Beckwourth and in other areas of Sierra Valley.

2.1.2 Water Resources Monitoring and Management Programs *(Reg. § 354.8 c, d, e)*

Per Reg. § 354.8(c), (d), and (e), this section includes description of water resources monitoring and management programs in the SV Subbasin, including:

- Identification of existing water resources monitoring and management programs in the Sierra Valley, and description of any such programs SVGMD plans to incorporate in its monitoring network or in development of this Plan, (SVGMD may coordinate with existing water resource monitoring and management programs to incorporate and adopt that program as part of the Plan),

- A description of how existing water resource monitoring or management programs may limit operational flexibility in the SV Subbasin, and how the Plan has been developed to adapt to those limits, and
- A description of conjunctive use programs in the basin.

2.1.2.1 Existing Water Resources Monitoring Programs [This section is preliminary and may need updating]

Documentation of water resources monitoring preceding the 1960s is relatively limited. Water Resources monitoring programs conducted since then and associated studies and findings are summarized below.

2.1.2.1.1 Groundwater Conditions Studies

A key component of water resources monitoring in the SV Subbasin has been through the study of groundwater conditions and how they have changed over time. The SV Subbasin has been included in several geology and hydrogeology studies and several focused studies and monitoring projects. The first comprehensive study was by DWR (1983) and included review of all previous studies of the area geology, hydrogeology, and natural resources. Since 1983, DWR Northern District prepared eight annual updates on groundwater conditions in the Sierra Valley Subbasin extending through 1991 and Kenneth D. Schmidt and Associates prepared updates for the following time intervals: 1991-1994, 1994-1998, 1998-2003, 2003-2005, 2005-2011, 2011-2014, and 2014-2016. A comprehensive review of groundwater data was later prepared by Bachand and Associates (Bachand and Associates, 2019) which included data extending through 2018.

Current and historic groundwater conditions as documented in the above-mentioned studies are described in detail in Section 2.2.2 of this Plan. Studies and monitoring by SVGMD and DWR are ongoing. Studies will be conducted and associated reports will be prepared annually throughout the implementation horizon of this Plan, as described in Sections 5.3 and 5.4.

2.1.2.1.2 Groundwater Level Monitoring

SVGMD has been monitoring groundwater levels in Sierra Valley since 1980. As of 2015, six District groundwater level monitoring wells were being monitored monthly as weather and access conditions allowed. DWR has been monitoring groundwater levels since at least 1960. As of 2015, 51 wells in the main part of Sierra Valley and eight wells in the Chilcoot sub-basin were monitored. Monitoring frequency of DWR monitoring wells has typically been twice annually.

Other groundwater level monitoring includes piezometric monitoring of seasonal high groundwater levels in areas of proposed onsite wastewater treatment systems (OWTS) as required by the California Water Quality Control Policy for Siting, Design, Operation and Maintenance of Onsite Wastewater Treatment Systems (OWTS Policy). Such monitoring typically takes place over one winter/spring at depth of approximately 8 feet and less. All associated data is filed through the Plumas and Sierra County Environmental Health Departments.

Current and historic groundwater level monitoring observations are described in detail in Section 2.2.2.1. A detailed description of the groundwater level monitoring network and protocol and proposed improvements is provided in Section 3.5.

2.1.2.1.3 Agricultural Groundwater Extraction Monitoring

Per SVGMD Ordinance 82-03, continued monitoring of agricultural extraction wells is required in the SV Subbasin. SVGMD has been monitoring agricultural groundwater extraction using flowmeters since 1989. As of 2015, pumping from 50 active agricultural wells was metered to measure the volume of groundwater extracted. Current and historic agricultural groundwater extraction data are depicted and trends discussed in Section 2.1.2.1.3. Agricultural groundwater extraction monitoring is critical for water budget refinement and sustainable management of groundwater resources, as groundwater extraction for agriculture exceeds groundwater extraction for municipal, industrial, commercial, and de minimum uses. As detailed in Section 2.2.3, having complete data records dating back to 1989 enables assessment of the dynamics of groundwater use and groundwater system response and the relation of weather patterns with groundwater use, positioning SVGMD to predict changes in demands and likely basin impacts on the basis on weather patterns. This is one significant advantage SVGMD has over most other basins in the state with regard to the ability to sustainability manage groundwater.

2.1.2.1.4 Stream and Channel Surface Water Flow Monitoring

Stream and channel surface water flows have been and continue to be monitored by the area Water Master. Additionally, a stream gauge along the Middle Fork of the Feather River near the outlet from Sierra Valley (CDEC MFP; USGS 11392100) has been monitored and maintained since 1968. USGS monitored and maintained the gauge[6] from 1968 to 1980 and DWR has monitored and maintained the gauge[7] since 2006. Available data include daily flow records for the water years 1969-1980 and 15-minute discharge records from 10/31/2006 to present. The gauge data was utilized to calculate surface water outflow in the water budget development (see Section 2.2.3) and will continue to provide critical information for water budget refinement and associated groundwater management decision making.

Water Master data dating back to 2011 was obtained by SVGMD in 2018 for analysis to supplement water budget development/conjunctive use assessment (see Section 2.2.3). Water Master data will continue to be obtained from the area Water Master and will continue to be incorporated in water budget refinement and groundwater management decision making.

Additional stream and channel surface water flow monitoring would be beneficial and is proposed as described in Section 3.5.

2.1.2.1.5 Water Quality Monitoring

Sierra Valley groundwater chemistry data have been collected by DWR since the late 1950s and SVGMD has expanded the database through their monitoring efforts. The first comprehensive groundwater chemistry data was collected in 1981, including major ion chemistry and selected trace element data from 40 wells. Over the following 14 years DWR continued collecting data and by 1995 a total of 177 samples had been collected from 67 wells. This database was expanded with another 27 wells sampled in 2002 by a contractor working for the SVGMD (data in Schmidt, 2003). Fourteen chemistry data sets were later collected from the five District monitoring wells sampled at shallow, intermediate, and deep levels (Schmidt, 2003; 2005). These monitoring wells were resampled in the summer of 2015, including for light stable isotopes. A groundwater chemistry data base of 45 samples collected in 2014 from selected valley floor wells was developed as part of a SVGMD-funded study (Bohm, 2016a).

Surface water quality has also been monitored with 48 surface water quality samples evaluated between 1970 and 1980 at USGS Streamgage 11392100 (Middle Fork Feather River, a few

[6] https://waterdata.usgs.gov/ca/nwis/inventory/?site_no=11392100

[7] https://water.weather.gov/ahps2/hydrograph.php?wfo=rev&gage=mftc1

miles downstream from Sierra Valley). Additionally, an isotope database was collected from upland springs and streams as part of the SVGMD-funded study (Bohm, 2016a).

Current and historic water quality observations are described in detail in Section 2.2.2.4. A detailed description of the groundwater quality monitoring network and protocol and proposed improvements is provided in Section 3.5.

2.1.2.2 Existing Water Resources Management Programs

Several water resources management programs exist in the Sierra Valley, including surface water rights allocation management/tracking by the area Water Master, waterway preservation/restoration efforts by the Sierra Valley Resource Conservation District, groundwater management by SVGMD (including a well inventory and tracking program, with a database of coordinates of all agricultural, commercial, industrial, municipal, inactive, and geothermal wells). The Upper Feather River Integrated Regional Water Management Plan addresses planning issues and priorities for the larger watershed encompassing SV subbasin.

2.1.2.3 Conjunctive Use Programs

Indirect recharge (or conjunctive use) involves supplying a water demand with an alternative water source that would otherwise be met by groundwater extraction or surface water diversion. In California, conjunctive use is defined as "the coordinated and planned use and management of both surface water and groundwater resources to maximize the availability and reliability of water supplies in a region to meet various management objectives."[8]

In the SV Subbasin, conjunctive use plays a major role in optimizing management/use of water resources. It is common practice in the SV Subbasin to maximize surface water use for irrigation as water rights allow and switch to groundwater irrigation/supplement with groundwater irrigation only as needed[9]. The degree of such conjunctive use/opportunity for conjunctive use varies widely from ranch to ranch depending on water rights/availability, with some of the ranches in the valley able to meet irrigation demand entirely with surface water during typical water years and others depending on groundwater entirely even during wet years. Generally speaking, surface water is more abundantly and reliably available in the southern/western portions of the valley, where precipitation totals are high and the number of tributaries flowing down from the surrounding hills are greater in number relative to the northern/eastern portions of the valleys. For ranching and other activities, there is a variety of irrigation types and water sources that facilitate conjunctive use in the Sierra Valley, with a wide array of diversions, conveyance channels, and irrigation ditches in existence throughout the valley, as described in Section 2.2.1.5.

Existing conjunctive use programs include the reuse of treated wastewater from the Loyalton wastewater treatment system (originates as GW from Loyalton's wells mostly) to irrigate alfalfa fields. Construction of ponds on certain parcels and efforts to improve recharge by property owners (i.e., through construction of on-contour swales to infiltrate sheet flow runoff) are also present in the valley and along the valley periphery. Work with US Forest Service to improve upland recharge through improved forest management is also another example of a potential recharge action.

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[8] DWR (2016), Conjunctive Management and Groundwater Storage – A Resource Management Strategy of the California Water Plan. https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/California-Water-Plan/Docs/RMS/2016/08_ConjMgt_GW_Storage_July2016.pdf

[9](groundwater irrigation demand = total irrigation demand – surface water irrigation supply

Perhaps the greatest opportunity for conjunctive use in the SV Subbasin is optimization of storage of water in Frenchman Lake (reservoir) during the wet season and years of above-average precipitation and strategic use for surface irrigation and recharge in the SV Subbasin during the dry season, especially during years of below average precipitation. Such optimization would require the GSAs of the SV Subbasin to work together with DWR on revising the Frenchman Dam operating policy within State Water Project requirements.

Over the course of the implementation of this Plan, the GSAs of the SVGMD will strive to optimize conjunctive use strategies to maximize groundwater recharge and minimize agricultural demand for groundwater. A comprehensive approach to conjunctive water management will include: improved monitoring, ongoing evaluation of monitoring data, and use of monitoring data to inform management actions.

2.1.2.4 Incorporating Existing Water Resources Monitoring and Management Programs to the GSP

The existing monitoring programs and networks provide data to be used to characterize current conditions in the Sierra Valley as described in Section 2.2.2. The existing monitoring programs and networks will be expanded as described in Section 3.5.4 to ensure groundwater and related conditions can be adequately monitored and documented. Existing water resources management programs will also be continued and strengthened in concert with the implementation of this GSP through an integrated effort between local districts, agencies, etc., and relevant state entities. No conflicts are expected to arise between monitoring and/or management programs as a result of the implementation of the GSP.

2.1.2.5 Limits to Operational Flexibility from Existing Water Resources Monitoring and Management Programs

The existing monitoring and management programs described above are not expected to limit the operation flexibility of this GSP.

2.1.3 Land Use Elements or Topic Categories of Applicable General Plans *(Reg. § 354.8 f)*

Per Reg. § 354.8(f), this section includes:

- Summary of general plans and other land use plans
  - Information could include crop types and acreages, urban land designation, and identification of open spaces.
- Description of how implementation of the land use plans may change water demands or affect achievement of sustainability and how the GSP addresses those effects
- Description of how implementation of the GSP may affect the water supply assumptions of relevant land use plans
- Summary of the process for permitting new or replacement wells in the basin
- Information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management

2.1.3.1 Summary of General Plans and Other Land Use Plans

All cities and counties are required by State law to prepare and periodically update general plans. General plans are intended to guide growth in light of sensitive resources—both human and natural—and available services. Specifically, Government Code Section 65031.1 provides growth be guided by a general plan with goals and policies directed to land use, population growth and distribution, open space, resource preservation and utilization, air and water quality, and other physical, social, and economic factors. Sierra Valley Watershed is subject to county general plans, except the federally owned lands within the Sierra Valley Watershed. The process to update general plans involved extensive public review and environmental review under the California Environmental Quality Act (CEQA).

Plumas County's General Plan objectives are to identify and protect for present and future utilization of commercially viable resource production areas with safeguards for the surrounding lands and the environment. It is also used to establish land use patterns based on constraints and opportunities with intensity and density of development tied largely to the availability of public facilities and services.

Sierra County's General Plan objective is to protect existing qualities and address local concerns as Sierra County grows. Plan objectives and fundamental goals of the General Plan are as follows:

- It is the county's most fundamental goal to maintain its culture, heritage, and rural character and preserve its rural quality of life.
- It is the county's goal to defend its important natural features and functions; these have included and always will include scenic beauty, pristine lakes and rivers, tall mountain peaks and rugged forested canyons, abundant and diverse plants and animals, and clean air, water, and watershed values.
- It is the county's goal to foster compatible and historic land uses and activities which are rural and which contribute to a stable economy.
- It is the county's goal to direct development toward those areas already developed, where there are necessary public facilities, and where a minimum of growth inducement and environmental damage will occur. The pattern of land uses sought by the county is a system of distinct and cohesive rural clusters amid open land.
- It is the county's goal to provide a comprehensive plan for all lands and uses within the county regardless of ownership or governmental jurisdiction.
- The previous mentioned objectives are carried out in detailed policies, implementation measures, land use diagram, and the overall theme of the General Plan, which is as follows:
    - Direct growth of the community influence and community core areas;
    - Discourage development outside these communities;
    - Create Special Treatment Areas where a more detailed level of planning is needed due to resources or constraints in these areas;
    - Utilize optional general plan elements to emphasize protection of the environment and economic value of the County's resources;
    - Protect the county's natural resource-based industries; and
    - Limit extension of county services outside the Community Core and Community Influences Areas to reduce fiscal impacts and protect the environment and economic value of the county's resources.

Other relevant General Plans and/or Land Use Plans include:

- City of Loyalton General Plan (2008)

- Plumas National Forest Land and Resource Management Plan (1988)
- Tahoe National Forest Land and Resource Management Plan (1990)

2.1.3.2 Description of How Land Use Plan Implementation May Change Water Demands or Affect Achievement of Sustainability and How the GSP Addresses Those Effects

No land use plans have been identified which are considered likely to significantly affect water demands or achievement of sustainability in the SV Subbasin. Should any such plans be identified in the future, they will be added to the GSP in this section as well as discussion of coordination and other efforts that will seek to address such effects.

2.1.3.3 Description of How Implementation of GSP May Affect the Water Supply Assumptions of Relevant Land Use Plans

No land use plans have been identified which have water supply assumptions that are considered likely to be affected by implementation of this GSP. Should any such plans be identified in the future, they will be added to the GSP in this section as well as discussion of coordination and other efforts that will seek to prevent such effects or adjust the land use plan water supply assumptions accordingly.

2.1.3.4 Summary of Processes for Permitting New or Replacement Wells in the SV Subbasin

The process for permitting new wells in the SV Subbasin is governed by SVGMD Ordinance 18-01, which requires that all applications to construct wells in the SV Subbasin be reviewed and approved by SVGMD prior to permit issuance by Plumas or Sierra Counties and limits construction of new high-capacity wells where such construction would likely impact groundwater resources (e.g., within the “Restricted Area” as described in Section 2.2.4). SVGMD approved applications for which sufficient data is available which suggests construction and use of the proposed well will not adversely impact sustainability of groundwater management.

The process for permitting replacement wells is governed by the same ordinance. Replacement wells are typically permissible provided the proposed replacement well does not exceed the capacity of the well it is replacing, as documented by the well pumping rate capacity recorded on the well log by the well driller at the time of construction of the original well which is being replaced.

The aforementioned ordinance and a supplemental notice letter sent by SVGMD to the landowners of Sierra Valley shortly after passage of the ordinance addressed existing inactive wells in the valley. The ordinance/letter required resident to respond to the letter registering (i.e., providing the number of and information on) any existing inactive wells that may be present on their property, stated that failure to register inactive wells within the allotted timeframe would effectively forfeit the right for an owner to reactive an inactive well, and stated that reactivation of any inactive well would be subject to SVGMD approval. In doing so, SVGMD was able to complete their existing well database and bring the last remaining “unmanaged” potential groundwater extraction path under the control of the District (such that groundwater pumping capacity cannot be significantly increased without the knowledge and approval of SVGMD).

2.1.3.5 Information Regarding the Implementation of Land Use Plans Outside the SV Subbasin that could Affect the Ability of the GSAs to Achieve Sustainable

No land use plans outside the SV Subbasin have been identified which are thought to have the ability to significantly affect the GSAs ability to achieve sustainable groundwater management in the SV Subbasin. Should any such plans be identified in the future, they will be added to this Plan Concept Document here as well as discussion of coordination and other efforts that will seek to prevent such effects.

2.1.4 Additional GSP Elements *(Reg. § 354.8 g)*

Per Reg. § 354.8(g), this section includes information on:

- Control of saline water intrusion
- Wellhead protection
- Migration of contaminated groundwater
- Well abandonment and well destruction program
- Replenishment of groundwater extractions
- Conjunctive use and underground storage
- Well construction policies
- Groundwater contamination cleanup, recharge, diversions to storage, conservation, water recycling, conveyance, and extraction projects
- Efficient water management practices
- Relationships with State and federal regulatory agencies
- Land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity
- Impacts on groundwater dependent ecosystems

2.1.4.1 Control of Saline Water Intrusion

Control of saline water intrusion is not applicable in the Sierra Valley due to its elevation above and distance from saline water sources.

2.1.4.2 Wellhead Protection

Minimum wellhead protection requirements for wells in the SV Subbasin is as described in the California Well Standards (Bulletin 74).

2.1.4.3 Migration of Contaminated Groundwater

With the limited data available, it is difficult to characterize or quantify the migration of contaminated groundwater in the SV Subbasin. Based on the most recent and comprehensive study on groundwater quality in the SV Subbasin (Bohm, 2016b), it is apparent that faulting in the valley significantly affects groundwater flow in several areas, largely by creating northeast and northwest trending groundwater migration zones. Bohm (2016b) also elucidated the primary sources of contaminated groundwater as being thermal waters associated with this faulting, especially in the central west part of the valley. In the event of groundwater contamination, migration of that contaminated groundwater would therefore likely be the highest risk in the vicinity of these faults. See additional information and discussion on water quality in Sections 2.2.1.4 and 2.2.2.4.

2.1.4.4 Well Abandonment and Well Destruction Program

Well abandonment and well destruction in the Sierra Valley is per the requirements described in the California Well Standards (Bulletin 74). Sierra and Plumas Counties have well abandonment and destruction requirements included in their respective codes as well.

2.1.4.5 Replenishment of Groundwater Extraction

Replenishment of groundwater extraction is by efforts to improve recharge through various projects and measures, include restoration projects and erosion control measures. Other forms of replenishment include water conservation efforts which reduce groundwater pumping thereby contributing to replenishment of the SV Subbasin aquifer system. Subsequent sections of this Plan Concept Document discuss these various replenishment efforts in greater detail.

2.1.4.6 Conjunctive Use Programs and Underground Storage

Several conjunctive use programs exist in Sierra Valley, as described in Section 2.1.2.3. Underground storage also exists. Based on best available data, it is expected that the majority of underground water storage in the SV Subbasin is for domestic/fire purposes at private residences for which public water access is not available. Such storage is typically in poly or precast concrete tanks ranging in size from a few thousand to several thousand gallons.

2.1.4.7 Well Construction Policies

The well construction policy which governs well construction in Sierra Valley is the California Well Construction Standards (Bulletin 74). Sierra and Plumas Counties have well construction requirements included in their respective codes as well. Additionally, SVGMD passed an ordinance (Ordinance 18-01) requiring that all applications to construct wells in the SV Subbasin be reviewed and approved by SVGMD prior to permit issuance by the county and limiting construction of new high-capacity wells where such construction would likely impact groundwater resources, as described in Sections 2.1.3.4 and 4.1.

2.1.4.8 Groundwater Contamination Cleanup, Recharge, Diversions to Storage, Conservation, Water Recycling, Conveyance, and Extraction Projects

Groundwater cleanup activities in Sierra Valley are described in Section 2.2.2.4.6. Industry, fuel storage, and other activities that are likely to cause groundwater contamination requiring cleanup are relatively sparse in the Sierra Valley.

Recharge projects have been a primary focus of SVGMD since the start of implementation of SGMA in the SV Subbasin. A detailed study (Bachand and Associated, 2019) was conducted exploring opportunities for improving recharge, including potential for pilot studies, possibility of groundwater injection, and more. Recharge research and efforts to identify and leverage opportunities to improve recharge are ongoing, as described in Section 4.

Diversion to storage in the Sierra Valley is limited. There are a handful of ranches on the periphery of the valley which have constructed ponds for various purposes, but none with significant storage capacity.

Conservation efforts in the Sierra Valley are extensive. Sierra Valley are extensive. Over 30,000 acres of private land in Sierra Valley are protected with conservation easements that conserve ranching and its culture and the valley’s extraordinary ecological richness, primarily thanks to efforts by the Feather River Land Trust. Water conservation efforts include research on and support efforts for switching traditional irrigation systems to higher efficiency irrigation technologies (i.e., LESA/LEPA technologies). Other efforts for water conservation include agricultural residents of the Valley exploring possibilities for changing agricultural business frameworks to reduce water demand, i.e., by switching to production of crops with lower water demand, etc.

Water recycling projects include the Loyalton Wastewater Treatment Plant effluent recycling project and the Loyalton Biomass Plant effluent recycling project, as described in Section 2.1.2.3 of this Plan. The broad use of onsite wastewater treatment systems (a.k.a. septic systems) that exists in the Sierra Valley (only Loyalton has a sewer system and centralized wastewater treatment system, while the rest of the valley's population is on septic systems; Beckwourth also has a centralized wastewater treatment system, but no information on the system could be found) could also be considered a form of water recycling, given all domestic/commercial water that is used in the valley at properties with such systems is returned back into the groundwater system via leachfield dispersal. This practice also enables the recycling of nutrients in some circumstances (i.e., through nutrient uptake by plants from shallow groundwater with which leachfield percolate mixes), but is also a primary water quality impairment concern, as described in Section 2.2.2.4.

Water conveyance in the Sierra Valley is via a series of channels, canals, and ditches, both natural and manmade, as described in detail in Section 2.2.1.1.

No groundwater extraction projects, other than typical residential/commercial/public well drilling, are known to be occurring or expected to occur in the Sierra Valley.

2.1.4.9 Efficient Water Management Practices

Efficient water management practices in Sierra Valley include conjunctive use practices as described in Section 2.1.2.3, irrigation efficiency practices as described in Section 4.1, and typical water efficiency practices implemented in all new residential, commercial, and industrial construction throughout the valley as required by the California Plumbing, Building, and Residential Codes.

2.1.4.10 Relationships with State and Federal Regulatory Agencies

Relationships between SVGMD and state and federal regulatory agencies in Sierra Valley are relatively limited. The relationships are monetary (charging management charge to state/federal landowners) and managerial (ensuring groundwater extraction on federal and state lands comply with SVGMD management policies). Other aspects of the relationships include coordination as needed for property access, collaborative projects, etc.

2.1.4.11 Land Use Plans and Efforts to Coordinate with Land Use Planning Agencies to Assess Activities that Potentially Create Risks to Groundwater Quality or Quantity

Applicable land use plans are those described in Section 2.1.3. Efforts to coordinate with the planning agencies (Plumas and Sierra Counties, City of Loyalton) include the development of the SV GSP (SVGMD and Plumas County collective effort) and the Joint Powers Agreement between the counties and SVGMD.

2.1.4.12 Impacts on Groundwater Dependent Ecosystems

As described in DWR's reprioritization documentation (DWR, 2019a), several monitoring wells adjacent to wetlands and streams are showing significant declines that could be impacting the largest freshwater marsh in the Sierra Nevada Mountains. The dependence of the marsh ecosystems on the deep aquifer that is primarily being impacted by groundwater extraction is likely relatively minimal, based on past studies and knowledge of the aquifer system as described in Section 2.2. More information on impacts on groundwater dependent ecosystems is provided in Section 2.2.2.7 of this Plan Concept Document. More detailed studies on this topic are needed, as described in Sections 2.2.1.6 and 3.5.4.

2.1.5 Notice and Communication *(Reg. § 354.10) [not for review/ to be developed further]*

Per Reg. § 354.10, this section includes:

- Description of beneficial uses and users in the basin
- A Communications Section that describes:
  - Decision-making processes
  - Public engagement opportunities
  - Encouraging active involvement
  - Informing the public on GSP implementation progress

Stakeholder communications and engagement have been carried out by SVGMD in accordance with the Stakeholder Communication and Engagement Plan (CE Plan) included as Appendix G. As described in the CE Plan, the central objective of the CE Plan is to provide a framework and identify tools to engage stakeholders in current and future SGMA activities in the SV Subbasin. A list of public meetings at which the Plan was discussed or considered by the GSAs is included as Appendix C. A list of comments regarding the Plan received by the GSAs and responses provided by the GSAs is included as Appendix F. Beneficial uses and users of groundwater in the SV Subbasin, a description of the GSAs decision-making process, and additional communication information is provided below.

2.1.5.1 Beneficial Uses and Users

2.1.5.2 Decision-Making Processes

2.1.5.3 Public Engagement Opportunities

[to be updated to describe TAC and current process]

2.1.5.4 Encouraging Active Involvement

2.2 Basin Setting

2.2.1 Hydrogeologic Conceptual Model *(Reg. § 354.14)*

A hydrogeologic conceptual model (HCM) is a framework for understanding how water moves into, within, and out of a groundwater basin and underlying aquifer system. According to the California Department of Water Resources (DWR), the HCM fundamentally provides [DWR, 2016]:

- *An understanding of the general physical characteristics related to regional hydrology, land use, geology and geologic structure, water quality, principal aquifers, and principal aquitards of the basin setting*
- *Context to develop water budgets, mathematical (analytical or numerical) models, and monitoring networks*
- *A tool for stakeholder outreach and communication*

All groundwater sustainability plans (GSPs) are required to include an HCM (23 CCR §354.14) that contains the following information:

- *Regional geologic and structural setting*
- *Basin boundaries*
- *Principal aquifers and aquitards*
- *Primary use or uses and general water quality for each principal aquifer*
- *At least two (2) scaled geologic cross sections*
- *Physical characteristics (e.g., topography, geology, soils, etc.)*

Development of a basin HCM is an iterative process as data gaps (see Monitoring Network and Data Gaps Analysis technical memo, Appendix X) are addressed and new information becomes available.

Several geologic and water resource studies have been conducted in Sierra Valley since the 1960's. A detailed review of all previous work is beyond the scope of this report, but all relevant information was reviewed during development of the Sierra Valley HCM. The sections below summarize information pertinent to HCM development.

2.2.1.1 Physiography

Sierra Valley is a large sub-alpine valley located in the eastern Sierra Nevada Mountains in the northern portion of the Sierra Nevada geomorphic province of California and drains nearly 374,000 acres. The groundwater basin is about 125,900 acres and comprised of the Sierra Valley (5-012.01) and Chilcoot (5-012.02) subbasins. Although the Chilcoot subbasin is currently designated as very low priority by DWR and therefore not required to have a GSP, it has been included in this Plan.

The valley is surrounded by steep mountains and alluvial fans with various slope gradients. Elevations in the watershed range between 4,854 feet above mean sea level (amsl) in the valley floor to 8,740 feet amsl at Babbit Peak in the southeastern mountains (Figure 2.2.1-1). The valley floor is a relatively flat Pleistocene lakebed, with a zero to five percent slope gradient. Volcanic outcrops disrupt the flat topography in various locations throughout the valley.

Figure 2.2.1-1 Sierra Valley Subbasin Topography

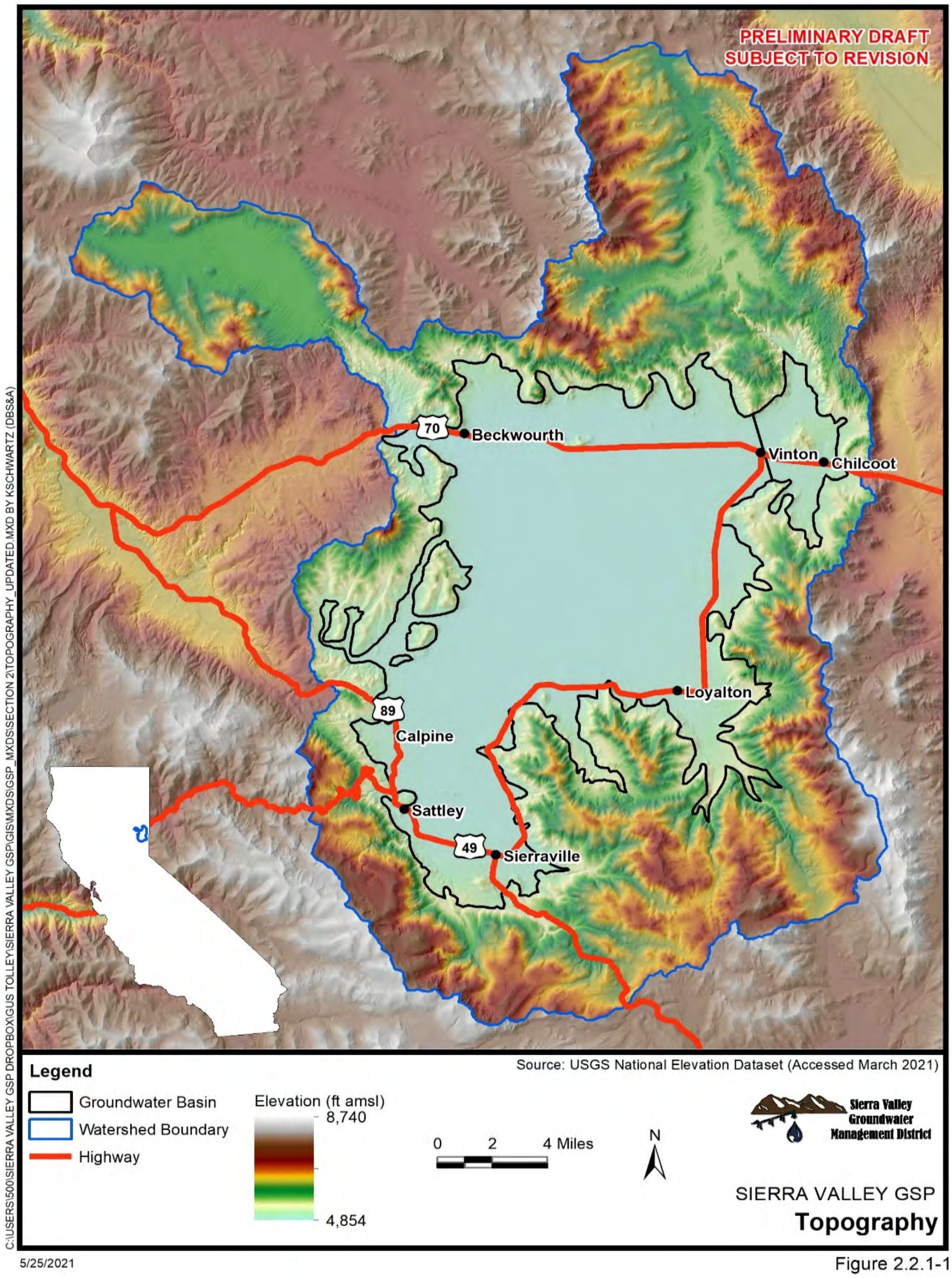

Figure 2.2.1-1

Stream channels cutting through the steep slopes of the surrounding mountains drain precipitation and snowpack into the Sierra Valley and seasonally connect to the headwaters of the Middle Fork Feather River (MFFR) (Figure 2.2.1-2).

2.2.1.2 Climate

Climate in Sierra Valley watershed is strongly correlated with elevation. The higher elevations receive the greatest amount of precipitation (Figure 2.2.1-3) and are cooler (Figure 2.2.1-4).

The watershed experiences more precipitation in the west due to the “rain shadow effect” caused by the Sierra Nevada Mountains. Moist air masses moving eastward off the Pacific Ocean rise as they encounter the Sierra Nevada slopes, the rising air cools, and water vapor condenses and falls as rain or snow. As air masses descend the eastern slope, the descending air warms, clouds evaporate, and precipitation declines east of the Sierra Nevada. The combination of topography and the “rain shadow effect” results in highly variable precipitation in the watershed. Sierra Valley also becomes drier northward.

Long-term total mean annual precipitation (1981-2010) in the watershed ranges from 62.4 inches in the southwest mountain slopes to 13.6 inches in the eastern part of the Chilcoot Sub-Basin (PRISM Climate Group, n.d.). On average, most areas of the Sierra Valley watershed receive approximately 15 to 20 inches of precipitation per year. Most precipitation falls during the winter months, with 77% of the annual total received between November and March and less than 5% accounted for during summer months.

Long term averages of total mean annual temperatures (1981-2010) range from 40.4°F in the mountain slopes in the southwest portion of the watershed to 48.5°F in the eastern part of the basin. Monthly averages are lowest from December through February and highest in July and August (PRISM Climate Group, n.d.). In addition to high elevations, cold continental air masses moving west from the Great Basin create cold winter temperatures and a short growing season in Sierra Valley. Data collected at the Sierraville Ranger Station (elevation 4,190 feet above amsl), show freezing temperatures typically occur from September until May, while some surrounding higher elevations experience freezing temperatures throughout the year. Growing season of the valley floor is approximately 60 to 90 days and shortens considerably in the mountainous regions to the west and south of the valley.

In this high elevation valley, snow tends to stay on the ground for long periods. Sierraville Ranger Station shows January has the highest monthly average snowfall at approximately 17.9 inches, and average annual snowfall of approximately 71.8 inches. The average snow depth measured in Sierraville is 5 to 6 inches in January and consistently greater than two inches from December through April.

2.2.1.3 Vegetation and Land Use

The majority of the Sierra Valley subbasin is private land, while the surrounding watershed is primarily National Forest. Approximately 1,200 plant species representing 18% of California’s flora are found in Sierra Valley (NRCS, 2016). Vegetation overlying the watershed is a mix of desert and semi-arid desert, agricultural, forest and woodland, and shrub and herb classification types (Figure 2.2.1-5).

On the valley floor, alfalfa grown for hay is the dominant irrigated crop. Braided streams and agricultural irrigation support wetland and riparian communities. The western valley supports approximately a 20,000-acre wetlands complex and 30,000-acre meadow complex, both the largest in the Sierra Nevada (NRCS, 2016). Bulrushes grow in anaerobic soil conditions in the larger wetlands, whereas sedges and rushes thrive in the fringes and smaller wetlands. Willows and other riparian vegetation grow along the streams and canals in the Sierra Valley (Vestra, 2005). The western portion of Sierra Valley contains vernal pools, which are seasonally flooded depressions with limited drainage due to an underlying hardpan soil layer (CDFG, 2003). Vernal pools typically support a specialized set of species (ie. Sierra Valley ivesia and Plumas ivesia) due to their seasonal cycle of filling in the winter, flourishing in spring, and drying out in summer. The pools are surrounded by rush dominated meadows. Grasslands and sagebrush scrub cover areas that have not been cultivated. Native grasses of the basin include Sandberg Bluegrass, Idaho fescue, various needlegrasses, and wildrye. Although colder temperatures of the Sierra Valley have helped prevent most invasive grass species from spreading, Cheatgrass is an invasive European grass found on the valley floor that poses a fire risk and out compete native species. Sagebrush scrub is more concentrated along the perimeter and in the eastern portion of the basin and includes big sagebrush, antelope bitterbrush, curlleaf mountain mahogany, and rubber rabbitbrush (Vestra, 2005).

Sagebrush scrub and juniper woodlands transition from the lower slopes and merge with the montane conifer forest species found covering the uplands. Coniferous forest cover approximately half of the Sierra Valley and are concentrated in the southwest slopes, where there is higher precipitation. Red fir forests in the highest elevations (6,000 to 9,000 feet) along the southwest watershed's border, white fir below (5,000 to 6,000 feet), greenleaf manzanita and snow brush in open, undisturbed areas. The Sierran mixed Conifer forest in the watershed includes white fir, ponderosa pine, sugar pine, incensed cedar, and Douglas fir (in certain areas above Calpin). The upland areas of the watershed also contain wet meadows, montane riparian aspen, and other hardwood vegetation types. Wildfires have burned 44,000 acres of upland vegetation within the watershed since 1994 (Vestra, 2005).

Climate, fire, invasive species, agriculture, timber harvest, and livestock have notably changed the composition of Sierra Valley watershed vegetation (Vestra, 2005).

2.2.1.4 Soils

Surficial soil data were obtained from the Natural Resources Conservation Service (NRCS) soil survey geographic (SSURGO) database. Areas of similar soils are grouped into map units, which have similar physical, hydrologic, and chemical properties. Map unit properties are assigned a range of values based on the soils contained within them.

Soils within the Sierra Valley Watershed vary considerably in productivity, depth, and use based on parent material, topography, and precipitation. A total of 2,499 unique soil map units were identified within the Sierra Valley watershed with 1,071 units overlying the groundwater basin. Figure 2.2.1-6 shows a general summary of these map units classified by soil type defined by the classified by the Unified Soil Classification System (USCS), with approximately 90% of the groundwater basin defined. Surface soil types within the groundwater basin are dominated by sands, clays, and silts (Table 2.2.1-1). Silty sands make up the largest fraction of surficial soils in the groundwater basin, accounting for about 41% of the surface area. Finer grained soil textures, such as silts and clays, make up approximately 37% of the surface area and are generally located adjacent to stream channels and wetland regions. The rest of the basin has either not been classified or is composed of relatively small fractions of mixed soils.

792 **Figure 2.2.1-2 Surface Water Features [preliminary to be updated]**

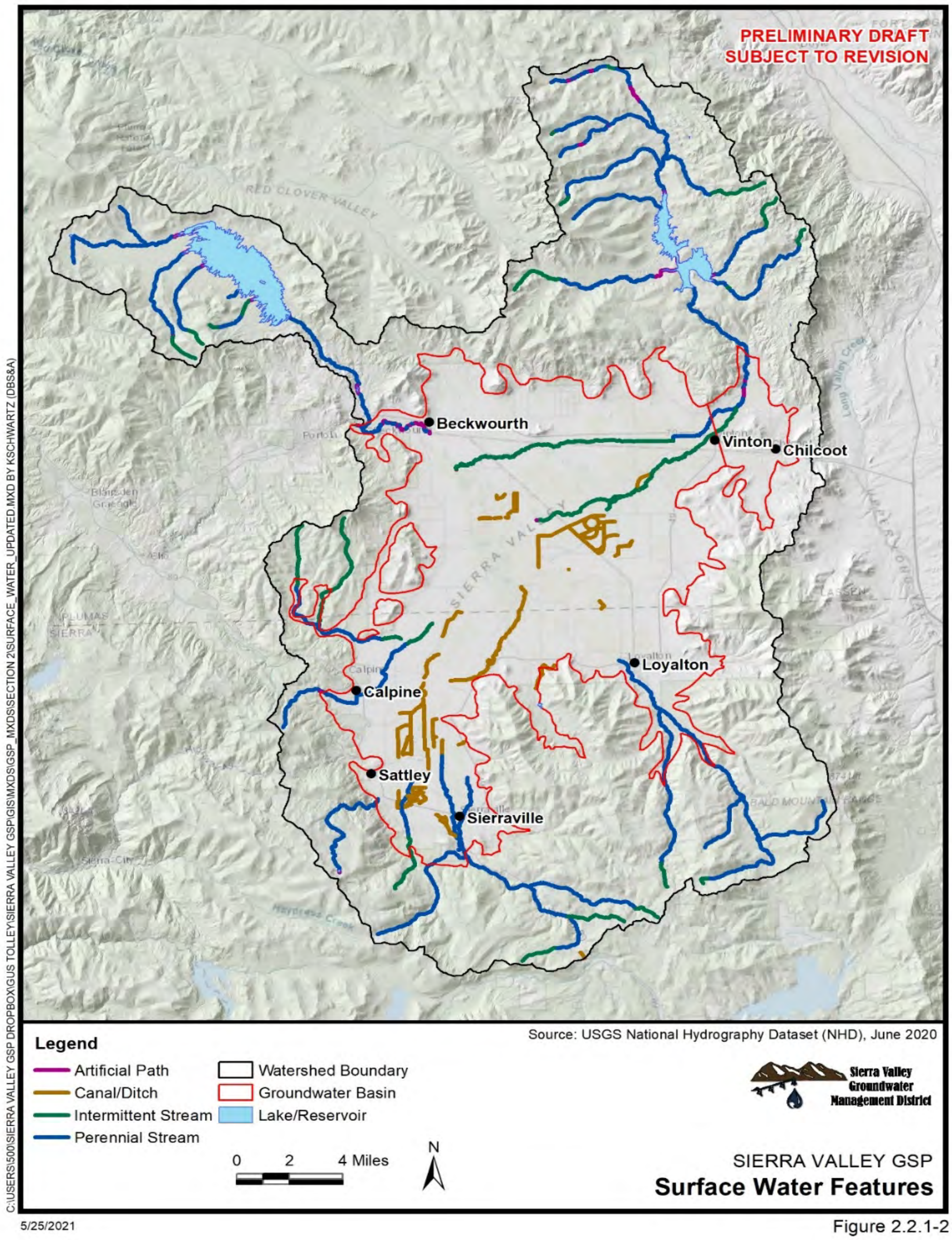

Figure 2.2.1-2

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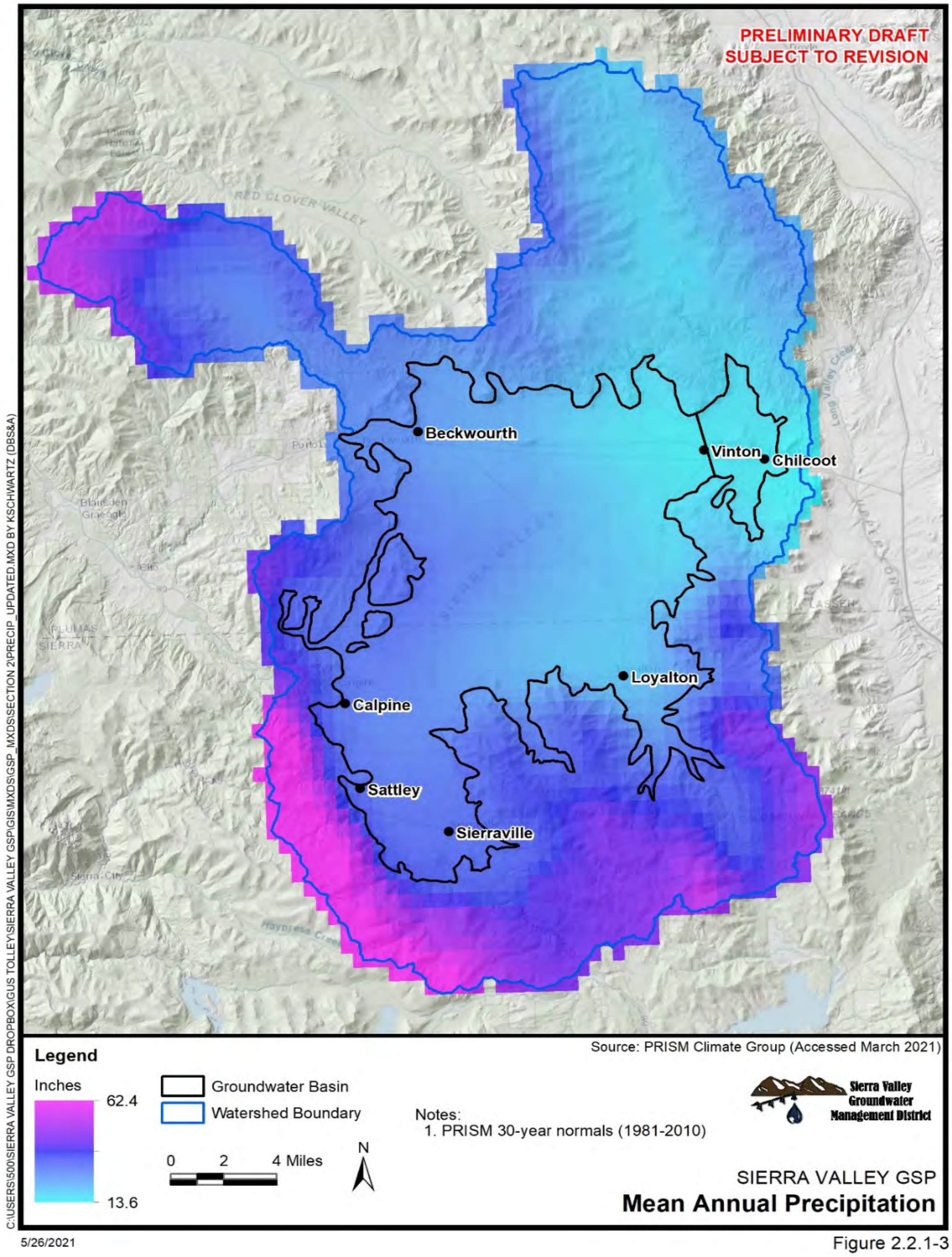
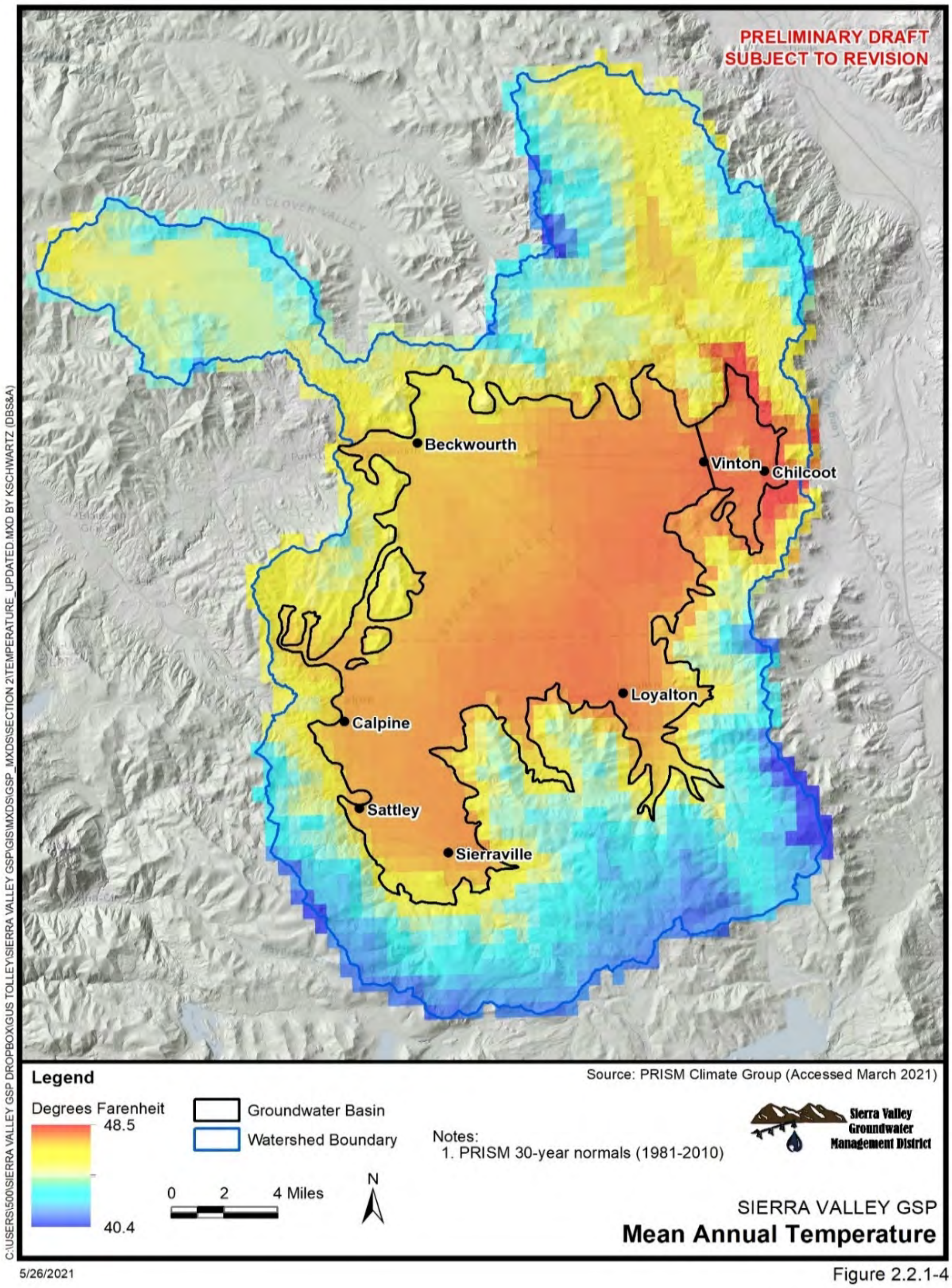
Figure 2.2.1-3 Mean Annual Precipitation



796 **Figure 2.2.1-4 Mean Annual Temperature**



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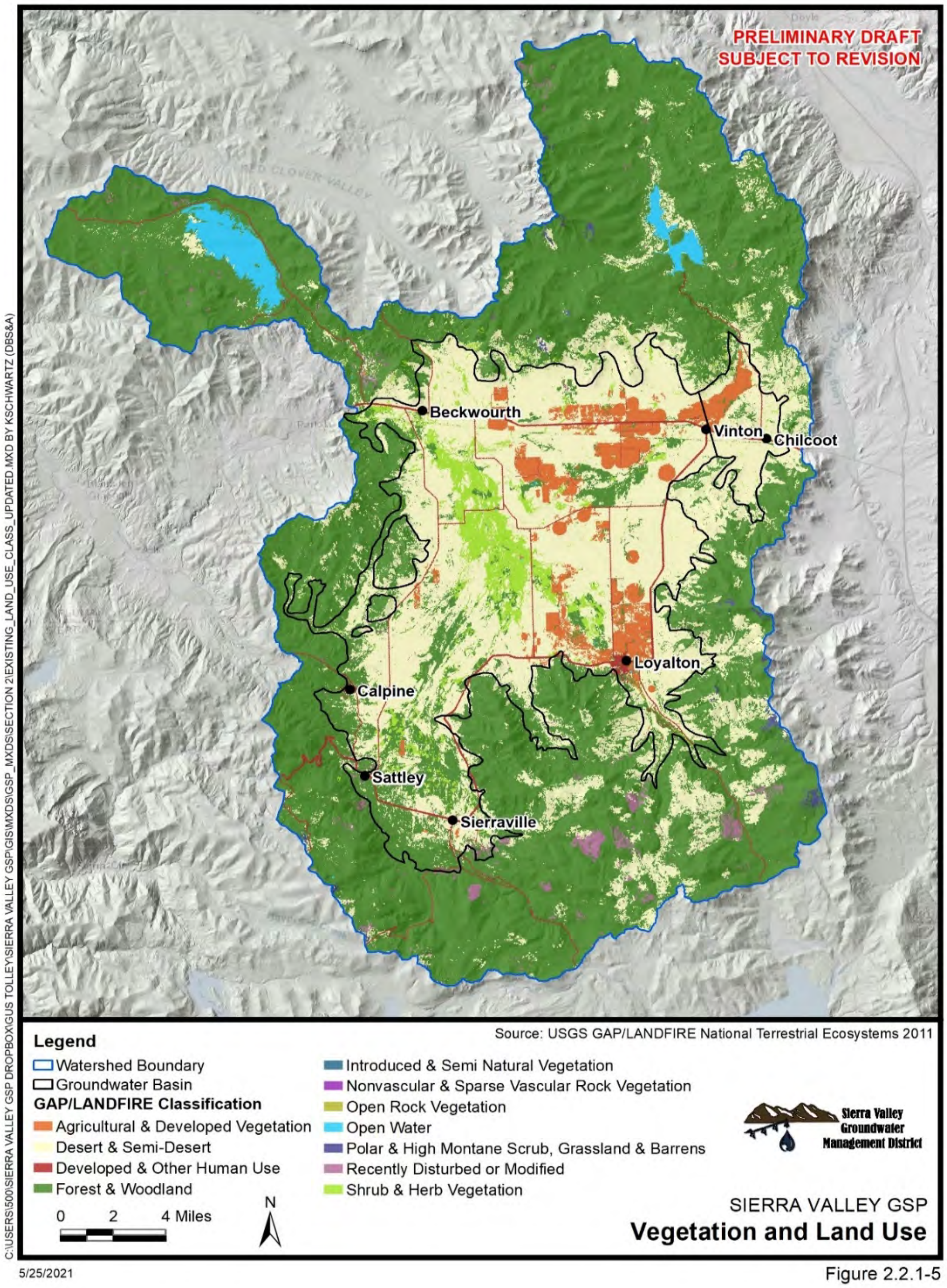
798 **Figure 2.2.1-5 Vegetation and Land Use**



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800 **Figure 2.2.1-6 Soil Types**

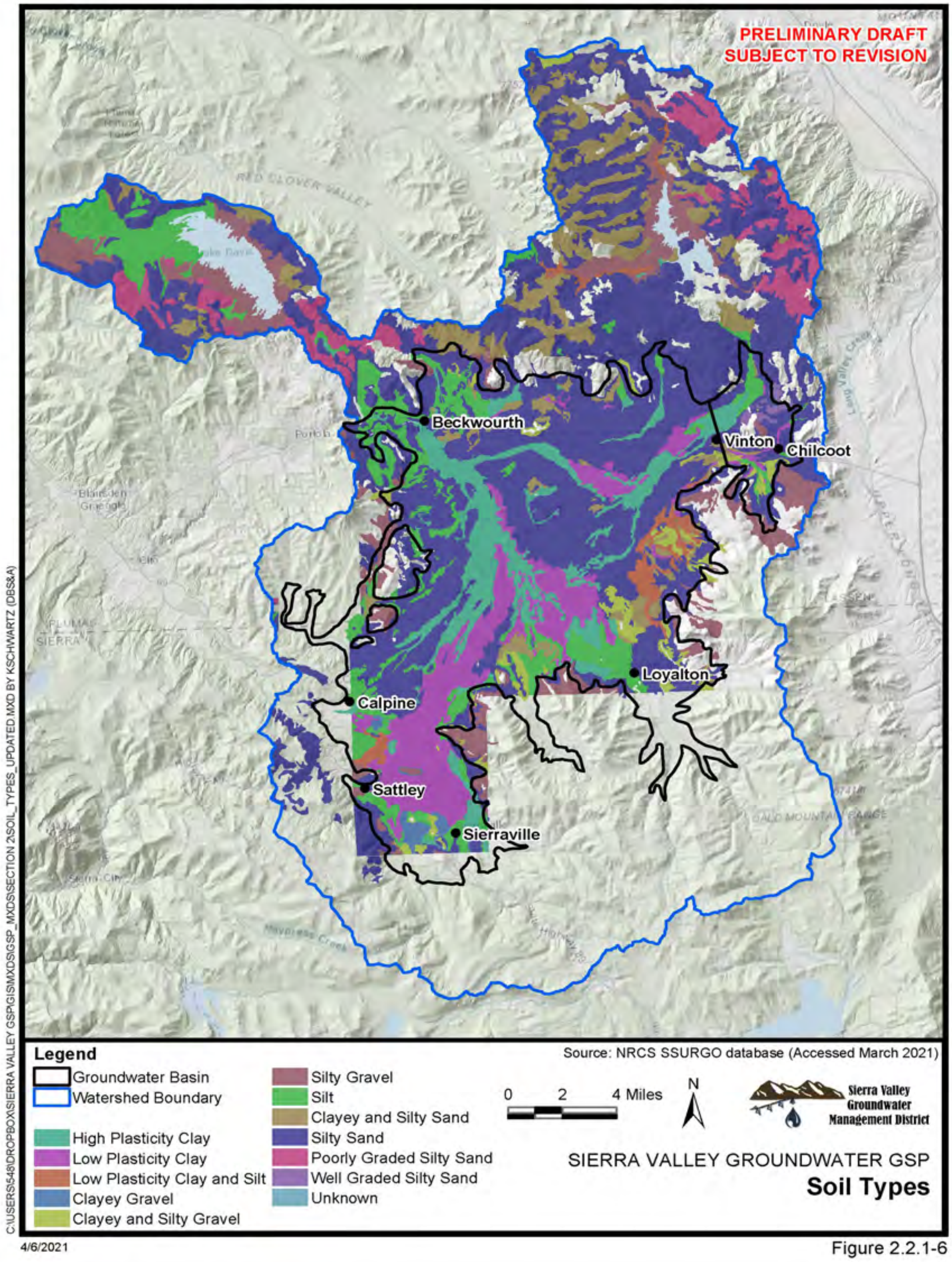

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Table 2.2.1-1 Summary of groundwater basin soil texture composition

Soil Type	Area (Acres)	Area (%)
Silty Sand	51,333.5	41.10
Low Plasticity Clay	17,549.4	14.05
High Plasticity Clay	15,751.2	12.61
Silt	13,276.0	10.63
Unknown	12,446.9	9.97
Clayey and Silty Sand	4,047.6	3.24
Clayey and Silty Gravel	4,012.0	3.21
Low Plasticity Clay and Silt	2,703.3	2.16
Silty Gravel	2,323.3	1.86
Clayey Gravel	1,058.6	0.85
Well Graded Silty Sand	400.4	0.32

Figure 2.2.1-7 shows the drainage class for soils in the watershed. Poorly drained soils are found primarily in areas of fine-grained sediments adjacent to stream channels and wetlands, where finer textured soils and shallow groundwater depths are found. Well-drained very stony soils underlain by hardpan approximately 10 to 20 inches below ground surface is found on terrace deposits around the western and southern rims of the valley. In general, soils located along the rim of the valley, where various alluvium soil types and lake terrace deposits exist, are excessively to moderately drained due to a combination of coarse soil textures and lack of a shallow water table. Soils found in the mountains surrounding are generally moderately to excessively drained soils that were derived from the various volcanic flows, tuffs, granitic rocks, and some metamorphic rocks found in the mountains.

Saturated soil hydraulic conductivity of surface soils in the groundwater basin ranges over four orders of magnitude from 0 to 40 ft/day (Figure 2.2.1-8). The lowest conductivity soils are generally located adjacent to stream channels and wetlands. The distribution of hydraulic conductivity values are similar to the distribution of soil textures in the groundwater basin, which is expected as coarser soil textures tend to have greater hydraulic conductivities. Saturated hydraulic conductivity within the groundwater basin generally exceeds 1 ft/day.

Soil salinity in the watershed ranges from non-saline to strongly saline (Figure 2.2.1-9). In general, the high elevation areas of the watershed and the western portion of the groundwater basin have non saline to very slightly saline soils due to the greater amount of precipitation received. Moderately to strongly saline soils are primarily found in the central basin and adjacent to the creeks and wetlands where the water table is shallowest.

Figure 2.2.1-7 Soil Drainage Class

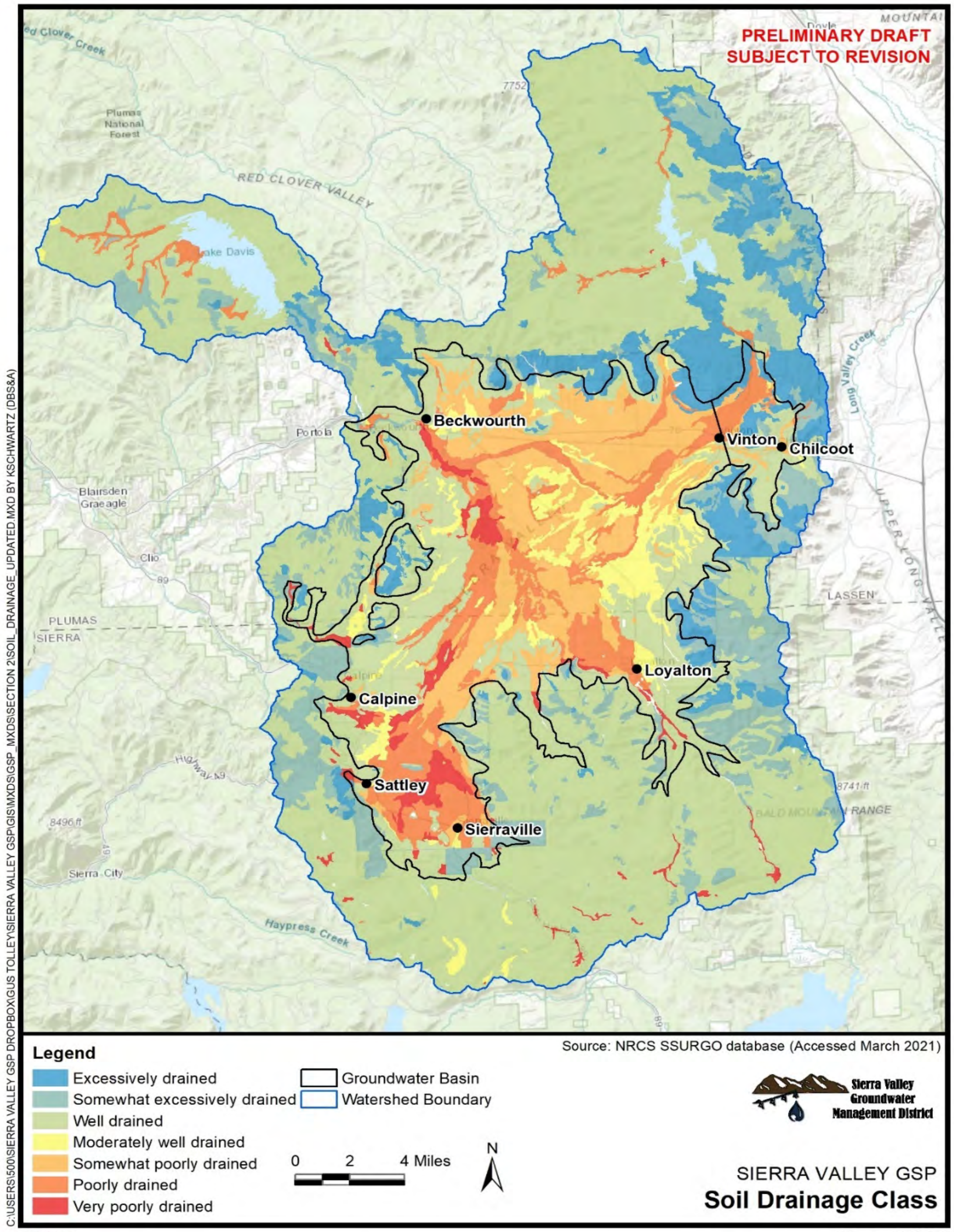
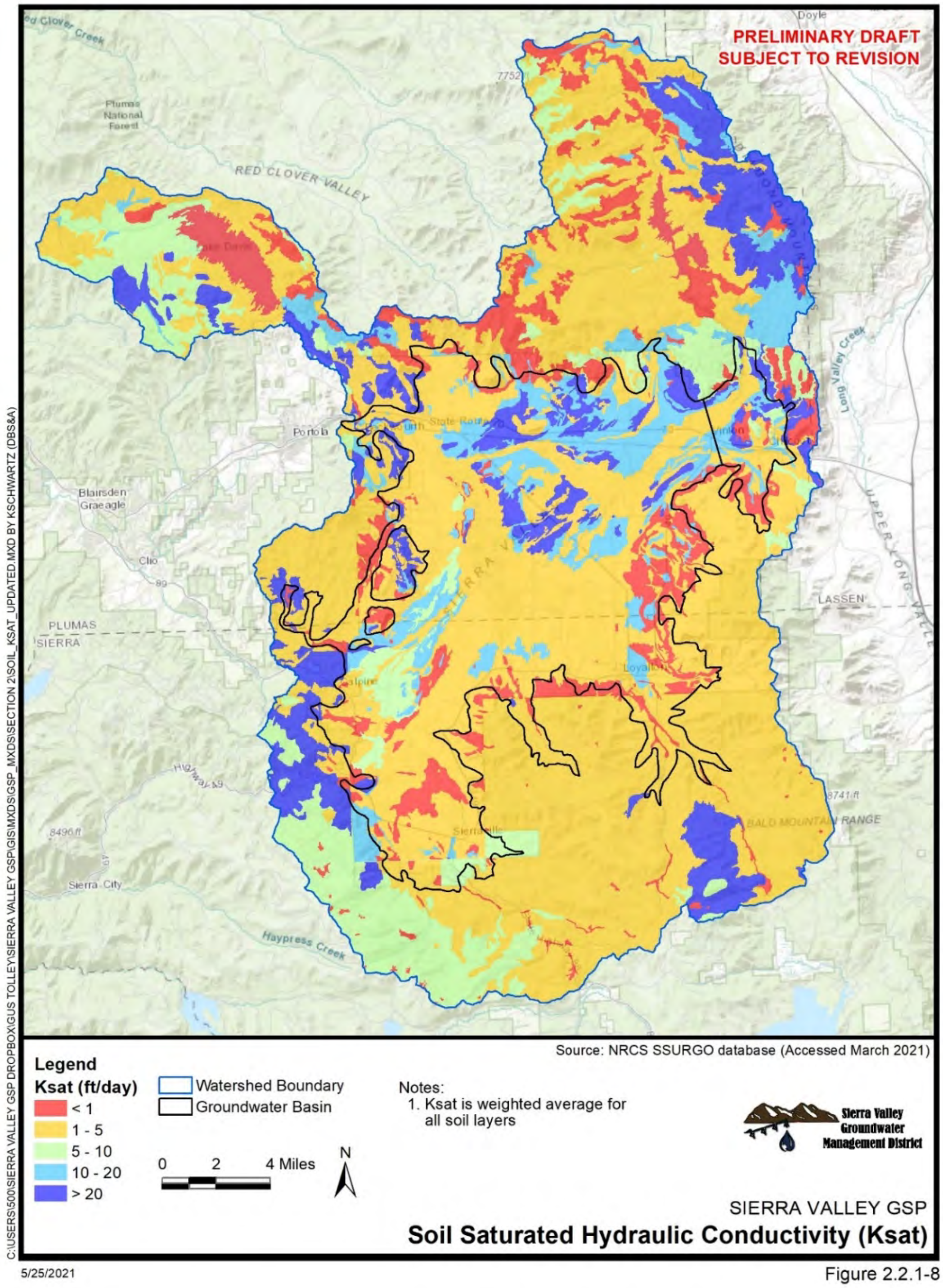


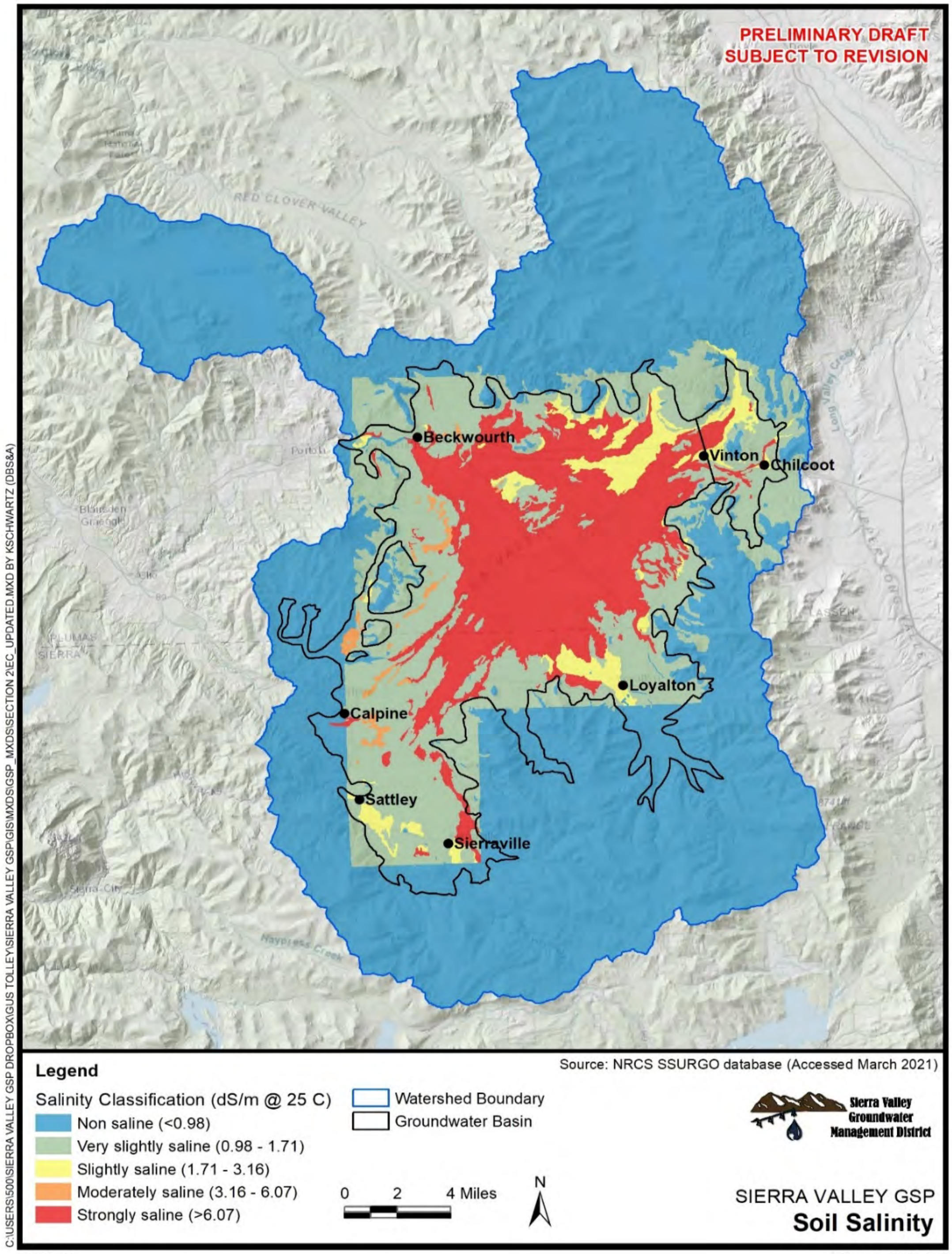
Figure 2.2.1-7

827 **Figure 2.2.1-8 Soil Saturated Hydraulic Conductivity**



828

829 **Figure 2.2.1-9 Soil Salinity**



830

2.2.1.5 Geology

Sierra Valley lies at the eastern edge of the Sierra Nevada Province, along the western edge of the Great Basin Province. The 400-mile-long Sierra Nevada mountain range trends north-northwesterly and is a west-dipping block of granitic and remnant metamorphic rocks. The geologic history of Sierra Valley is a complex mixture of orogenies, volcanism, rifting, faulting, and deposition. Figure 2.2.1-10 provides a spatial overview of Sierra Valley geology, and Figure 2.2.1-11 provides a stratigraphic overview interpreted by DWR (1963). Figures 2.2.1-12 depict generalized cross-sections of the Sierra Valley prepared by DWR (1963). Schmidt and Associates created several additional subsurface geologic cross-sections (Figure 2.2.1-13) showing more detail using electrical logs (Schmidt, 2003; Schmidt, 2005).

Sierra Valley subbasin is part of a down dropped fault block, or graben, surrounded by uplifted mountains, or horsts. The valley floor consists of an irregular surface of basement rock, formed by steeply dipping northwest and northeast-trending vertical, normal, and strike-slip faults. Throughout its geologic history, the fault trough floor gradually subsided, while being occupied by one or several lakes (Durrell, 1986). Lacustrine (lake), fluvial, and alluvial deposits were formed as sediments eroded from the surrounding uplands and volcanic tuffs (ash deposits) and filled the space created by the fault trough floor as it continued to subside.

Sierra Valley geologic units can be divided into three groups: 1) basement complex metamorphic and granitic rocks, 2) Tertiary volcanics, and 3) Quaternary sedimentary deposits of clay, silt, sand, and gravel. The following descriptions are summarized from DWR (1983).

The basement complex contains metamorphic rocks that represent volcanic rocks and sediments deposited and altered as a result of regional overthrusting and volcanism during a series of orogenic events between the Farallon plate and the North American plate. The basement complex consists of quartzite, slate, marble, and metavolcanics of Paleozoic to Mesozoic age. Although most of these rocks have since eroded away, they are still present in some locations such as the belt exposed on the east side of the valley. It is presumed that these rocks underlie some of the region now covered by Tertiary and Quaternary units. Subsequent subduction of the Farallon plate beneath the North American plate resulted in emplacement of Mesozoic Sierran granitic pluton intrusions into the basement metamorphic complex (country rock). Exposures of these granitic rocks occur along the northern and western edges of the valley, predominantly in the higher elevations, as part of the Sierran batholith of the Jurassic to Cretaceous age and underlie the majority of the basin. An exploratory drill hole in the middle of the valley encountered granitic rocks at a depth of 2,165 feet (DWR, 1983). These generally massive, crystalline, fractured rocks range in composition from quartz diorite to granite and are observed as rounded outcrops and some granitic pegmatite dikes.

A variety of Tertiary volcanic rocks were erupted as subduction continued, consisting of rhyolite, andesite, basalt, and pyroclastic flows. These rocks outcrop mainly in the upland areas surrounding the valley or as isolated buttes and low hills in the valley but are also present at depths within the valley according to drill logs. The basin is bounded to the north by Miocene pyroclastic rocks of Reconnaissance Peak, to the west by Miocene andesite, to the south and east by Tertiary andesite, and to the east by Mesozoic granitic rocks (DWR, 2004; Saucedo, 1992).

In Late-Pliocene time, faulting and erosion began to change the landscape toward its present shape (Berry, 1979). Lakes filled depressions and received sediment from the surrounding highlands. Plio-Pleistocene Lake Beckwourth filled Sierra Valley to a probable elevation of 5,120 feet above sea level (Berry, 1979). During the Pleistocene age, glaciers formed in the mountains south and west of Sierraville and contributed sediment and water to the lake.

878

Figure 2.2.1-10 Geology

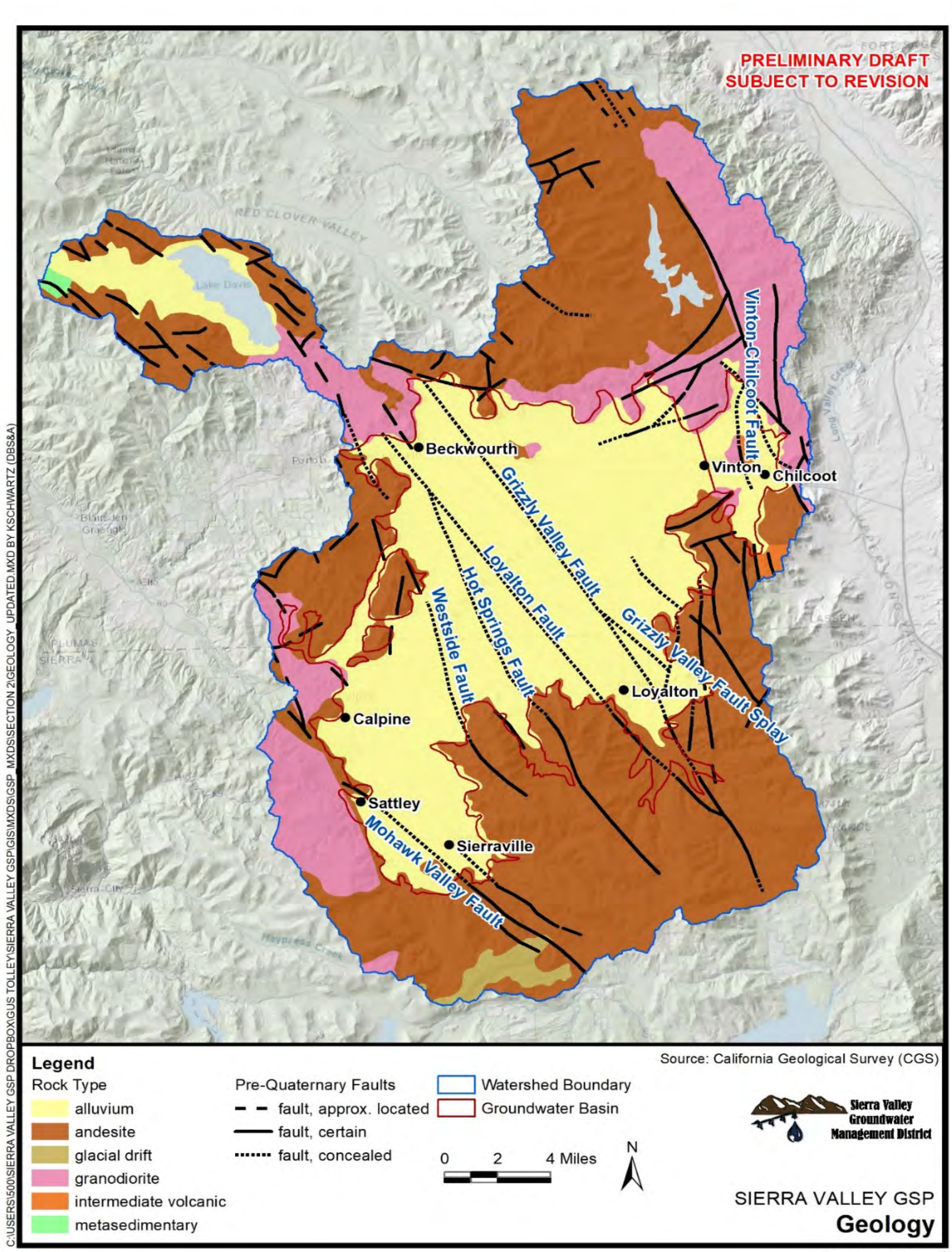


Figure 2.2.1-10

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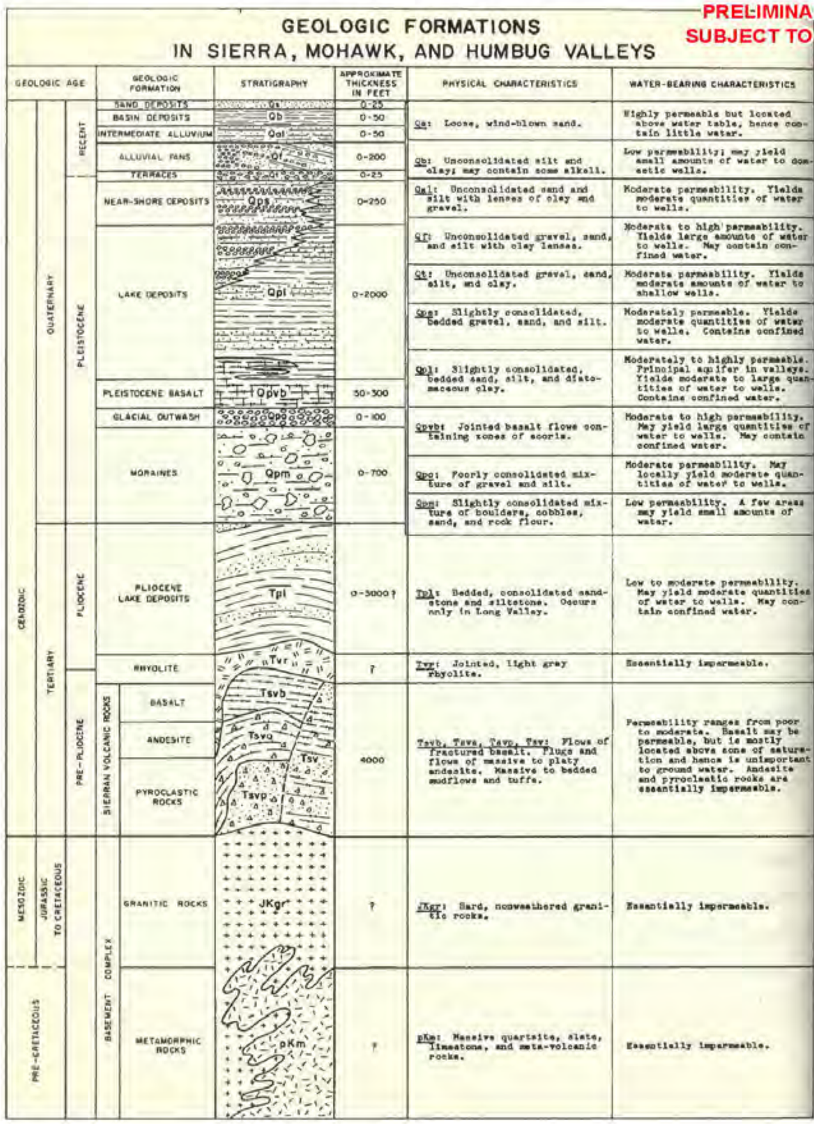
Figure 2.2.1-11 Stratigraphic Column of Sierra Valley



GEOLOGIC FORMATIONS
IN SIERRA, MOHAWK, AND HUMBUG VALLEYS

Geologic Age (Era)	Geologic Age (Period)	Geologic Age (Epoch)	Geologic Formation	Stratigraphy	Approximate Thickness in Feet	Physical Characteristics	Water-Bearing Characteristics
Cenozoic	Quaternary	Recent	Sand deposits	Qs	0-25	Qs: Loose, wind-blown sand.	Highly permeable but located above water table, hence contain little water.
Cenozoic	Quaternary	Recent	Basin deposits	Qb	0-50	Qb: Unconsolidated silt and clay; may contain some alkali.	Low permeability; may yield small amounts of water to domestic wells.
Cenozoic	Quaternary	Recent	Intermediate alluvium	Qal	0-50	Qal: Unconsolidated sand and silt with lenses of clay and gravel.	Moderate permeability. Yields moderate quantities of water to wells.
Cenozoic	Quaternary	Recent	Alluvial fans	Qf	0-200	Qf: Unconsolidated gravel, sand, and silt with clay lenses.	Moderate to high permeability. Yields large amounts of water to wells. May contain confined water.
Cenozoic	Quaternary	Recent	Terraces	Qt	0-25	Qt: Unconsolidated gravel, sand, silt, and clay.	Moderate permeability. Yields moderate amounts of water to shallow wells.
Cenozoic	Quaternary	Pleistocene	Near-shore deposits	Qps	0-250	Qps: Slightly consolidated, bedded gravel, sand, and silt.	Moderately permeable. Yields moderate quantities of water to wells. Contains confined water.
Cenozoic	Quaternary	Pleistocene	Lake deposits	Qpl	0-2000	Qpl: Slightly consolidated, bedded sand, silt, and diatomaceous clay.	Moderately to highly permeable. Principal aquifer in valleys. Yields moderate to large quantities of water to wells. Contains confined water.
Cenozoic	Quaternary	Pleistocene	Pleistocene basalt	Qpvb	50-300	Qpvb: Jointed basalt flows containing zones of scoria.	Moderate to high permeability. May yield large quantities of water to wells. May contain confined water.
Cenozoic	Quaternary	Pleistocene	Glacial outwash	Qpo	0-100	Qpo: Poorly consolidated mixture of gravel and silt.	Moderate permeability. May locally yield moderate quantities of water to wells.
Cenozoic	Quaternary	Pleistocene	Moraines	Qpm	0-700	Qpm: Slightly consolidated mixture of boulders, cobbles, sand, and rock flour.	Low permeability. A few areas may yield small amounts of water.
Cenozoic	Tertiary	Pliocene	Pliocene lake deposits	Tpl	0-3000?	Tpl: Bedded, consolidated sandstone and siltstone. Occurs only in Long Valley.	Low to moderate permeability. May yield moderate quantities of water to wells. May contain confined water.
Cenozoic	Tertiary	Pliocene	Rhyolite	Tvr	?	Tvr: Jointed, light grey rhyolite.	Essentially impermeable.
Cenozoic	Tertiary	Pre-Pliocene	Sierran volcanic rocks: Basalt; Andesite; Pyroclastic rocks	Tsvb; Tsva; Tsvp; Tsv	4000	Tsvb, Tsva, Tsvp, Tsv: Flows of fractured basalt. Plugs and flows of massive to platy andesite. Massive to bedded mudflows and tuffs.	Permeability ranges from poor to moderate. Basalt may be permeable, but is mostly located above zone of saturation and hence is unimportant to ground water. Andesite and pyroclastic rocks are essentially impermeable.
Mesozoic	Jurassic to Cretaceous		Basement complex: Granitic rocks	JKgr	?	JKgr: Hard, nonweathered granitic rocks.	Essentially impermeable.
Pre-Cretaceous			Basement complex: Metamorphic rocks	pKm	?	pKm: Massive quartzite, slate, limestone, and meta-volcanic rocks.	Essentially impermeable.

PRELIMINARY DRAFT
SUBJECT TO REVISION

Source: DWR (1963)

Sierra Valley Groundwater Management District

SIERRA VALLEY GSP
Stratigraphic Column of Sierra Valley

C:\USERS\548\DROPBOX\SIERRA VALLEY GSP\GIS\MXDS\GSP_MXDS\SECTION 2\STRAT COLUMN.MXD BY KSCHWARTZ (DBS&A)

4/7/2021

Figure 2.2.1-11

Figure 2.2.1-12 Generalized Cross Sections

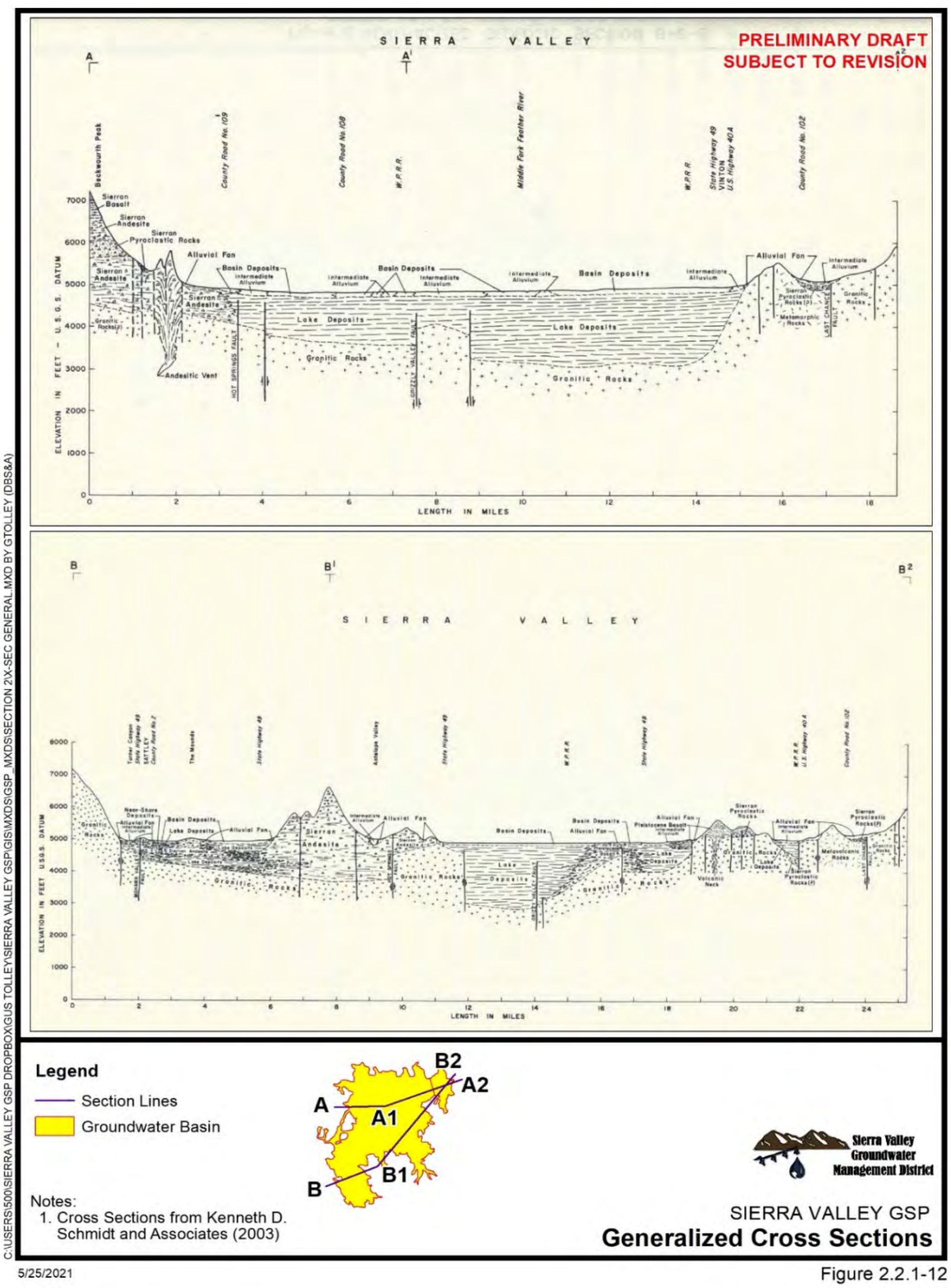
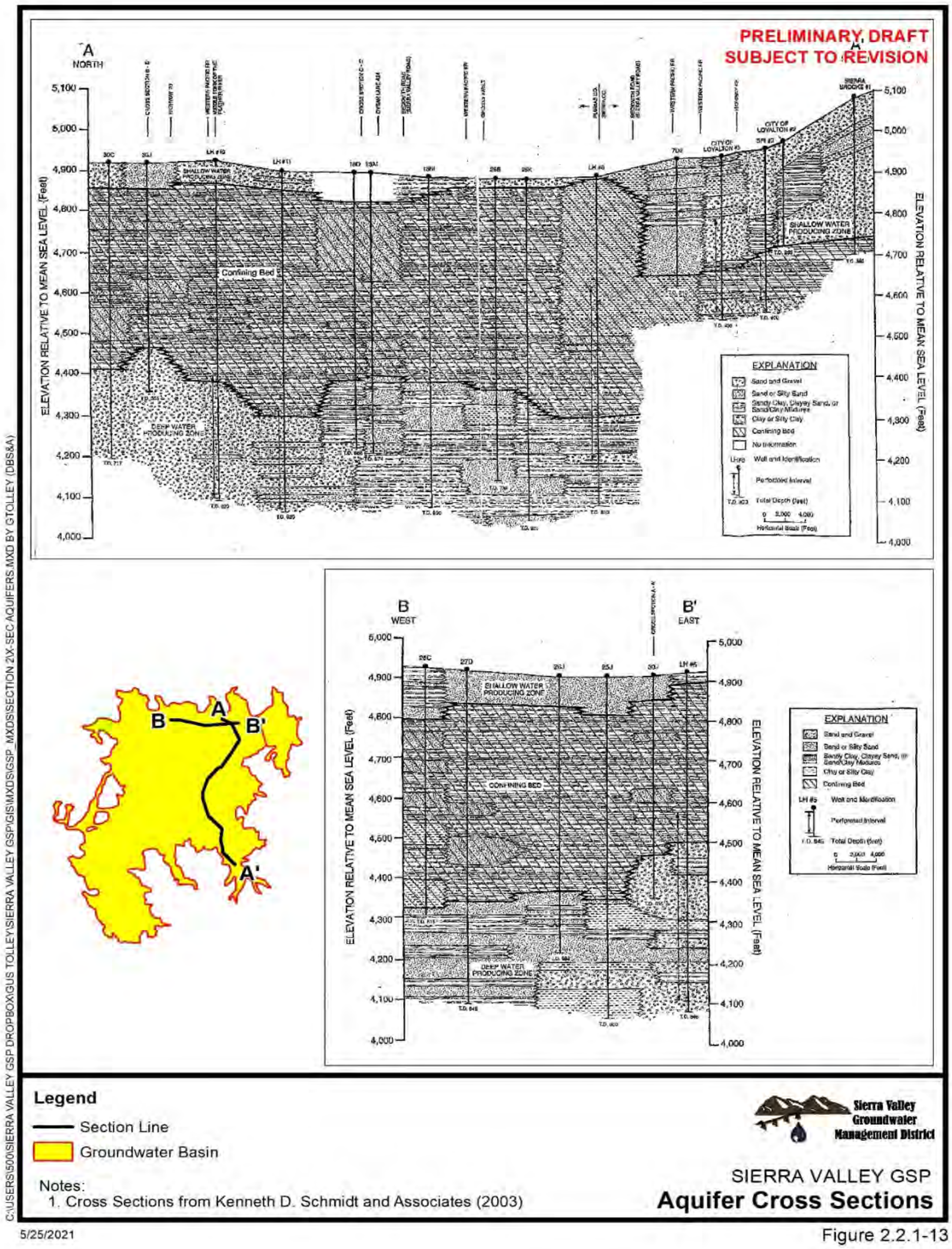


Figure 2.2.1-13 Aquifer Cross Sections



Approximately 10,000 years ago outflow from the lake eroded a gap to the west and slowly emptied, forming the present-day headwaters of the MFFR.

Sedimentary deposits found in the valley Sierra Valley vary in origination, weathering methods, and particle size distribution that range in age from Pleistocene to Recent. Pleistocene lake deposits underlie a thin layer of recent sediments throughout the valley floor and outcrop around the basin perimeter. The lake deposits vary in thickness (up to 2,000 feet) and grade from generally coarse-grained around the basin perimeter to finer in the central valley. Probable reasons for this variability include diversity in upland rock lithology, local tributary sediment input, slow filling of the lake, lake level fluctuations corresponding to seasonal and longer-term climatic variations, and topographic changes caused by erosion and seismic activity (DWR,1983). A few small Pleistocene glacial moraines exist around Sierraville. Recent alluvial fan deposits occur around the margins of the valley adjacent to highland areas, predominantly where streams enter the valley floor. Up to 200 feet thick, the alluvial fan deposits consist of stratified, poorly sorted sand, gravel, and silt layers, with occasional clay lenses. Recent alluvium up to 50 feet thick is found along stream channels and slightly elevated areas in the center valley and consists of a heterogeneous mixture of poorly sorted sand and silt with some lenses of clay and gravel. Along active stream channels, sand, gravel, cobbles, and occasionally boulders are predominant. Extensive recent basin deposits consisting of clay and silt are found throughout Sierra Valley that are up to 35 ft thick and overlie the Pleistocene lake deposits. In the northeastern corner of the valley there are unconsolidated, fine-grained recent sand deposits representing an area of once active sand dunes that have stabilized and are now vegetated.

Sierra Valley lies among one of the most faulted regions in California with regional strike-slip and normal faulting. The area is dominated by northwest and northeast striking faults. Boundary faults define the basin periphery and act as permeable barriers. It is suspected many normal faults propagate into the underlying basement rocks, resulting in substantial variations in the thickness of valley sediments with estimates ranging from 800 feet below ground surface (bgs) to 2,000 feet bgs (DWR, 1963). The primary faults and fault zones that are suspected to dissect the basin are identified differently by various individual sources. For the purpose of this document, we will use the identifications shown in Figure 2.2.1-10 and described below.

The Grizzly Valley Fault Zone consists of left lateral high angle normal fault striking northwest. It divides the basin into a southwestern one-third and northeastern two-thirds and acts as a potential barrier to groundwater flow. The fault zone is approximately 10 miles long and 1 to 2 miles wide and is traced from Mapes Canyon (north of Beckwourth), along Smithneck Creek and into Sardine Valley. The eastern lineament of the fault zone is identified as Grizzly Valley Fault. The western lineaments are identified as Hot Springs Fault and Loyalton Fault. Hot Springs Fault parallels Grizzly Valley Fault approximately 3 miles to the southwest. A number of springs occur along this and other faults in the area that act as barriers to flow across the fault plane. Loyalton Fault is located between Grizzly Valley Fault and Hot Springs Fault and is traced from Smithneck Creek Canyon to a point west of Beckwourth, where it apparently merges with Hot Springs Fault. These two faults are mostly strike-slip faults and with a significant dip-slip component (Bohm, 2016). An additional fault southwest of Hot Springs Fault has been identified as Westside fault and assumed as part of the fault zone.

Mohawk Valley Fault Zone defines much of the topography of the uplands west of Sierraville and Sattley (Bohm, 2016). The northwest striking fault is a high angle normal fault with occurrences of dextral divergent movement. Vertical offset is estimated to be from 1,640 to 3,870 feet (Sawyer, 1995).

Sierra Valley has a relatively high potential for seismic activity. Since 1932, 43 earthquakes with a Richter magnitude of 4.0 or greater have been recorded within 34 miles of Sierraville (Berry, 1979). The most recent was a magnitude 4.7 that occurred on May 6th, 2021, about 20 miles south of the basin.

2.2.1.6 Hydrogeologic Framework

Sierra Valley and the surrounding uplands support the MFFR headwaters and provides water to Lake Oroville as part of the California State Water Project (SWP). Many named and unnamed streams enter the Sierra Valley subbasin (Figure 2.2.1-2) creating a large braided stream network on the valley floor. These stream flows are fed seasonally by rainfall, snowmelt, and groundwater discharge. The western portion of the valley receives greater precipitation and has more surface water than the eastern valley. Appropriative and riparian water rights holders divert most of eastern stream flow during summer, such that the downstream stretches usually dry out completely before confluence with the western channels (Vestra, 2005, Bohm 2016). Releases from Frenchman Lake and imported water from the Little Truckee River Diversion support valley irrigation during the growing season (DWR, 1983). Many of these tributaries drain the valley as they connect to the headwaters of MFFR through a water gap in the northwestern corner of the Sierra Valley watershed.

Table 2.2.1-2 Historical streamflow summary for tributaries to MFFR

Stream Name	Average Flow (CFS)	Average Discharge (AF/Year)	Percent of MFFR Discharge (Measured near Portola)	Record Period	Monitoring Agency
Smithneck Creek	11.1	8,076	4.5%	1937 - 1966	DWR
Bonta Creek[1]	39.0	28,224	16%	1940 - 1959	DWR
Berry Creek	11.3	7,838	4.4%	1940 -1967, 1971 - 1983	DWR, USGS
Little Truckee Diversion[2]	19.4	7,039	4.0%	1937 - 1966	DWR
Little Last Chance Creek	26.8	19,400	11%	1959 - 1979	USGS
Big Grizzly Creek	34.7	25,100	14%	1926 - 1931, 1951 - 1952, 1955 - 1979	USGS
Middle Fork Feather River (MFFR)	246	177,800	100%	1969 - 1979, 2007 - Present[3]	USGS

1. Gauge location unclear, may include Cold Stream
2. Diversion is open no longer than 6 month irrigation season, often less, and feeds into Cold Stream
3. Recent MFFR data not included in average calculation

The only active flow monitoring station in Sierra Valley is the MFFR station near Portola. Table 2.2.1-2 provides a summary of historical streamflow for tributaries to the MFFR and respective percentages of gauged MFFR discharge (Bachand, 2020). The sum of historically gauged discharge in the valley only accounts for about 45% of gaged MFFR discharge, likely due to inflows from ungaged streams in the western valley where greater precipitation occurs and groundwater-surface water connections occur (Bohm, 2016) as well as mountain front recharge that enters the groundwater basin from fractures in the surrounding bedrock (Bachand, 2020). Total average annual MFFR discharge of 177,800 AF was measured at the Portola station downgradient of the Sierra Valley groundwater basin. Total MFFR discharge from Sierra Valley Subbasin equals 157,700 AF since 25,100 AF of the total gauged discharge at Portola is attributed to Big Grizzly Creek. Big Grizzly Creek, supplied by Lake Davis, enters the groundwater basin less than a mile from the outlet and, therefore, does not have a significant impact on groundwater conditions in Sierra Valley.

Little Last Chance Creek, supplied by Frenchman Lake, and Smithneck Creek are the main perennial creeks that spread across the eastern basin and feed the many braided channels to the west. Little Last Chance Creek and Smithneck Creek and contribute approximately annually 19,400 AF and 8,076 AF, respectively, to the valley surface water in the eastern portion as regulated discharge from Frenchman Lake (55,477 AF capacity).

Several creeks enter the valley from the west and southern uplands, where rain is more significant, and are the primary source of MFFR outflows from the basin. Webber Lake supplies the Little Truckee River, which diverts imported water into the Sierra Valley via the Little Truckee Diversion Canal. Bonta Creek (may include Cold Stream flow), Berry Creek, and Little Truckee Diversion Canal contribute a total of about 42,000 AF annually as surface water flow into Sierra Valley.

There are at least 5,000 acres of seasonal and perennial flooded wetlands on the valley floor, the largest being a 3,000-acre fresh emergent wetland (Vestra, 2005). For example, the area of the valley surrounding Island Ranch (north of the channel through which Smithneck Creek flows through the southeastern portion of the valley) has been inundated well into the summer in recent years.

Inflows to the Sierra Valley groundwater system are primarily sourced from infiltration of surface-water in the alluvial fans at the periphery of the valley from adjacent uplands and flow from the fractured bedrock in contact with the shallow and deep aquifers (Bohm, 2016). A small amount of recharge is likely derived from direct precipitation on fan surfaces, deep percolation from irrigated agricultural fields, seepage from losing reaches of tributaries, and irrigation ditches in the valley. Recharge areas tend to be high elevation areas with underlying soils and geologic formations containing sufficient hydraulic conductivity and the right combination of climate. The eastern part of basin is drier and pumped significantly more, creating substantial changes in storage and room for recharge. The western portion experiences more precipitation and minor changes in storage, producing more runoff. Groundwater elevation data show that the Chilcoot sub-basin, south valley, and Smithneck Creek drainage are main groundwater supply sources (Bohm, 2016). Upland recharge centers may provide significant recharge into limited portions of the Sierra Valley Subbasin aquifers by distinct zones of high permeability fractured rock. Bohm (2016) identified nine recharge centers supplying Sierra Valley using groundwater quality and isotopic data and general (Figure 2.2.1-14). Little Truckee Summit, Yuba Pass, and Dixie Mountain (connection via Frenchman sub-basin) were identified as likely the three most significant recharge areas for the Sierra Valley (Bohm, 2016).

Most natural groundwater discharge occurs on the valley floor in the form of evapotranspiration (ET), direct surface evaporation, outflowing reaches of streams, natural springs, seeps, and wetlands. Approximately 70 to 80% of the watershed's total water budget is lost to evapotranspiration (Vestra, 2005). Springs and wetlands are found around the edges of the valley floor and are generally more abundant in the southwestern portions of the valley, where the uplands receive significantly more precipitation. Some exist along the northern valley perimeter, likely fed by the relatively large upland recharge areas that exist north of the valley (Bohm, 2016). Flowing artesian wells are present in many parts of the valley and discharge confined ground water at varying rates; flow during the winter and spring is usually greater than the summer and fall flows. A small amount of water seeps into the railroad tunnel east of Chilcoot, forms a small stream, and flows east out of the basin. Local residents say the tunnel intercepted the water table and caused a drop in water levels in surrounding wells DWR (1983).

The Sierra Valley subbasin is a fault-trough basin that has been filled with various lacustrine and fluvial sediment, which encompass the primary aquifers of the basin and are the source of most of the areas pumped groundwater. The trough floor is characterized by several subsiding fractured volcanic and granitic bedrock blocks. The basin boundaries are generally delineated by the contact between the basin fill and adjacent bedrock units created by deposition or faulting. Well drilling records and gravity surveys conducted by DWR in 1960 indicate depth to bedrock up is to 1,500 feet in the central basin, with sediment thickness along the periphery of the basin being no more than a few hundred feet. These two hydrostratigraphic units will be referred to as the "basin fill unit" and "bedrock unit" for the purpose of this report. Some deeper sediments near centrally located geothermal areas have been lithified by low grade hydrothermal alteration, resulting in a shallower aquifer system in these areas. The basin fill unit contains the primary water-bearing formations in Sierra Valley and includes Holocene sedimentary deposits, Pleistocene lake deposits, and Pleistocene lava flows. Fine grained sediments generally dominate the central portion of the groundwater basin, whereas coarse grained sediments are found along the margins of the valley and represent the former lake shoreline (Bohm, 2016). As the faulted basin has continued to subside the older layers have become increasingly curved with depth, whereas recent (shallow) deposits are relatively flat lying. Alternating non-contiguous layers of clay, sand and silt are in lenticular form, and do not necessarily cover the entire basin. Low-permeability fine-grained layers separating aquifers are thinner to non-existent near the valley periphery. (Bohm, 2016). Although "shallow" and "deep" aquifer terms have been historically adopted by DWR, analysis of data from drilling records, water level response, groundwater chemistry and groundwater temperature studies do not necessarily indicate two distinctive aquifers throughout the groundwater basin. Parts of a deep aquifer zone may be pressurized by confining low-permeability layers (Bohm, 2016), although extent and isolation between shallow and deep aquifer zones likely vary throughout the Sierra Valley subbasin (Schmidt, 2005 and Bohm, 2016). Very few pumping test data is available for the basin fill unit. As shown in Table 2.2.1-3 from Bohm (2016), reported hydraulic conductivities range from 36 to 69 gpd/ft^2, with an anomalous 375 gpd/ft^2 for the basin fill.

Table 2.2.1-3 Summary of basin-fill aquifer parameters

Aquifer parameters in valley fill formations

Pumpingtest results, Sierra Valley

Location	well #	T, gpd/ft	S	K, gpd/ft2	t-max, hrs	Q, gpm	SWL, ft	h-max, ft	SPC	screen, ft	TD, ft	pw/obs?	comments
Lucky Herford Old Well #4	2215.36J1	17,900	nd	36	12	1,800	40	120	22	504	775	p	DWR (1983)
Genasci Well	2115.12P3	19,500	nd	69	23	1,330	35	153	11	284	514	p	DWR (1983)
Lucky Hereford #10	2316.32Q1	110,900	nd	375	20	3,150	69	126	55	296	820	p	DWR (1983)
		98,200	0.00031									o	DWR (1983)
Sposito resid. Well, Calpine		9,825	0.0051	68	72	119	9.8	119	1	145	145	o	Smith(2007)

The bedrock units underlying the basin fill units are characterized by secondary (fracture) permeability and porosity. Except for the highly permeable fault zones, the bedrock unit is deemed impermeable for all practical purposes (Bohm, 2016). A number of pumping test in the bedrock have been conducted in the basin periphery. Aquifer parameters determined are highly variable dependent on number of fractures intersected and rock's material ability to hold open fractures and joints with seismic activity. The estimated bedrock hydraulic conductivity is about three orders of magnitude smaller than that sedimentary basin fill in Sierra Valley. Bedrock aquifer parameters are included in Table 2.2.1-4 from Bohm (2016).The principle geologic structures affecting groundwater flow are the basin's bedrock boundaries and faults in the valley-fill material. The bedrock underlying the basin is generally impermeable relative to the valley fill sediments, with the exception of zones where faulting has significantly increased the secondary permeability. Generally, the northwest striking faults can act as partial barriers to groundwater flow, while northeast striking normal faults can possibly act as conduits for groundwater flow (Bohm, 2016). Evidence of faults acting as groundwater flow barriers includes emergence of springs along fault traces and changes in water level elevations across faults. Well level data analyzed suggests the northwest trending Grizzly Valley Fault Zone impeded horizontal flow along the eastern gradient, although the impediment may not be contiguous along the entire length of the lineaments (Bachand, 2020). Northwest striking Mohawk Fault Zone acts as a barrier between the Sierra Valley groundwater basin and Mohawk Valley groundwater basin, with about a 500 foot groundwater level difference between the basins (Bohm, 2016).

Table 2.2.1-4 Summary of bedrock aquifer parameters

Bedrock aquifer parameters
Sierra Valley bedrock aquifers
from selected well tests

Well name/project:	location	aquifer formation	aquifer thickness b, ft	**Transmissivity T** gpd/ft		**Hydraulic Conductivity, K:** gpd/sq-ft	m/day	m/s	Data Source
Calpine VFD well	Calpine	granite	single fracture	-----	K measured	4.2	0.172	2.0E-06	Bohm (2010)
Anderson test well	Sierraville	T. volcanics	210	1271	K measured	6.1	0.247	2.9E-06	Bohm(2006)
Amodei dom. Well	Sierraville	T. volcanics		1012	K measured	8.3	0.341	3.9E-06	Bohm(2006)
John Amodei, dom well	Sierraville	T. volcanics	50	1000	T measured	20.0	0.816	9.4E-06	Bohm(1998)
test well, "The Ridges"	Chilcoot	granite	185	1440	K measured	7.8	0.318	3.7E-06	Bohm(2006)
Test w. RH-2, Beckw. Pass	Chilcoot	granite	160	4911	T measured	30.7	1.252	1.4E-05	Bohm & Juncal (1989)
SPI well No. 3	Loyalton	T. volcanics	190	787	T measured	4.1	0.169	2.0E-06	Bohm (1997)
River valley Subd.	RV-1	T. volcanics	350	3440	T measured	9.8	0.401	4.6E-06	Bohm (2002)
River valley Subd.	RV-1	T. volcanics	350	6000	T measured	17.1	0.699	8.1E-06	Bohm (2002)
Frenchman Lake Road Esta	FLRE-1	granite	265	1162	T measured	4.4	0.179	2.1E-06	Juncal & Bohm, 1986)
Frenchman Lake Road Esta	FLRE-2	granite	254	27	T measured	0.1	0.004	5.1E-08	Juncal & Bohm, 1986)
Frenchman Lake Road Esta	FLRE-3	granite	96.74	13	T measured	0.1	0.005	6.3E-08	Juncal & Bohm, 1986)
Frenchman Lake Road Esta	FLRE-1	granite	265	2364	T measured	8.9	0.364	4.2E-06	Bohm (1995)
Well 1B, Cedar Crest, 14 day test		granite	433	1380	T measured	3.2	0.130	1.5E-06	Bohm (1997)
		maximum		6000		30.7	1.252	1.4E-05	
		minimum		13		0.1	0.004	5.1E-08	

Water supply sources include groundwater and surface water. Groundwater accounts for 36% of the total (DWR, 2019). Location of groundwater wells are shown in Figure ## and discussed in further detail in Section ## of this Plan. Irrigated agriculture is the primary groundwater use in the Sierra Valley. Since 1989, agricultural groundwater extraction rates have been metered by SVGMD. An average annual pumping volume of 8,500 acre-feet was estimated from 1999 to 2017 (Bachand, 2020). Agricultural pumping ranges are substantially influenced by precipitation and snowpack. Only approximately 6% of the total number of wells in Sierra Valley are irrigation wells, however they have a high pumping capacity. Total municipal annual pumping for residential water supply in Sierra Brooks, Calpine, and Loyalton averages 665 acre-feet (SVGMD, 2019). Most domestic pumping in the Sierra Valley occurs along the margin of the valley with many wells completed in bedrock outside of the groundwater basin boundary.

Surface Water Diversions are managed by the area Watermaster and include the following:

- Cold Creek
- Fletcher Creek
- Hamlin Creek
- Lemon Creek
- Little Truckee
- Miller Creek
- Antelope Lake Dam outlet
- Frenchmen Dam outlet
- Lake Davis outlet
- Smithneck Creek
- Smithneck Creek East
- Smithneck Creek West
- Perry Creek
- Town Creek
- Turner Creek
- Webber Creek
- Pasquetti Ditch
- Pasquetti runoff
- Van Vleck
- West Creek
- SN31715
- SN31715A
- TP61215
- TP61215W
- Diversion 129
- Diversion 131
- Diversion 136 East
- Diversion 137
- Diversion 138
- Diversion 139
- Diversion 142
- Diversion 146
- Diversion 146A
- Diversion 147
- Diversion 148 East
- Diversion 148 West
- Diversion 150
- Diversion 150A
- Diversion 151
- Diversion 151A
- Diversion 152
- Diversion 154
- Diversion 158 East
- Diversion 202
- Diversion 222
- Diversion 225

Water quality in the Sierra Valley subbasin is generally good due to the large amount of snowmelt runoff from the surrounding mountains that recharges the groundwater aquifer and the limited amount of industry in the basin. A wide range of water types exists in the basin, a pattern that is symptomatic of groundwater chemistry evolution in silicate rocks and sediments under various elevated groundwater temperatures (up to 174ºF was reported by GeothermEx, 1986). The basin ranges from comparatively low percentages of chloride, sulfate, sodium, and potassium plotting in the southwest of the basin to high percentages of the same constituents in the northeast portion of the basin. Total dissolved solids (TDS) range between about 100 and 1,500 mg/L. Chloride and sulfate concentrations range between 1 to 545 mg/L and 1 to 370 mg/L, respectively. Approximately 25% of all wells measured exceed the drinking water standard of 10 mg/L as N for nitrate (Bohm, 2016a). The poorest quality groundwater is found in the central west side of the valley where fault-associated thermal waters and hot springs yield water with high concentrations of boron, fluoride, iron, and sodium (DWR, 1983). In Sierra Valley high boron levels correlate with groundwater temperature and TDS. However, the correlations are rather coarse, suggesting other unknown associations might be involved (Bohm, 2016a). Boron concentrations in thermal waters have been measured in excess of 8 mg/L, and usually less than 0.3 mg/L at the basin margin (DWR, 1983). Several wells in this area also have high arsenic and manganese concentrations. There is also a sodium hazard associated with thermal waters and some potential for problems in the central portion of the basin (DWR, 1983).

2.2.2 Current and Historical Groundwater Conditions *(Reg. § 354.16)*

Per Reg. § 354.16, this section includes:

- Groundwater elevation data
- Estimate of groundwater storage
- Seawater intrusion conditions

- Groundwater quality issues
- Land subsidence conditions
- Identification of interconnected surface water systems
- Identification of groundwater-dependent ecosystems including potentially related factors such as instream flow requirements, threatened and endangered species, and critical habitat.

Each of the issues require discussion.

2.2.2.1 Groundwater elevation data

2.2.2.1.1 Introduction to Groundwater Elevations

Groundwater elevation (vertical distance from ground surface to the top of the groundwater table) is a primary measure of the sustainability of groundwater management. Simply stated, when too much groundwater is being extracted, groundwater elevations fall, posing risk of land subsidence, associated reduction in aquifer storage capacity and alteration of hydraulic properties of the aquifer system, affecting migration of pollutants in groundwater, and potentially affecting surface water flows and groundwater-dependent ecosystems. Conversely, when groundwater is being sustainably managed, annual average groundwater elevations remain relatively constant with seasonal fluctuations of increased elevations in the wet season and decreased elevations in the dry season, and perhaps subtle long-term fluctuations associated with changing precipitation patterns. Because of the fundamental importance of groundwater elevations from the perspective of groundwater management sustainability and the relationship between groundwater elevations and other sustainability indicators, groundwater elevations are generally considered the most telling indicator of groundwater management sustainability.

2.2.2.1.2 Summary of Groundwater Elevations in the Sierra Valley

Based on the comments provided by DWR as part of their basin prioritization (DWR, 2019a), DWR's interpretation of groundwater levels in SV Subbasin can be summarized as follows: the majority of long-term SV Subbasin hydrographs along the periphery of the basin are relatively stable, with a wells in the central basin showing declining groundwater levels. Groundwater level trends for select monitoring wells are displayed in Figure 2.2.2-1. The trend of groundwater level change ranges from deep red for high rates of declining to deep blue for high rates of increasing levels. The wells are generally slightly increasing to slightly decreasing, with wells in the central portion of the basin showing the greatest decline. Trends for six of the wells are displayed on the right side of the figure. Wells with greatest declines generally have high seasonal variability corresponding to seasonal irrigation use. Groundwater level trends are shown for shallow and deep wells in Figure 2.2.2-6. As noted in the figure, the trends for the majority of wells are between +1 and -1 ft/yr.

Average spring measurements of groundwater levels for 2013-2016 are presented in Figure 2.2.2-7. These levels represent recent conditions during dry and critically dry years reflective of minimal wet-season recharge. Figure 2.2.2-8 is a depiction of the water levels averaged over 2013-2016 fall measurements. Comparing the two figures provides a basis for evaluating the effect of groundwater use during dry periods and the ability of the basin to recharge with under dry water years. The eastern, and especially the north-eastern portion of the basin experiences the greatest depression of groundwater levels over the irrigation season, and the western portion of the basin remains relatively stable.

Figure 2.2.2-1 Sierra Valley Groundwater Level Trends

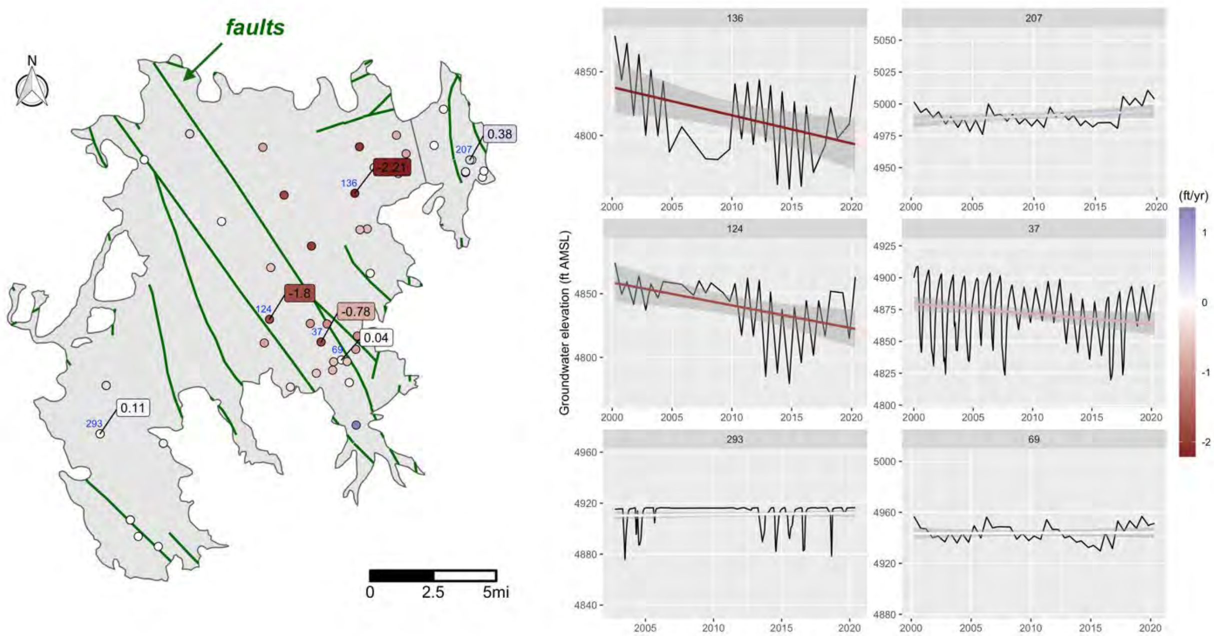
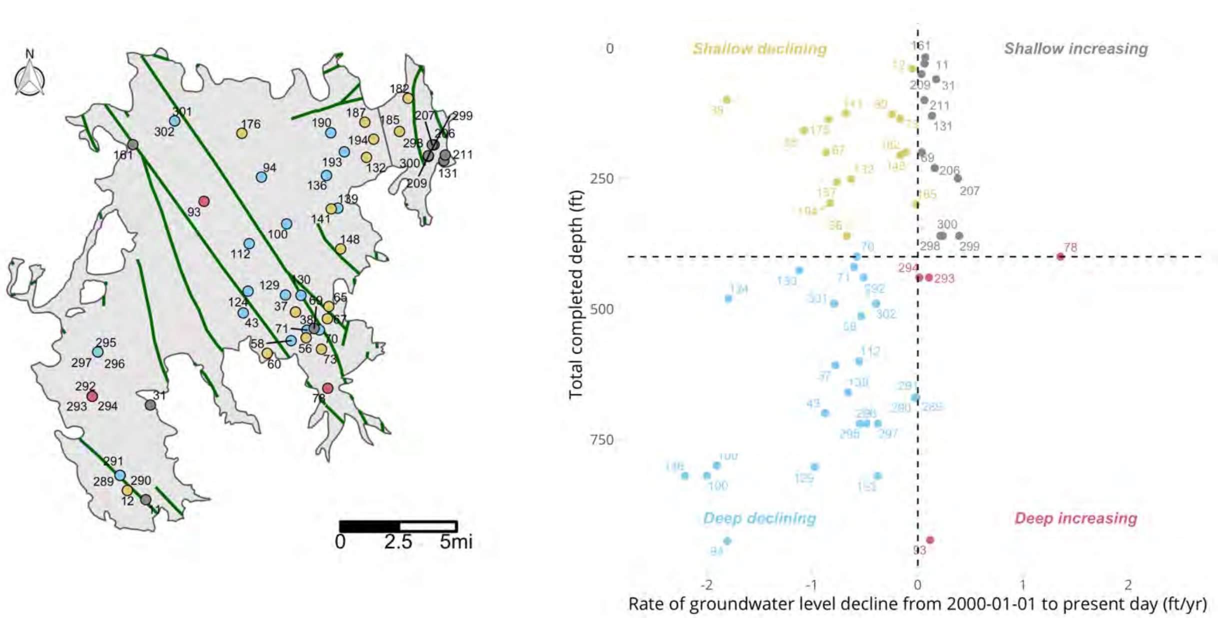
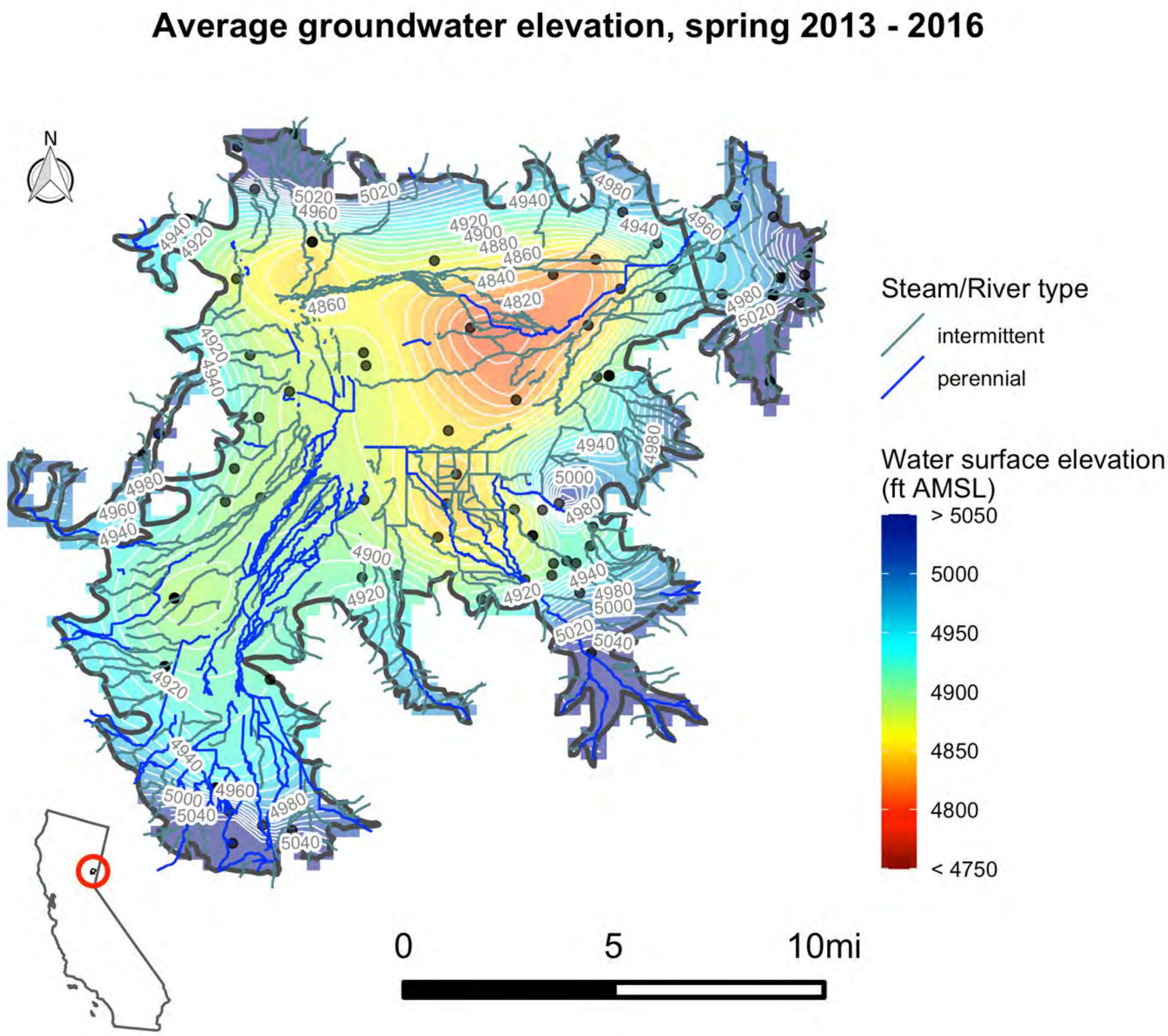


Figure 2.2.2-2 Sierra Valley Groundwater Level Trends for Deep and Shallow Wells

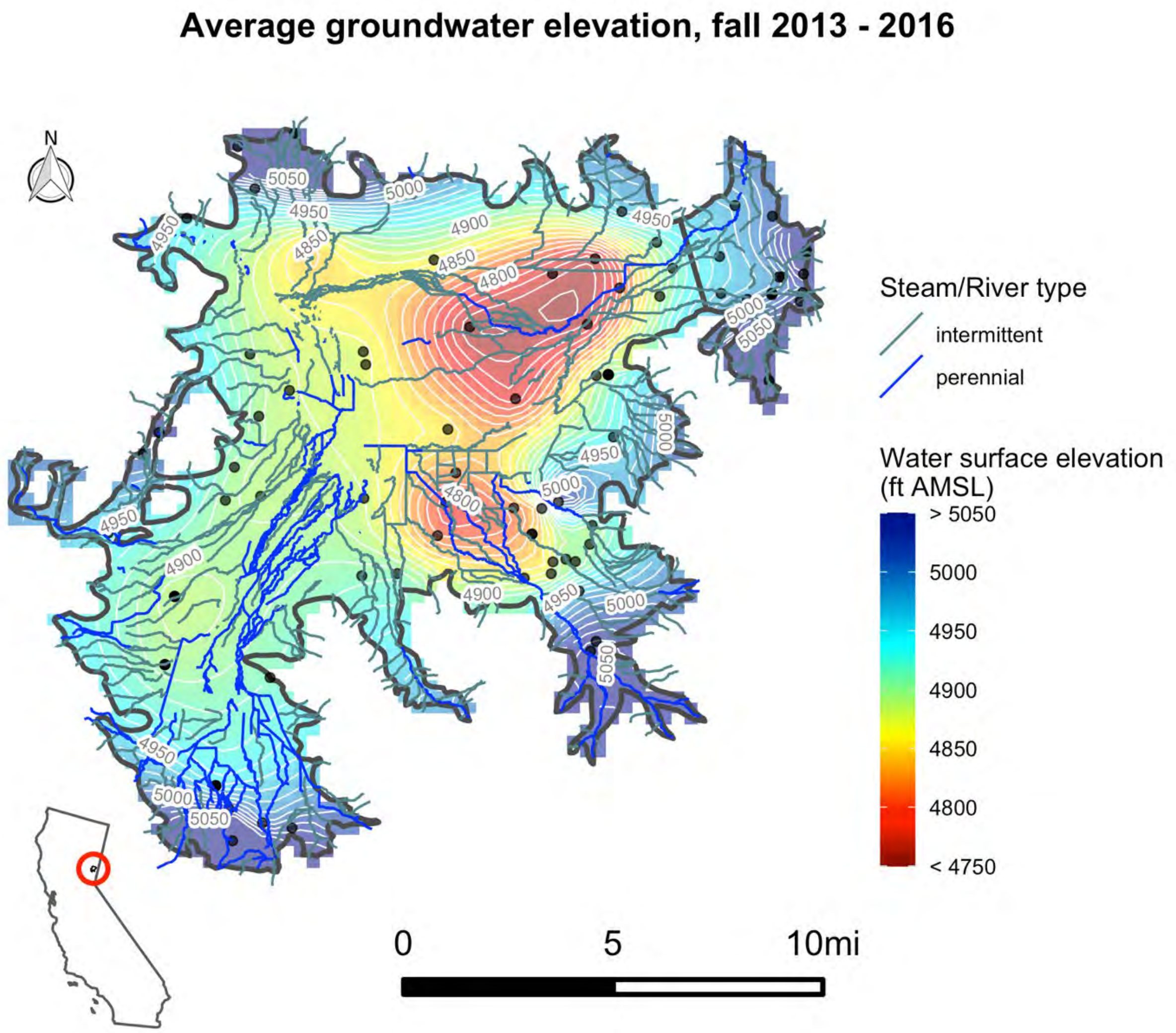


1199 **Figure 2.2.2-3 2013-2016 Spring Average Sierra Valley Groundwater Levels**



1200

Figure 2.2.2-4 2013-2016 Fall Average Sierra Valley Groundwater Levels



2.2.2.2 Estimate of groundwater storage

2.2.2.3 Seawater intrusion conditions

The SV Subbasin is not located in a coastal, therefore, seawater intrusion conditions are not applicable to this GSP.

2.2.2.4 Groundwater quality issues

SGMA regulations require that the following be presented in the GSP, per §354.16 (d): Groundwater quality issues that may affect the supply and beneficial uses of groundwater including a description and map of the location of known groundwater contamination sites and plumes.

2.2.2.4.1 Basin Groundwater Quality Overview

Water quality includes the physical, biological, chemical, and radiological quality of water. An example of a biological water quality constituent is E. coli bacteria, commonly used as an indicator species for fecal waste contamination. Radiological water quality parameters measure the radioactivity of water. Chemical water quality refers to the concentration of thousands of natural and inorganic and organic chemicals. All groundwater naturally contains some microbial matter, chemicals, and usually has a low level of radioactivity. Inorganic chemicals that make up more than 90% of the total dissolved solids (TDS) in groundwater include calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^{+}), potassium (K^{+}), chloride (Cl^{-}), bicarbonate (HCO_3^{-}) and sulfate (SO_4^{2-}) ions. Water with a TDS content of less than 1,000 mg/L is generally referred to as "freshwater". Brackish water has a TDS concentration between 1,000 mg/L and 10,000 mg/L. In saline water, TDS exceeds 10,000 mg/L. Water hardness typically refers to the concentration of calcium and magnesium cation in water.

When levels of one or more constituents become a concern for either ecosystem health, human consumption, industrial or commercial uses, or for agricultural uses, the water quality constituent of concern becomes a "pollutant" or "contaminant". Groundwater quality is influenced by many factors – polluted or not – including elevation, climate, soil types, hydrogeology, and human activities. Water quality constituents are therefore often categorized as "naturally occurring", "point source", or "non-point source" pollutants, depending on whether water quality is the result of natural processes, of contamination from anthropogenic point sources, or originates from diffuse (non-point) sources that are the result of human activity.

Groundwater in the Subbasin is generally of good quality and meets local needs for municipal, domestic, and agricultural uses. This is the result of the large amount of snowmelt runoff from the surrounding mountains that recharges the groundwater aquifer and the limited amount of industry in the basin (see section 2.2.1.6 for further detail). As described below, ongoing monitoring programs show that some constituents, including TDS, boron, arsenic, and manganese exceed water quality standards in parts of the Subbasin. Exceedances may be caused by localized conditions and may not be reflective of regional water quality. Two points of concern raised by stakeholders within the Subbasin include: 1) higher levels of naturally occurring arsenic and manganese near Calpine; and, 2) possible water quality impacts from septic systems.

A summary of information and methods used to assess current groundwater quality in the Subbasin as well as the results of the assessment, are presented below. A detailed description of information, methods, and all findings of the assessment can be found in Appendix ## – Water Quality Assessment.

2.2.2.4.2 Existing Water Quality Monitoring Networks

Water quality data for at least one constituent – sometimes many - are available for some wells in the Subbasin but not most. Of those wells for which water quality data are available, most have only been tested less than three times, but some have been tested more than three times, and in few cases are tested on a regular basis (e.g., annually). The same well may have been tested for different purposes (e.g., research, regulatory, or to provide owner information), but most often, regulatory programs drive water quality testing. For this GSP, all available water quality data, obtained from the numerous available sources, are first grouped by the well from where the measurements were taken.

2.2.2.4.3 Data Sources for Characterizing Water Quality

The assessment of groundwater quality for the Subbasin was prepared using available information obtained from the California Groundwater Ambient Monitoring and Assessment (GAMA) Program Database, which for the Sierra Valley Subbasin includes water quality information collected by the following agencies:

- Department of Water Resources (DWR)

- State Water Board, Division of Drinking Water public supply well water quality (DDW)
- State and Regional Water Board Regulatory Programs (Electronic Deliverable Format (EDF) and Irrigated Agricultural Land Waiver (AGLAND))
- U.S. Geological Survey (USGS)

Groundwater quality data, as reported by GAMA, has been collected in the Subbasin since 1955. Within the Subbasin, a total of 200 wells were identified and used to characterize existing water quality based on a data screening and evaluation process that identified constituents of interest important to sustainable groundwater management. Figures in Appendix ## show the Subbasin boundary, as well as the locations and density of all wells with available water quality data for the GSP constituents of interest collected in the past 30 years (1990-2020). In addition to utilizing GAMA for basin-wide water quality assessment, GeoTracker, the State Water Board's internet accessible database system to track discharges to land and groundwater, was searched individually to identify data associated with groundwater contaminant plumes.

2.2.2.4.4 Classification of Water Quality

To determine what groundwater quality constituents in the Subbasin may be of current or near-future concern, a reference standard was defined to which groundwater quality data were compared. Numeric thresholds are set by state and federal agencies to protect water users (environment, humans, industrial and agricultural users). The numeric standards selected for the current analysis represent all relevant state and federal drinking water standards, and state water quality objectives, for the constituents evaluated and are consistent with state and Regional Water Board assessment of beneficial use protection in groundwater. The standards are compared against groundwater quality data to determine if a constituent's concentration exists above or below the threshold and is currently impairing or may have the potential to impair beneficial uses designated for groundwater.

Although groundwater is utilized for a variety of purposes, the use for human consumption requires that supplies meet strict water quality regulations. The federal Safe Drinking Water Act (SDWA) protects surface water and groundwater drinking water supplies. The SDWA requires the United States Environmental Protection Agency (USEPA) to develop enforceable water quality standards for public water systems. The regulatory standards are named maximum contaminant levels (MCLs) and they dictate the maximum concentration at which a specific constituent may be present in potable water sources. There are two categories of MCLs: Primary MCLs (1^{o} MCL), which are established based on human health effects from contaminants and are enforceable standards for public water supply wells and state small water supply wells; and Secondary MCLs (2^{o} MCL; or SMCL), which are unenforceable standards established for contaminants that may negatively affect the aesthetics of drinking water quality, such as taste, odor, or appearance.

The State of California has developed drinking water standards that, for some constituents, are stricter than those set at the federal level. The Basin is regulated under the Central Valley Regional Water Quality Control Board (Regional Water Board) and relevant water quality objectives (WQOs), and beneficial uses are contained in the Water Quality Control Plan for the Central Valley Region (Basin Plan). For waters designated as having a Municipal and Domestic Supply (MUN) beneficial use, the Basin Plan specifies that chemical constituents are not to exceed the Primary and Secondary MCLs established in Title 22 of the California Code of Regulations (CCR) (hereafter, Title 22). The MUN beneficial use applies to all groundwater in the Sierra Valley subbasin.

Constituents may have one or more applicable drinking water standard or WQOs. For this GSP, a prioritization system was used to select the appropriate numeric threshold. This GSP used the strictest value among the state and federal drinking water standards and state WQOs specified in the Basin Plan for comparison against available groundwater data. Constituents that do not have an established drinking water standard or WQO were not assessed. The complete list of constituents, numeric thresholds, and associated regulatory sources used in the water quality assessment can be found in Appendix ##. Basin groundwater quality data obtained for each well selected for evaluation were compared to a relevant numeric threshold.

Groundwater quality data were further categorized by magnitude of detection as 1) not detected, 2) detected below half of the relevant numeric threshold, 3) detected below the relevant numeric threshold, and 4) detected above the relevant numeric threshold. Maps were generated for each constituent of interest showing well locations, the maximum value measured at each well, and the number of measurements for each category of detection (Appendix ## Figures ## - ##). These maps, contained in Appendix ##, Figures ## - ##, indicate wells designated as municipal in the GAMA dataset.

To analyze groundwater quality that is representative of current conditions in the Subbasin, several additional filters were applied to the dataset. Though groundwater quality data are available dating back to 1955 for some constituents, the data evaluated were limited to those collected from 1990 to 2020. Restricting the time span to data collected in the past 30 years increases confidence in data quality and focuses the evaluation on information that is considered reflective of current groundwater quality conditions. A separate series of maps contained in Appendix ## was generated for each constituent of interest showing the location of wells with two or more measurements collected during the past 30 years (1990-2020; Figures ## - ##). This series of maps also indicates the maximum value measured at each well.

Finally, for each constituent, an effort was undertaken to examine changes in groundwater quality over the period 1990-2020. Constituent concentrations were plotted as “box and whisker” plots, where the box represents the concentration range for the middle 50 percent of the data (first quartile to third quartile, or interquartile range), the mean is represented as an ‘x’, and the median is shown as the line in the center of the box. The top whisker extends to the highest concentration that is less than or equal to the sum of the third quartile and 1.5 times the interquartile range; and the bottom whisker extends to the lowest concentration that is greater than or equal to the difference of the first quartile and 1.5 times the interquartile range. Regulatory limits are displayed as a dashed red line, and the concentration is displayed on the left side of each plot. Maps and box and whisker plots for each constituent of interest are referenced in the following subsections and are provided in Appendix ##.

The approach described above was used to consider all constituents of interest and characterize groundwater quality in the Subbasin. Appendix ## contains additional detailed information on the methodology used to assess groundwater quality in the Subbasin.

2.2.2.4.5 Subbasin Groundwater Quality

All groundwater quality constituents monitored in the Subbasin that have a numeric threshold were initially considered. The evaluation process described above showed the following parameters to be important to sustainable groundwater management in the Subbasin: nitrate, TDS, arsenic, boron, pH, iron, manganese, MTBE. The following subsections present information on these water quality parameters in comparison to their relevant regulatory thresholds and how the constituent may potentially impact designated beneficial uses in different regions of the Subbasin. Table 2.2.2-1 contains the list of constituents of interest identified for the Subbasin and their associated regulatory threshold.

Table 2.2.2-1. Regulatory water quality thresholds for constituents of interest in the Sierra Valley Subbasin

Constituent	Water Quality Threshold	Regulatory Basis
Arsenic (µg/L)	10	Primary MCL - Title 22[1]
Boron (mg/L)	1.0	Cal. Notification Level[2]
Iron (µg/L)	300	Secondary MCL - Title 22[1]
Manganese (µg/L)	50	Secondary MCL - Title 22[1]
MTBE (µg/L)	13 5	Primary MCL – Title 22[1] Secondary MCL - Title 22[1]
Nitrate (mg/L as N)	10	Primary MCL - Title 22[1]
pH	6.5 – 8.5	Basin Plan[3]
Total Dissolved Solids (mg/L)	500	Secondary MCL - Title 22[1]

1. Reference for Primary, and Secondary MCL – Title 22: https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/lawbook/dw_regulations_2019_04_16.pdf
2. Reference for Cal. Notification level: https://www.waterboards.ca.gov/water_issues/programs/gama/docs/coc_boron.pdf
3. Central Valley Basin Plan, surface water objective

NITRATE

Nitrate is one of the most common groundwater contaminants and is generally the water quality constituent of greatest concern. Natural concentrations of nitrate in groundwater are generally low. In agricultural areas, application of fertilizers or animal waste containing nitrogen can lead to elevated nitrate levels in groundwater. Other anthropogenic sources, including septic tanks, wastewater discharges, and agricultural wastewater ponds may also lead to elevated nitrate levels. Nitrate poses a human health risk, particularly for infants under the age of 6 months who are susceptible to methemoglobinemia, a condition that affects the ability of red blood cells to carry and distribute oxygen to the body. The Primary MCL (Title 22) for nitrate is 10 mg/L as N.

Recent nitrate data collected in the Subbasin (1990-2020) show that only 1 sample of 366 resulted in a concentration between 5-10 mg/L. No samples were above the MCL of 10 mg/L. The highest concentration during the period was 5.2 mg/L, and the average concentration during the last ten years (2011-2020) was 1.5 mg/L. Samples are primarily collected near Loyalton and Beckworth. Box and whisker plots for seven periods show that nitrate concentrations have been relatively stable during the period of analysis, with increasing concentrations from 2011-2020 (Appendix ##). As stated, average and median concentration remain relatively low during these years.

TOTAL DISSOLVED SOLIDS (TDS)

The TDS concentration in water is the sum of all the substances, organic and inorganic, dissolved in water. The dissolved ions calcium, magnesium, sodium, potassium, bicarbonate, sulfate, chloride, and nitrate typically make up most of the TDS in water. Natural and anthropogenic sources contribute to variations TDS in groundwater. Increases of TDS in groundwater can be due to dissolution of rock and organic material and uptake of water by plants, as well as anthropogenic activities including the application of fertilizers, discharges of wastewater and discharges from septic systems or industrial facilities. High TDS can be problematic as it can have adverse effects on plant growth and drinking water quality. The Title 22 SMCL for TDS is 500 mg/L, and the Upper SMCL is 1,000 mg/L. While the recommended SMCL of 500 mg/L is desirable for a higher degree of consumer acceptance, concentrations below the Upper SMCL of 1,000 mg/L are also deemed to be acceptable.

Recent TDS data collected in the Subbasin (1990-2020) show that only 11 of 216 samples resulted in a concentration between 500-1,000 mg/L, while the vast majority (175) resulted in a concentration less than 250 mg/L. No samples were above 1,000 mg/L. The highest concentration during this period was 864 mg/L, and the average concentration during the last ten years (2011-2020) was 200 mg/L. Spatial distribution of TDS samples is good, as samples are collected throughout the Subbasin. Spatial analysis shows that elevated concentrations are collected from wells located in the central and northwestern portion of the Subbasin. Box and whisker plots for seven periods show that average and median TDS concentrations have remained relatively stable since 1986 (Appendix ##).

ARSENIC

Arsenic is a naturally occurring element in soils and rocks and has been used in wood preservatives and pesticides. Classified as a carcinogen by the USEPA, the International Agency for Research on Cancer (IARC) and the Department of Health and Human Services (DHHS), arsenic in water can be problematic for human health. Drinking water with levels of inorganic arsenic from 300 to 30,000 parts per billion (ppb; 1 ppb = 1 µg/L) can have effects including stomach irritation and decreased red and white blood cell production (CITE ASTDR). Long-term exposure can lead to skin changes and may lead to skin cancer. The Primary MCL (Title 22) for arsenic is 10 µg/L.

Recent arsenic data collected in the Subbasin (1990-2020) show that only 16 of 128 samples resulted in a concentration between 5-10 µg/L, while the vast majority (112) resulted in a concentration less than 5 µg/L. No samples were above the MCL of 10 µg/L. The highest concentration during this period was 10 µg/L, and the average concentration during the last ten years (2011-2020) was 0.5 µg/L. Samples are primarily collected near Loyalton and Beckworth. Box and whisker plots for seven periods show that average concentrations have a decreasing trend (Appendix ##). It is noted that there are municipal wells near Calpine with elevated levels of arsenic (great than 20 µg/L); however, these wells are located outside the boundaries of the Subbasin and tap groundwater that is not hydrologically connected to the Sierra Valley Subbasin.

BORON

Boron in groundwater can come from both natural and anthropogenic sources. As a naturally occurring element in rocks and soil, boron can be released into groundwater through natural weathering processes. Boron can be released into the air, water or soil from anthropogenic sources including industrial wastes, sewage, and fertilizers. If ingested at high levels, boron can affect the stomach, liver, kidney, intestines, and brain (Agency for Toxic Substances and Disease Registry (ATSDR) 2010). The California Notification Level provides a threshold for boron of 1.0 mg/L as for groundwater in the Sierra Valley.

Recent boron data collected in the Subbasin (1990-2020) show that 14% of samples (15 of 104) resulted in a concentration greater than the Notification Level of 1.0 mg/L, while 78% of samples (81 of 104) have resulted in a concentration below 0.5 mg/L. The highest concentration during this period was 5.4 mg/L. High reporting limits[10] (typically 0.1 mg/L) are typical during the analytical assessment of boron and make analysis of average concentration imprecise. Spatial distribution of boron samples is good, as samples are collected throughout the Subbasin. Box and whisker plots for seven periods show that average and median boron concentrations have fluctuated since 1986. Since 2011, concentrations have decreased, with median values falling below the MCL (Appendix ##).

pH

The pH of groundwater is determined by a number of factors including the composition of rocks and sediments through which water travels in addition to pollution caused by human activities. Variations in pH can affect the solubility and mobility of constituents. Acidic or basic conditions can be more conducive for certain chemical reactions to occur; arsenic is generally more likely to mobilize under a higher pH while iron and manganese are more likely to mobilize under more acidic conditions. High or low pH can have other detrimental effects on pipes and appliances including formation of deposits at a higher pH and corrosion at a lower pH, along with alterations in the taste of the water. The Central Valley Basin Plan specifies a pH range of 6.5-8.5 as a water quality objective for surface water in the Sierra Valley. This range is used as an indicator of potential water quality concerns based on the beneficial use of the groundwater.

Recent pH data collected in the Subbasin (1990-2020) show that 2 of 71 samples resulted in a pH above the range of 6.5-8.5, while 2 samples resulted in a pH below the range. The highest concentration during this period was 8.7, while the lowest was 6.4. Spatial distribution of pH samples is good, as samples are collected throughout the Subbasin.

IRON AND MANGANESE

Iron and manganese in groundwater are primarily from natural sources. As abundant metal elements in rocks and sediments, iron and manganese can be mobilized under favorable geochemical conditions. Iron and manganese occur in the dissolved phase under oxygen-limited conditions. Anthropogenic sources of iron and manganese can include waste from human activities including industrial effluent, mine waste, sewage, and landfills. As essential nutrients for human health, iron and manganese are only toxic at very high concentrations. Concerns with iron and manganese in groundwater are commonly related to the aesthetics of water and the potential to form deposits in pipes and equipment. The Title 22 SMCLs, for iron and manganese are 300 µg/L and 50 µg/L, respectively.

Recent iron data collected in the Subbasin (1990-2020) show that 6 of 125 samples resulted in a concentration above the SMCL of 300 µg/L, while the vast majority (116) resulted in a concentration less than 150 µg/L. The highest concentration during this period was 2,400 µg/L, and the average concentration during the last ten years (2011-2020) was 82 µg/L. Except for the northeast portion of the Subbasin near Vinton, the spatial distribution of iron samples is good. Spatial analysis shows that elevated concentrations are collected from wells located near Loyalton and Beckworth. Box and whisker plots for seven periods show that average concentrations have remained relatively stable since 1986, with median concentrations decreasing from 2001-2020 (Appendix ##).

Recent manganese data collected in the Subbasin (1990-2020) show that 28 of 99 samples resulted in a concentration above the SMCL of 50 µg/L, while 71 of 99 samples resulted in a concentration below 50 µg/L. The highest concentration during this period was 1,200 µg/L, and

[10] Defined as the lowest concentration at which an analyte can be detected in a sample and its concentration reported with a reasonable degree of accuracy and precision.

the average concentration during the last ten years (2011-2020) was 119 µg/L. These elevated concentrations were sampled from monitoring wells less than 100 feet in depth located to the east of Loyalton. If these monitoring wells are removed from the data, the highest concentration during the period 1990-2020 decreases to 439 µg/L, and the average concentration during the last ten years (2011-2020) decreases to 25 µg/L. Except for the northeast portion of the Subbasin near Vinton, the spatial distribution of manganese samples is good. Wells sampled on the southern boundary of the Subbasin appear to contain lower concentrations of manganese compared to wells sampled near Beckworth or the central portion of the Subbasin. Box and whisker plots for seven periods show that average concentrations were elevated during the periods 2001-2005 and 2006-2010 in comparison to other periods (Appendix ##). As stated, these high concentrations are attributed to monitoring wells east of Loyalton.

MTBE

Methyl Tertiary Butyl Ether (MTBE) does not occur naturally in the environment, and is synthesized from methanol, a compound derived from natural gas, and isobutylene or other petroleum refinery products. It is a fuel oxygenate added to gasoline to reduce air pollution and increase octane ratings. MTBE can be released to groundwater by leaking underground storage tanks and piping, spills during transportation, and leaks at refineries. A minor amount can be attributed to atmospheric deposition. Underground storage tank or piping releases comprise the majority of the releases that have impacted groundwater. As of January 1, 2004, California has prohibited the use of MTBE in gasoline. Low levels of MTBE can make drinking water supplies undrinkable due to its offensive taste and odor. Although breathing small amounts of MTBE for short periods may cause nose and throat irritation, there are no data available on the effects in humans of ingesting MTBE. The primary MCL for drinking water is 13 µg/L, and the Title 22 SMCL is 5 µg/L.

Recent MTBE data collected in the Subbasin (1990-2020) show that 109 of 558 samples resulted in a concentration above the primary MCL of 13 µg/L, and 144 samples resulted in a concentration above the SMCL of 5 µg/L. The highest concentration during this period was 44,000 µg/L and average concentration during the last ten years (2011-2020) was 3 µg/L. All samples resulting in a concentration greater than 1,000 µg/L were collected during the period 2001-2005. Samples are primarily collected near Loyalton, Sierraville, and Beckworth, with primary MCL exceedances occurring near Loyalton and Sierraville. Box and whisker plots for seven periods show that concentrations were elevated during the period 2001-2005 and 2006-2010 (Appendix ##). Since 2011, concentrations have generally declined.

2.2.2.4.6 Contaminated Sites

Groundwater monitoring activities also take place in the Subbasin in response to known and potential sources of groundwater contamination, including underground storage tanks. These sites are subject to oversight by regulatory entities, and any monitoring associated with these sites can provide opportunities to improve the regional understanding of groundwater quality. To identify known plumes and contamination within the Subbasin, SWRCB GeoTracker was reviewed for active cleanup sites of all types. Within the Subbasin, the GeoTracker database shows one open land disposal site (Loyalton Sanitary Landfill) and one cleanup program site with potential or inactive groundwater contamination (SPI Loyalton Division). In addition to sites located within the Subbasin boundary, three sites are in close proximity to the Boundary. These include two land disposal sites (Portola Class III Landfill: open – closed/with Monitoring; and Golden Dome Project: open – inactive), and one cleanup program site (Vinton Spill: complete – case closed).

A brief overview of notable information related to open contaminated sites in the Subbasin is provided below; however, an extensive summary for each of the contamination sites is not presented. The location of the contaminated sites is shown in Figure 2.2.2-5.

Loyalton Sanitary Landfill

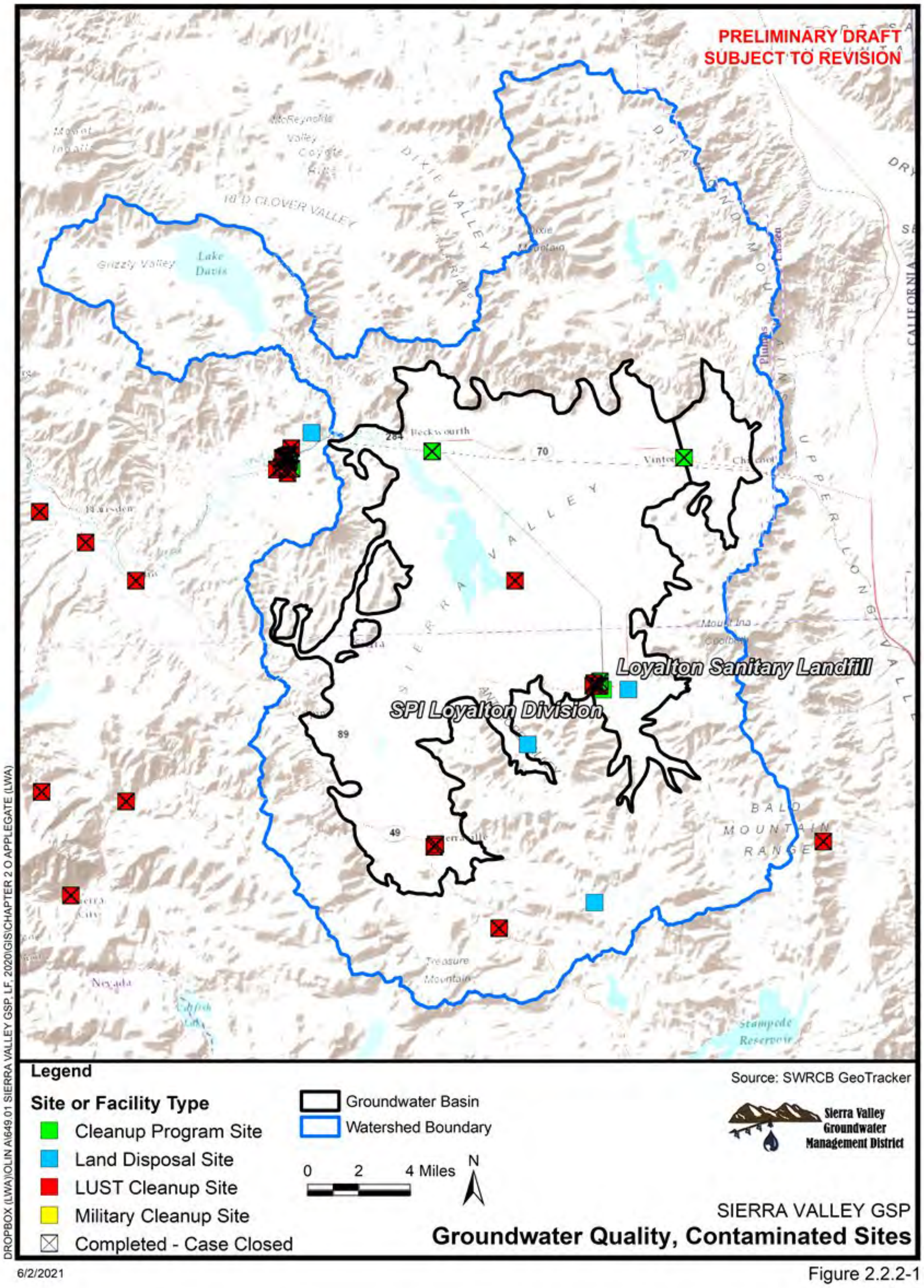
The case (No. 5A460300001) for this cleanup site was opened in January of 1965. This site is a Title 27 municipal solid waste landfill site. Substances released from the site, and contaminants of concern are not specified by GeoTracker.

SPI Loyalton Division

The leak associated with this case was reported in January of 1965, and the case for this cleanup site was opened in November 2004 and is currently listed as open and inactive. GeoTracker does not provide a case number for this site. Potential contaminants of concern associated with the site include waste oil (motor, hydraulic, lubricating).

While current data is useful to determine local groundwater conditions, additional monitoring is necessary to develop a basin-wide understanding of groundwater quality and greater spatial and temporal coverage would improve evaluation of trends. From a review of all available information, none of the sites listed above have been determined to have an impact on the aquifer, and the potential for groundwater pumping to induce contaminant plume movement towards water supply wells is negligible.

1538 **Figure 2.2.2-5 Contaminated Sites**



1539

2.2.2.5 Land subsidence conditions

Land subsidence is the lowering of the ground surface elevation. This is often caused by pumping groundwater from within or below thick clay layers. Land subsidence can be elastic or inelastic, meaning that the lithologic structure of the aquifer can compress or expand elastically due to water volume changes in the pore space or is detrimentally collapsed when water is withdrawn (inelastic). Inelastic subsidence is generally irreversible. Elastic subsidence is generally of a smaller magnitude of change, and is reversible, allowing for the lowering and rising of the ground surface and can be cyclical with seasonal changes.

The various data available for Sierra Valley show that inelastic subsidence has occurred in the recent past and likely continues to the present. While the subsidence has occurred in varying areas in Sierra Valley over time, it has overlapped with areas known to have significant groundwater pumping. The geology present in Sierra Valley is dominantly eroded alluvial sediment deposits consisting of clay, silt, sand, and gravel, which is typical of mountain valleys in California. The clay deposits are particularly susceptible to inelastic subsidence when heavy groundwater pumping is present.

2.2.2.5.1 Ground-based measurements of land subsidence

The first account of recorded subsidence in Sierra Valley was by the California Department of Water Resources (DWR, 1983). DWR (1983), along with Plumas County Road Department surveys, reported that inelastic subsidence occurred in the Sierra Valley and was consistent within the expected range considering the amount of groundwater decline observed. About 1-2 feet of total subsidence occurred during the period of 1960-1983. The subsidence during the period of 1983-2012 is unaccounted for as we have not found any reports accounting for subsidence during this period. The California Department of Transportation (CalTrans, 2016) conducted a survey where they collected data that suggested that subsidence of about 0.3 to 1.9 feet occurred in total during the period of 2012 to 2016. The area of this subsidence also coincided with known areas of heavy groundwater pumping.

There are no known Continuous Global Positioning System (CGPS) stations or extensometers installed in Sierra Valley. However, there are survey monuments remaining from previous ground elevation surveys.

Satellite observations of land subsidence

Satellite-based Interferometric Synthetic Aperture Radar (InSAR) data from a NASA JPL study show up to 0.5 feet of subsidence occurred in the northeast part of Sierra Valley during the period of 2015-2016. The study also shows up to 1.2 feet of subsidence occurred during the period of March 2015 to November 2019 (Farr et al., 2017; T. Farr, personal communications, Oct.-Dec. 2020). These data are shown in Figure 2.2.2-6 for the whole subbasin, and focused on the area with greatest subsidence in Figure 2.2.2-7.Time series of subsidence for six select locations are presented in Figure 2.2.2-8.Figure 2.1.1-4

To produce the subsidence dataset, NASA JPL obtained and analyzed data from ESA's satellite-borne Sentinel-1A from the period March 2015 – September 2016 and the NASA airborne UAVSAR for the period March 2015 – June 2016 and produced maps of total subsidence from the two data sets. These data add to the earlier data processed from the Japanese PALSAR for 2006 – 2010, Canadian Radarsat-2 for the period May 2014 – January 2015, and UAVSAR for July 2013 - March 2015, for which subsidence measurements were reported previously (Farr et al., 2015). They also present results for the South-Central coast of California including Ventura, Oxnard, Santa Barbara and north to the San Joaquin Valley as well as the Santa Clara Valley from colleagues who have processed Sentinel-1A data covering March 2015 – March 2016 (included are portions of the Sacramento Valley and various intermontane valleys in the Sierras, like Sierra Valley). As multiple scenes were acquired during these periods, they also produce time histories of subsidence at selected locations and transects showing how subsidence varies both spatially and temporally. Geographic Information System (GIS) files were furnished to DWR for further analysis of the 4-dimensional subsidence time-series maps.

A similar InSAR study from DWR/TRE Altamira (TRE Altamira, 2020; Towill, 2020) shows subsidence of up to 0.6 +/-0.1 feet over widespread areas, potentially higher in smaller areas, during the period of June 2015 to September 2019. They estimated an annual subsidence rates of up to 0.15 +/-0.1 feet/year in this same study. These data are shown in Figure 2.2.2-9.

The TRE Altamira InSAR dataset represents measurements of vertical ground surface displacement in more than 200 of the high-use and populated groundwater basins across the State of California between June of 2015 and September of 2019. Vertical displacement estimates are derived from Interferometric Synthetic Aperture Radar (InSAR) data that are collected by the European Space Agency (ESA) Sentinel-1A satellite and processed by TRE ALTAMIRA, Inc. (TRE), under contract with DWR as part of its SGMA technical assistance to provide important SGMA-relevant data to GSAs for GSP development and implementation. Sentinel-1A InSAR data coverage began in late 2014 for parts of California, and coverage for the entire study area began on June 13, 2015. Included in this dataset are point data that represent average vertical displacement values for 328 ft by 328 ft areas, as well as GIS rasters that were interpolated from the point data; rasters for total vertical displacement relative to June 13, 2015, and rasters for annual vertical displacement rates with earlier coverage for some areas, both in monthly time steps. Towill, Inc. (Towill), also under contract with DWR as part of DWR's SGMA technical assistance, conducted an independent study comparing the InSAR-based vertical displacement point time series data to data from CGPS stations. The goal of this study was to ground truth the InSAR results to best available independent data.

Regarding the similarities in InSAR data products from both organizations, TRE and JPL, they both process the same data set (Sentinel-1 satellite mission from the European Space Agency [ESA]) with slightly different techniques, so the results are similar but not exactly the same. It is also important to note that InSAR data reflect both elastic and inelastic subsidence and it can be difficult to isolate a signal solely for only the elastic subsidence amplitude. Visual inspection of monthly changes in ground elevations typically suggest that elastic subsidence is largely seasonal and can potentially be factored out of the signal, if necessary. Finally, the DWR/TRE InSAR data are the only InSAR data that can be used for estimating subsidence going forward as they are the only known subsidence-related data provided to and available for this subbasin by DWR for an indefinite period of time during the GSP implementation period.

2.2.2.5.2 DWR/TRE Altamira InSAR subsidence data quality

DWR has made Interferometric Synthetic Aperture Radar (InSAR) satellite data available on their SGMA Data Viewer web map as well as downloadable raster datasets to estimate subsidence. The TRE Altamira InSAR data provided by DWR are subject to compounded measurement and raster conversion errors. DWR has stated that for the total vertical displacement measurements, the errors are as follows (B. Brezing, personal communication, February 27, 2020):

1. The error between InSAR data and continuous GPS data is 0.052 ft (0.016 m) with a 95% confidence level.

2. The measurement accuracy when converting from the raw InSAR data to the maps provided by DWR is 0.048 ft (0.015 m) with 95% confidence level.

The addition of both of these errors results in the combined error is 0.1 ft (0.03 m). While not a robust statistical analysis, it does provide a potential error estimate for the TRE Altamira InSAR maps provided by DWR. A land surface change of less than 0.1 ft (0.03 m) is within the same magnitude of the noise of the data and is likely not indicative of groundwater-related subsidence in the basin. DWR contracted Towill, Inc. to complete a data accuracy report, and found similar levels of error to the 0.1 ft (0.03 m) error documented above. The full report is included in Appendix ## (subsidence appendix).

Figure 2.2.2-6 InSar-based land subsidence for the period of March 2015 to November 2019

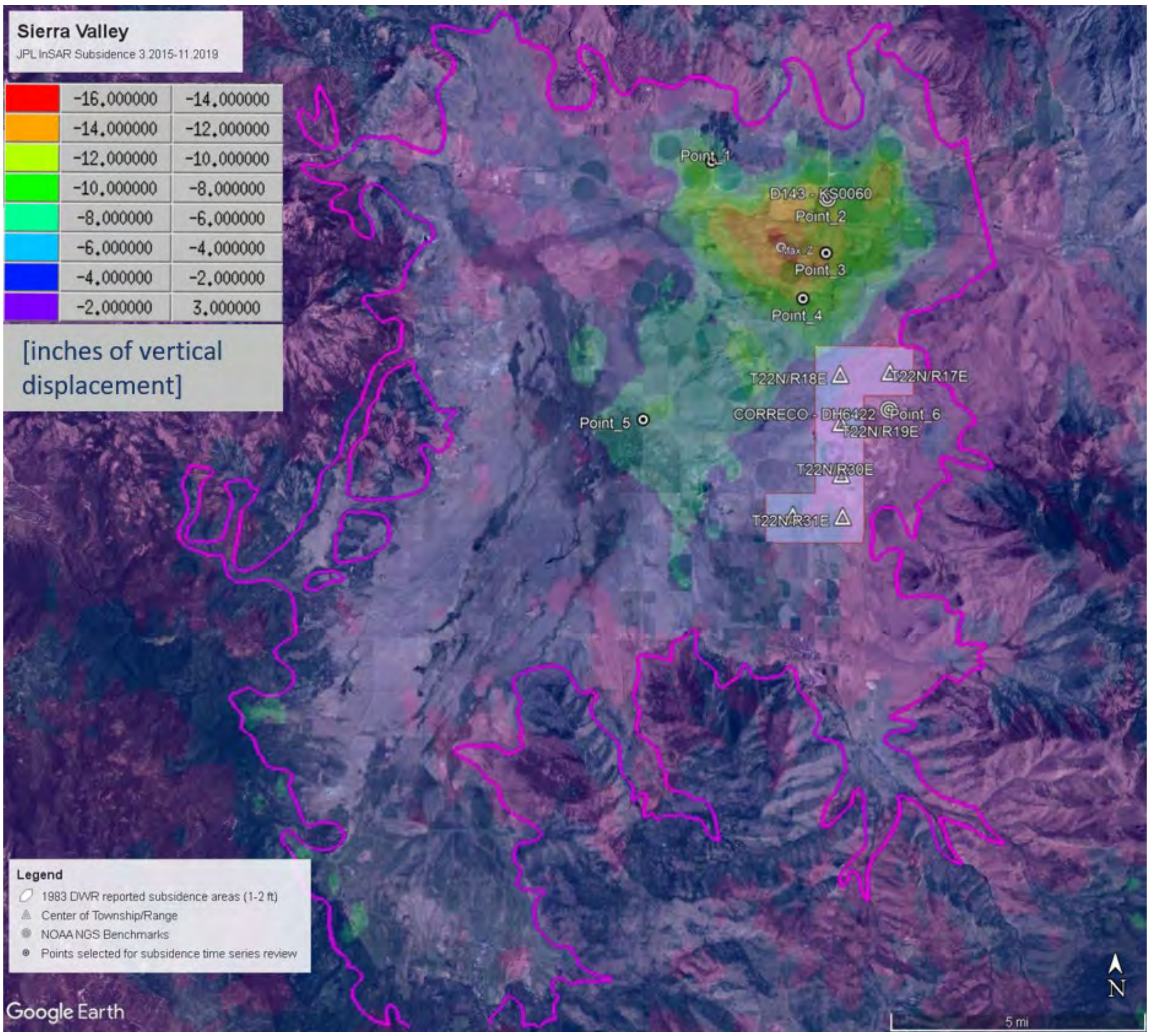


Figure 2.2.2-7 InSar-based land subsidence for the period of March 2015 to November 2019, focused on the portion of the subbasin with the greatest measured subsidence

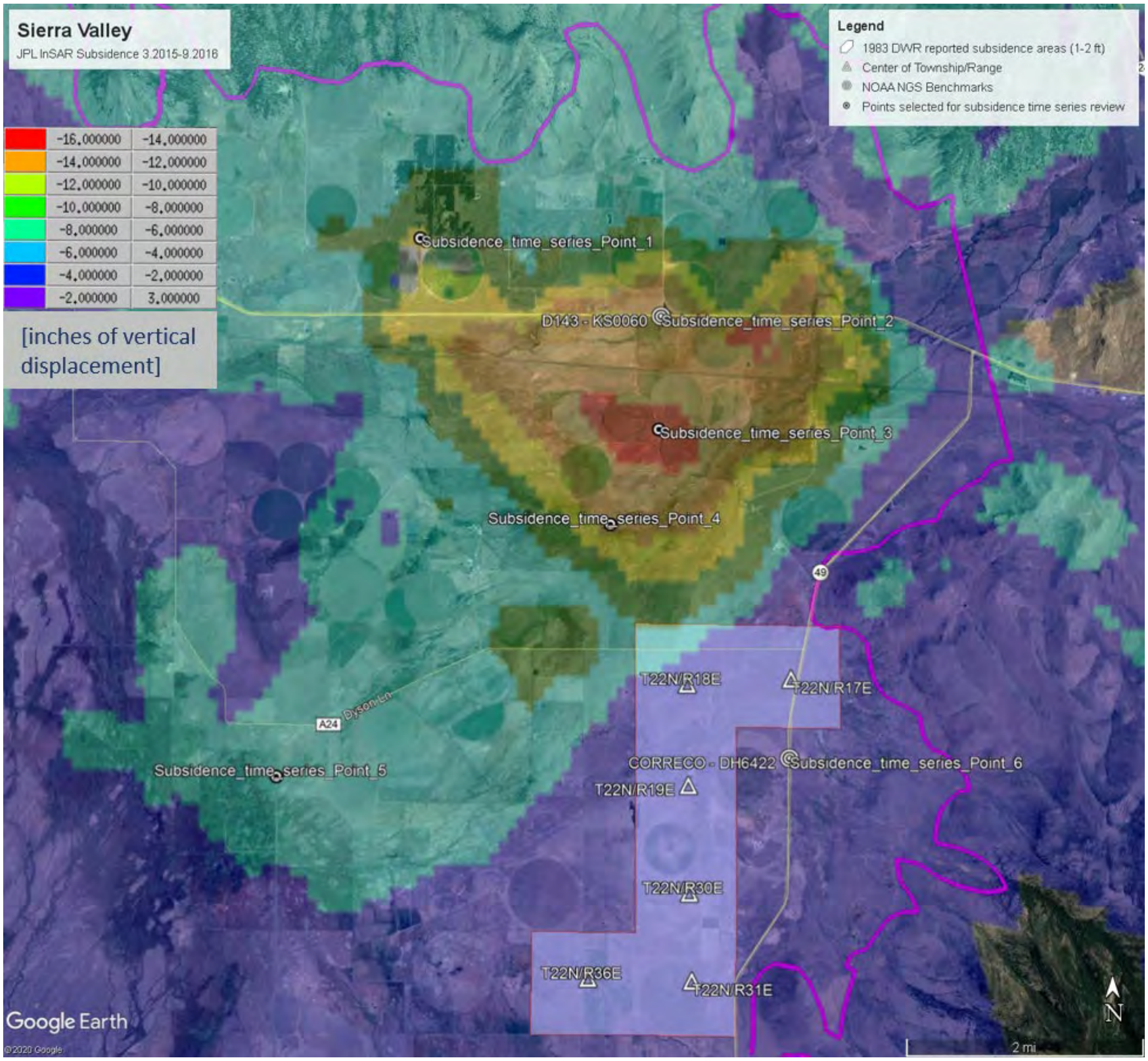


Figure 2.2.2-8 Time series of JPL InSAR land subsidence data for the locations called out in Figure 2.2.2-3

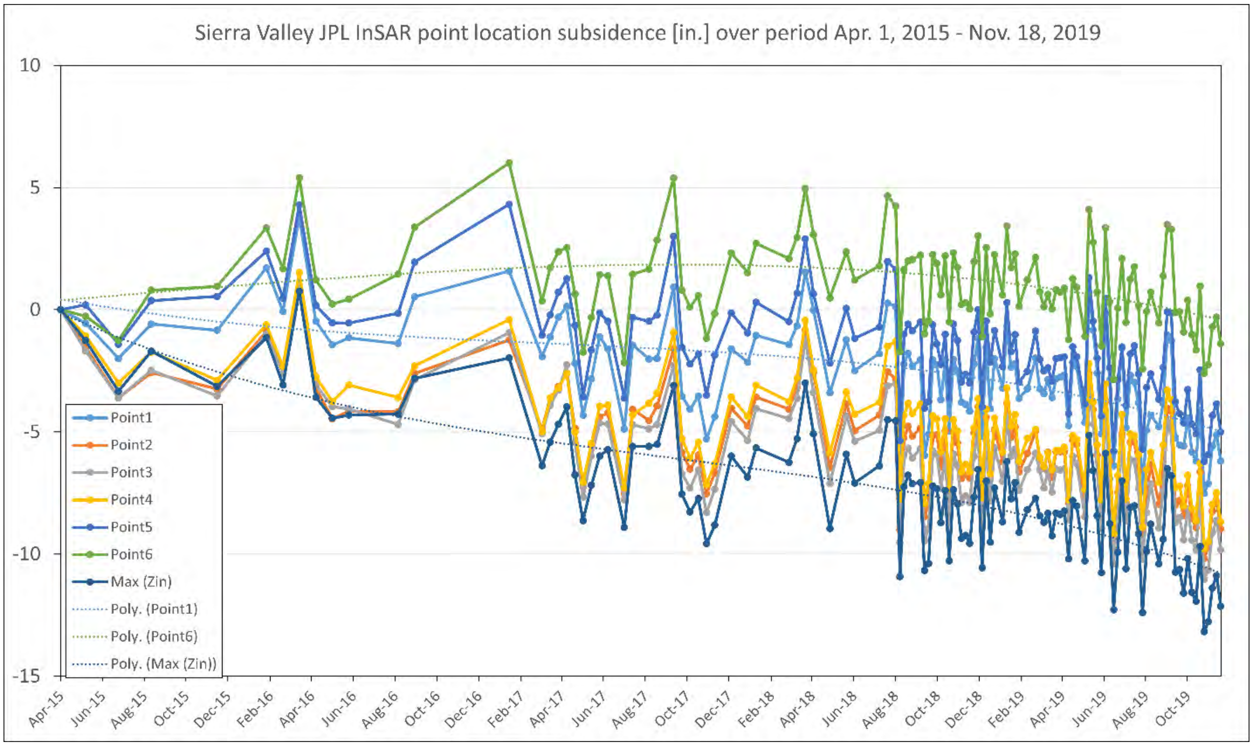
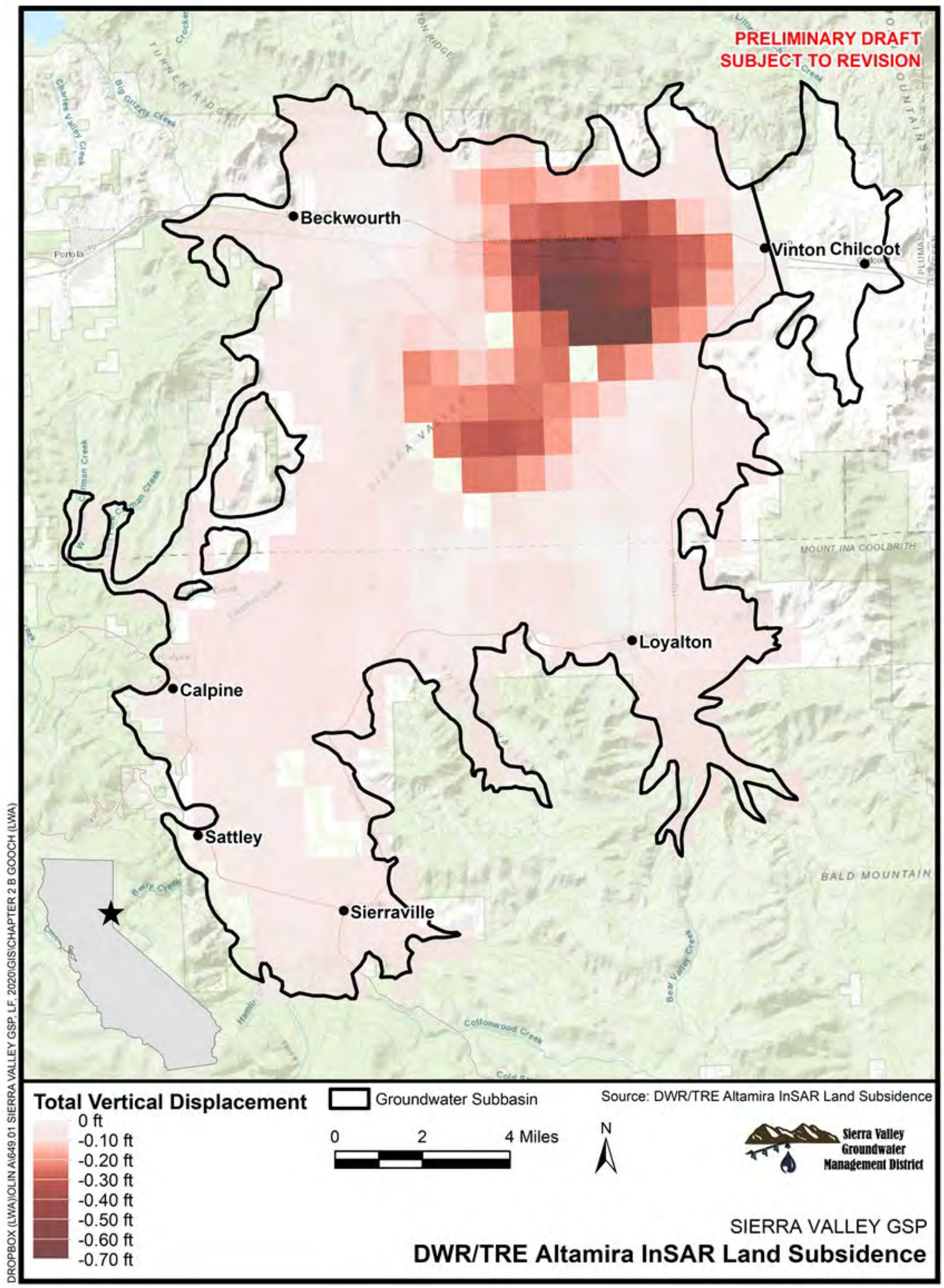


Figure 2.2.2-9 DWR/TRE Altamira InSAR land subsidence for the period June 2015 to September 2019



2.2.2.6 Identification of interconnected surface water systems

Surface water within the Sierra Valley is composed of a complex network of single and multi-channel streams, irrigation ditches, ponds, seasonal wetlands, and springs. In general, groundwater is located close to the land surface in much of the south and west side of the valley and near the valley margins. Where surface water features and shallow groundwater coincide is where the potential exists for interconnected surface water. Section 351 (o) of the GSP Regulations define interconnected surface water (ISW) as, “surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted.” The methodology of identifying interconnected surface water was to first identify the surface water features within the valley. We focused on streams and excluded emergent wetlands since those will be in the groundwater dependent ecosystem (GDE) mapping. We next looked at monitoring wells and springs within the valley and used that data over multiple years to generate a composite potentiometric surface of groundwater elevations. The generated groundwater surface elevations were then differenced from the land surface elevations to develop a map of the depth to groundwater. With the exception of portions of the Middle Fork Feather River, channel thalwegs (which are defined by a line connecting the lowest points along a stream) are on the order of 5 feet lower than the adjacent floodplain areas. Therefore, where overlying surface water exists and groundwater was estimated to be less than 5-feet below the land surface, the surface water body is considered to be hydraulically connected and classified as an ISW.

2.2.2.6.1 Identification of Surface Water

Unlike many groundwater basins where tributary streams join to form larger streams or rivers, the majority of streams entering the Sierra Valley are distributary in nature. As streams enter the Valley, they flow across alluvial fans in the transition zone from steep mountainous channel to flat valley bottom and bifurcate to become multi-threaded channels. This process of a single threaded channel transitioning to a multi-threaded channel has been further enhanced by decades of straightening, diverting, and otherwise altering flow paths to redistribute water and better irrigate the landscape for cattle grazing. Ultimately, the many streams that enter the valley coalesce in the central wetland complex before moving north as a more defined channel, the Middle Fork Feather River.

Due to the numerous streams and stream networks within the basin, the USGS National Hydrography Dataset Plus High Resolution (NHDPlus HR) was used as a first pass to map surface water. This dataset is created using a geospatial model to map the flow of water across the landscape using a digital elevation model of 10-meter ground spacing or better. The NHD mapping includes 844 miles of streams in the groundwater basin, which was then reduced to identify surface wager bodies through a mix of field and aerial imagery verification. The verified surface water mapping for this GSP now includes a total of 365 miles of streams.

2.2.2.6.2 Depth to Groundwater

The average depth to groundwater map was estimated using available data from CASGEM, district monitoring wells (DMWs), and mapped springs. Springs provide an indication of where groundwater levels are at the ground surface and were identified using the same process used to identify streams in the Valley. The NHD mapping of springs was then verified in the field or by high resolution aerial imagery. Due to the limited temporal resolution of the monitoring well dataset, it was necessary to use a four-year running seasonal mean to develop a potentiometric surface of groundwater elevations. The verified spring location data and four years of monitoring well data provided adequate spatial density to perform a kriging interpolation to come up with a meaningful map of groundwater elevations and depth to groundwater. For identification of ISW, we chose to use the average of monitoring well data from the Spring seasons from 2017 to

2020. This period includes an adequate amount of well data and represents a wetter than average period as a conservative approach to identify where groundwater levels may regularly be near the ground surface.

2.2.2.6.3 Identification of Interconnected Surface Water

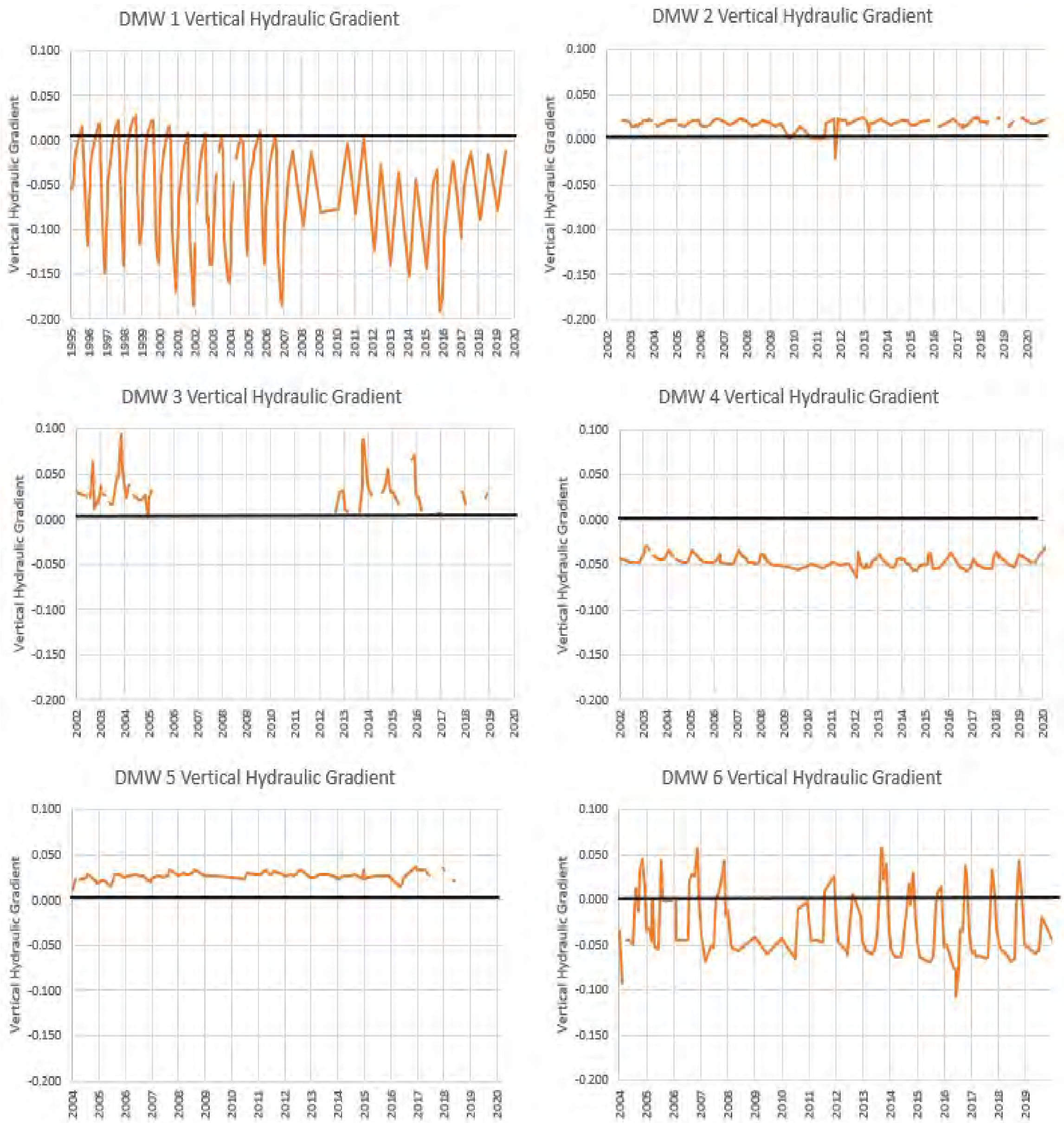
Together the surface water mapping of streams and the shallow depths to groundwater map were used to identify areas of potential ISWs. Before overlaying these two data sets, we first needed to estimate a buffer to account for the depth of the stream below the surrounding landscape. The channel thalweg represents the lowest point in a stream that could be connected to groundwater. The approximate channel thalweg elevation was estimated by evaluating channel sections cut from a 1-meter DEM prepared from the USGS LPC CA NoCAL Wildfires B1 2018 LiDAR dataset. Streams within the Sierra Valley are generally not deeply incised; the channel thalweg was consistently found to be 5-feet or less below the adjacent floodplain. Only dry channels were evaluated because the type of LiDAR data gathered does not penetrate water; therefore, better estimates of channel depth could be developed by conducting more detailed topographic and bathymetric surveys. Where overlying surface water was present and groundwater was found to be within 5-feet of the land surface, the surface water was classified as ISW.

Nested monitoring wells were used to confirm ISWs that were identified using the approach outlined above. Nested monitoring wells are District monitoring wells (DMW's) that were installed throughout the valley beginning in the Fall of 1995, with the majority of wells being installed in the early 2000's and the most recent in the Spring of 2020. A total of 7 sets of nested wells have been installed at varying depths throughout the valley. The DMW's are unique compared to other monitoring wells as each location contains two to three nested wells. Nested wells are constructed with two or more wells within the same borehole and screened at different depths. The wells are isolated from each other using an annular seal and were used to measure a difference in hydraulic head at the screened depths. Vertical hydraulic gradient was then calculated by differencing the hydraulic head of the shallow well to the deeper well and dividing by the distance between the midpoints of the screened intervals. A negative value indicates the potential for downward flow and is an indication that surface water or shallow groundwater is recharging the deeper aquifer. A positive value indicates the potential for upward flow where deeper groundwater is moving toward the shallow aquifer or discharging to surface water. Time series plots showing vertical hydraulic gradients in nested wells are presented in Figure 2.2.2-10, and locations of each DMW nested well is included in Figure 2.2.2-11.

Nested wells also help establish whether a surface water body is connected to a perched aquifer or the principal aquifer. Areas of perched groundwater can be found within the valley especially around the Little Last Chance Creek diversion ditches. Perched groundwater does not represent a continuous saturated zone to the principal aquifer; therefore, these areas are excluded from consideration as ISW.

Sierra Valley Groundwater Management District

Figure 2.2.2-10 Calculated vertical hydraulic gradients between deep and shallow nested district monitoring wells



[11]

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[11] Positive values indicate an upward gradient where the deep aquifer has the potential to flow toward shallow groundwater or discharge to surface water. A negative value indicates a downward gradient and the potential for shallow groundwater or surface water to be recharge the deep aquifer.

Figure 2.2.2-11 Locations of district monitoring wells in the Sierra Valley. Wells with both green and red arrows show seasonal changes in the vertical hydraulic gradient

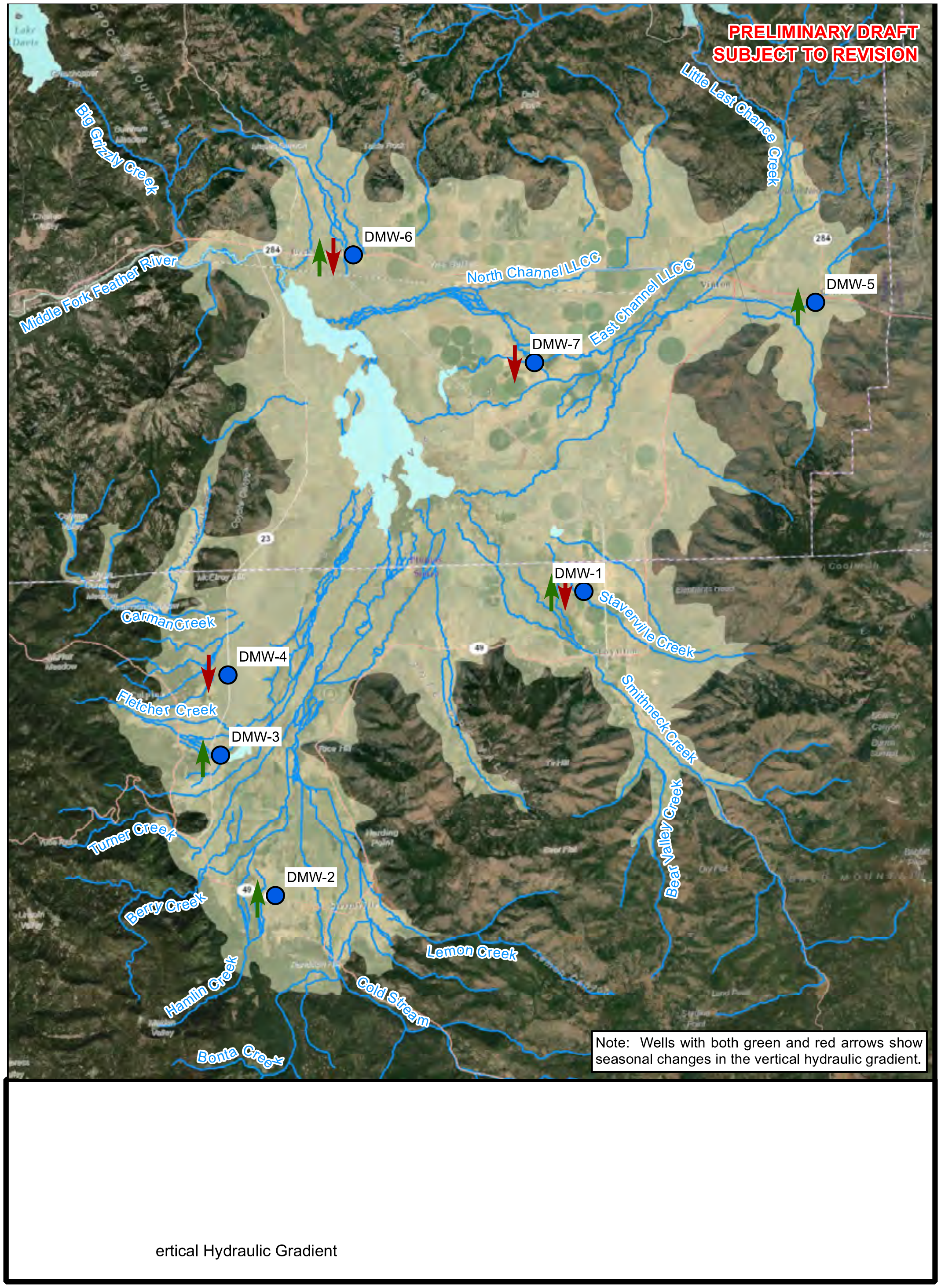
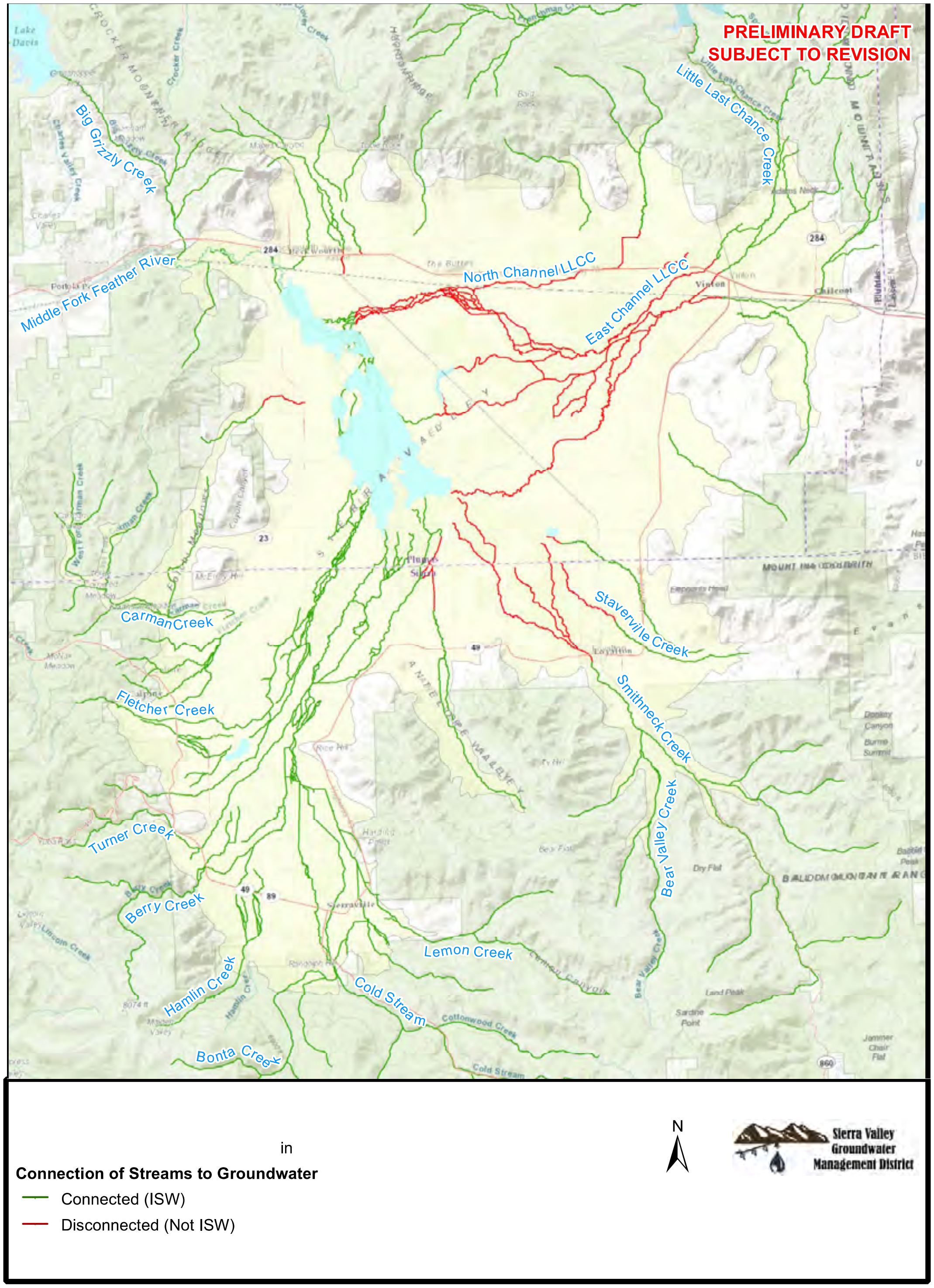


Figure 2.2.2-11 presents a map of streams identified as ISW along with streams which appear to be disconnected. In general, surface water in the central and eastern portions of the Sierra Valley does not appear to be hydraulically connected to groundwater. This includes Smithneck

Creek downstream of Loyalton and Little Last Chance Creek downstream of Highway 70 to the large central wetland complex. An area of disconnected streams also exists on the western side of the Valley including Carman and Fletcher Creeks downstream of the Westside Road. Streams on the south, west, and near the Valley margins are generally connected to groundwater. This includes the streams on the south and west side such as Lemon Creek, Cold Stream, Bonta Creek, Hamlin Creek, Berry Creek, Turner Creek, Fletcher Creek, and Carman Creek. On the east side of the Valley this includes Little Last Chance Creek above Highway 70, Staverville Creek, Smithneck Creek above Loyalton, and Bear Valley Creek.

Figure 2.2.2-12 Map of Interconnected Surface Water (ISW) in the Sierra Valley



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Update Fig #

2.2.2.6.4 Summary of available surface water data

Surface water monitoring is limited within the Sierra Valley watershed and the groundwater basin. The following are locations where surface water data is being actively collected. See Figure 2.2.2-13 and Figure 2.2.2-14 for locations maps of surface water monitoring stations.

- Frenchman Reservoir daily outflow data
- Davis Reservoir daily outflow data
- Little Truckee Diversion daily flow data during the irrigation season
- Middle Fork Feather 15-minute flow data
- Various streams and springs with periodic measurements during the irrigation season (see Table 2.2.2-2 for a better summary of this data)
    - Cold Stream
    - Webber
    - Lemmon
    - Spring East
    - Spring West
    - Fletcher
    - Turner
    - Berry (Miller)
    - Hamlin
    - Parshall 180
    - Smithneck
    - Staverville

Surface water monitoring is presently focused near and outside of the groundwater basin margin. There are no continuous streamflow monitoring locations within the central portion of the Valley. The data being collected by the DWR Watermaster for the Sierra Valley is only done in preparation for and during the irrigation season on up to 12 different tributaries that flow into the Valley. It is important to differentiate these periodic instantaneous measurements during the irrigation season from year-round continuous streamflow gaging, such as that which takes place on the Middle Fork Feather River. The periodic flow measurements are made solely for the purpose of determining surface water deliveries based on allocations defined by established water rights, and measurements are taken manually with a flow meter or by observing stage in an installed weir. Because of the discontinuous nature (only during the irrigation season) and infrequency of measurements (weekly at best), the data collected by the Watermaster can not be used for more in-depth analysis such as volume calculations or flood-frequency analysis. Table 2.2.2-2 summarizes the data collected by the Sierra Valley Watermaster since 2007.

Figure 2.2.2-13 Streams monitored by the Sierra Valley Watermaster during the irrigation season

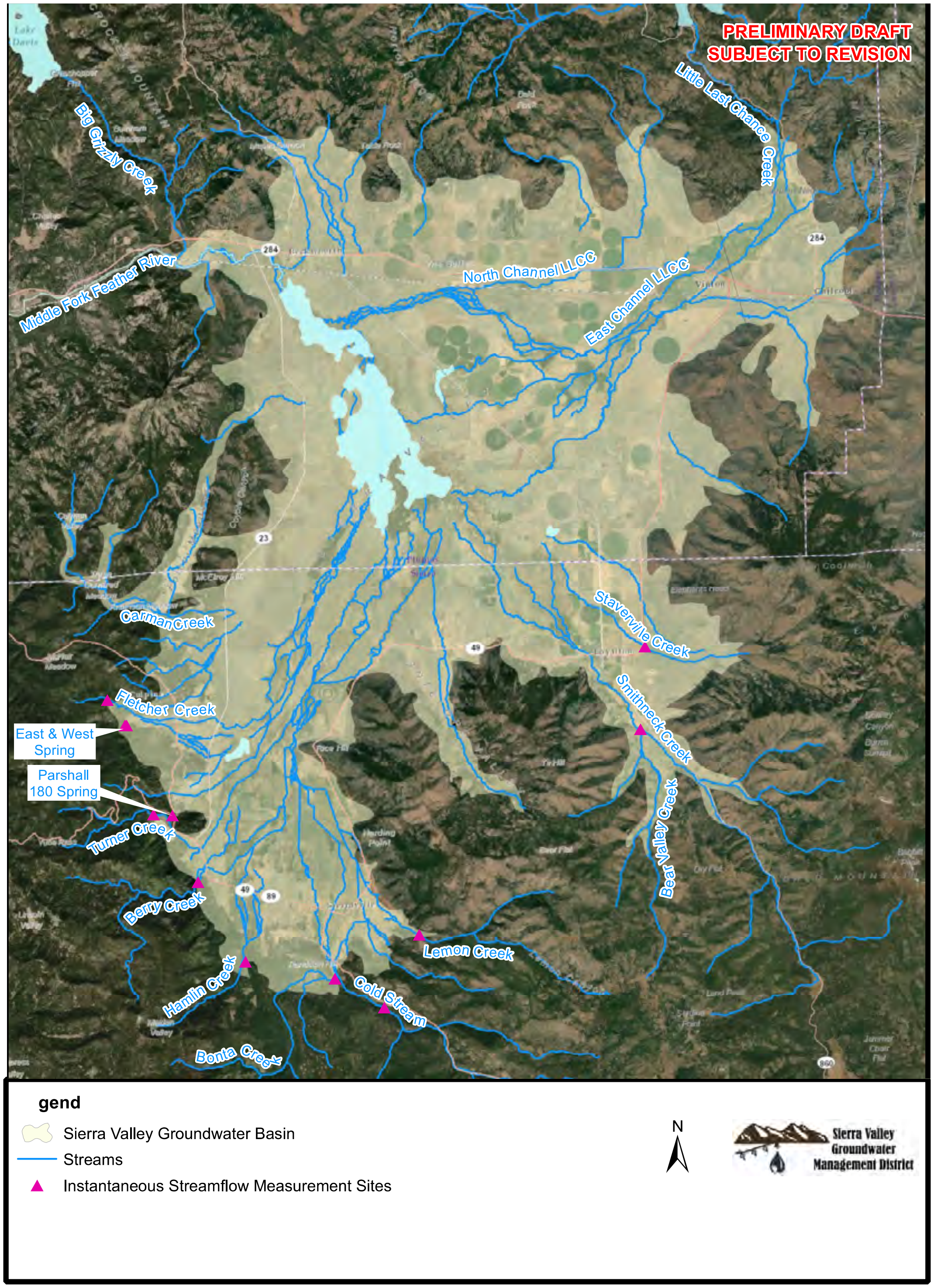


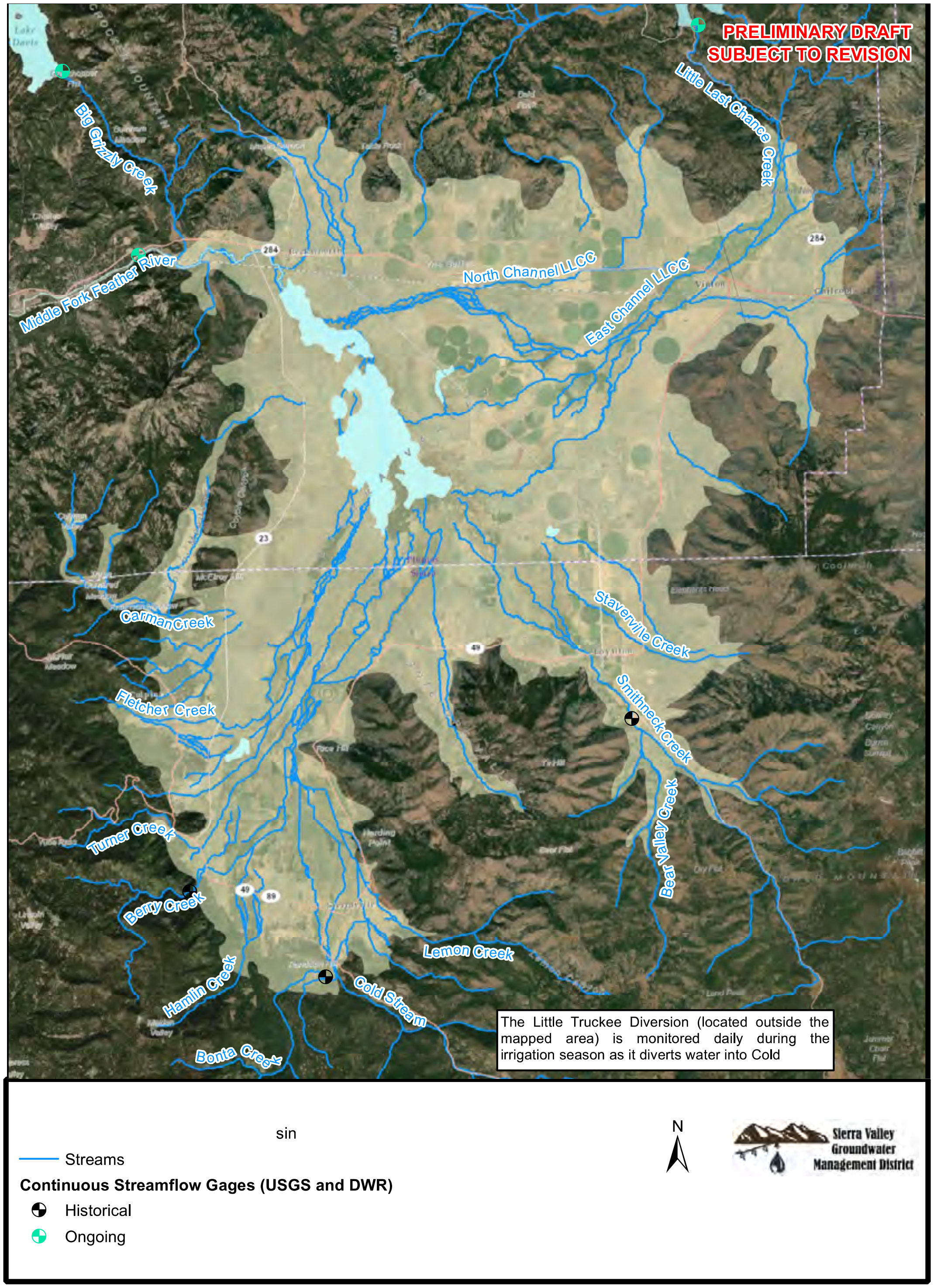
Table 2.2.2-2 Streamflow Measurements

Stream Name	Total No. of Observations	Stage Readings	Flow Measurements	Period of Record	Average Flow of All Observations (cfs)
Cold Stream	124	4	120	4/2007-9/2020	36.1
Webber	114	14	100	7/2007-9/2020	17.8
Lemmon	21	0	21	5/2009-9/2020	7.3
Spring East	22	11	11	6/2018-9/2020	0.9
Spring West	22	10	12	6/2018-9/2020	0.9
Fletcher	49	15	34	7/2011-9/2020	4.2
Turner	81	16	65	5/2009-9/2020	5.6
Berry (Miller)	89	0	89	4/2007-9/2020	14.6
Hamlin	74	0	74	4/2007-9/2020	13.0
Parshall 180	48	0	48	3/2015-9/2020	0.8
Smithneck	54	0	54	7/2008-9/2020	13.4
Staverville	7	0	7	3/2019-9/2020	3.9

Based on the available flow measurements, Cold Stream is the most significant water delivery to the Valley as that measurement also includes flow from the Little Truckee Diversion. Webber, Berry, Hamlin, and Smithneck also appear to be significant sources of surface water to the Valley; however, the discontinuous and periodic measurements during the irrigation season and do not represent the full range of hydrologic conditions in the streams.

Historically, a greater number of area streams were monitored continuously by the USGS or DWR. In the past streamflow data has been collected on Smithneck Creek near Loyalton, Bonta Creek near Sierraville, Berry (Miller) Creek near Sattley, and Little Last Chance Creek near Chilcoot (Vestra, 2005 and Bachand and others, 2019).

Figure 2.2.2-14 Ongoing and historical continuous streamflow gaging or reservoir outflow for the Sierra Valley



2.2.2.7 Identification of groundwater-dependent ecosystems

As part of SGMA, GSAs are required to consider groundwater dependent ecosystems (GDEs) and other beneficial uses of groundwater when developing their GSPs. SGMA defines GDEs as "ecological communities of species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" (23 CCR § 351(m)). As described in The Nature Conservancy's guidance for GDE analysis (Rohde et al. 2018), a GDE's dependence on groundwater refers to reliance of GDE species and/or ecological communities on groundwater for all or a portion of their water needs. GDEs include ecosystems associated with springs and seeps as well as plant communities that can tap groundwater using their roots. In addition, interconnected surface waters (see Section 2.2.2.7) can be used by both aquatic and riparian GDEs. and Identification of GDEs includes determining which vegetation types can tap groundwater through their root systems and mapping the extent of surface water (including rivers, springs, and seeps) that are interconnected with groundwater (Rohde et al. 2018). Here, potentially groundwater dependent vegetation units were identified from existing vegetation maps within Sierra Valley and compared with measurements of groundwater depth. Streams with interconnected surface water were identified in Section 2.2.2.7. Once the GDEs are mapped, the occurrence of special-status species was used to determine the beneficial users of GDEs and the ecological value of GDEs in the basin.

2.2.2.7.1 Methods

2.2.2.7.1.1 GDE Identification

This section includes brief descriptions of the vegetation community data and other information sources used to identify and aggregate potential GDEs into final GDE units. The Natural Communities Commonly Associated with Groundwater database (DWR 2020) was reviewed in a geographic information system (GIS) and used to generate a preliminary map to serve as the primary basis for initial identification of potential GDEs in the Sierra Valley Groundwater Basin.

The steps for defining and mapping GDEs outlined in Rohde et al. (2018) were used as a guideline for this process. A decision tree was applied to determine when species or biological communities were considered groundwater dependent based on definitions found in 23 CCR § 351(m) (State Water Resources Control Board 2021) and Rohde et al. (2018). This decision tree, created to systematically and consistently address the range of conditions encountered, is summarized below; the term "unit" refers to an area with consistent vegetation and hydrology:

The unit is a GDE if groundwater is likely:

1. Interconnected with surface water
2. An important hydrologic input to the unit during some time of the year, AND
3. Important to survival and/or natural history of inhabiting species, AND
4. Associated with a principal aquifer used as a regionally important source of groundwater

The unit is not a GDE if its hydrologic regime is primarily controlled by:

1. Surface discharge or drainage from an upslope human-made structure(s) with no connection to a principal aquifer, such as irrigation canal, irrigated fields, reservoir, cattle pond, or water treatment pond/facility.
2. Precipitation inputs directly to the unit surface. This excludes vernal pools from being GDEs where units are hydrologically supplied by direct precipitation and very local shallow subsurface flows from the immediately surrounding area.

Rohde et al. (2018) recommend that maps of potential GDEs be compared with local groundwater elevations to determine where groundwater is within the rooting depth of potential GDEs. Given uncertainties in extrapolating well measurements to GDEs and differences in surface elevation of wells and GDEs, Rohde et al. (2018) recommend assigning GDE status to vegetation communities either where groundwater is within 30 ft of the ground surface or where interconnected surface waters are mapped. Because of uncertainties in the source of water used by vegetation and aquatic organisms, ecosystems likely dependent on groundwater were identified as potential GDEs.

The following datasets were used to develop a map of potential GDEs in the Sierra Valley Groundwater Basin:

- Classification and Assessment with Landsat of Visible Ecological Groupings (CalVeg) – United States Department of Agriculture - Forest Service (USDA 2014). *North Sierra region: Imagery date: 2000–2009; Minimum mapping unit (MMU): 2.5-acre.*
- National Wetlands Inventory - Version 2.0 (NWI), U.S. Fish and Wildlife Service (USFWS 2018). *Imagery date: 1984; Minimum mapping unit (MMU): 0.5-acre.*
- Statewide Crop Mapping 2018, California Department of Water Resources (CA DWR 2018)
- Interconnected surface water map detailed in Section 2.2.2.6
- Average spring depth to water (2017-2020) in the Sierra Valley Groundwater Basin, Larry Walker Associates (LWA 2021)

Both CalVeg and NWI were used to construct the vegetation map, which are included in CA DWR (2020). Where CalVeg and NWI overlapped, NWI was used to denote potential wetland vegetation, based on comparison of the two vegetation maps and aerial photography. Potential GDEs were defined as plant communities that were likely dependent on groundwater or interconnected surface water were identified based on Sites classified as agriculture by CA DWR (2018) were not included as GDEs. Because the position of channels in the interconnected surface water (ISW) map (Section 2.2.2.6) differed from riverine map units in the NWI dataset. Where the NWI riverine polygons that were not within 50 ft of ISW points, was typed as an unlikely GDE.

The potential GDE map was then overlain with a depth to groundwater raster derived from average groundwater elevation contours from 2017–2020 were subtracted from a 2018 1-m USGS DEM (USGS 2021). Potential GDEs that occur where depth to groundwater exceeds 30 ft were removed from the potential GDE map. Average spring depth to water from 2017 to 2020 was used for this assessment. The average value from 2017 to 2020 was used instead of an individual year because using multiple years allowed for a much more robust estimate of groundwater depth.

Interconnected surface water maps described in Section 2.2.2.6 were used in place of NWI riverine polygons. Where the replaced riverine polygons occurred within other GDE polygons, they were not removed to avoid holes in the map. Otherwise, the riverine polygons were removed.

2.2.2.7.1.2 Special-status Species

As part of the ecological inventory, special-status species and sensitive natural communities that are potentially associated with GDEs in the Sierra Valley Groundwater Basin were identified. For the purposes of this document, special-status species are defined as those:

- listed, proposed, or under review as endangered or threatened under the federal Endangered Species Act (ESA) or the California Endangered Species Act (CESA);
- designated by California Department of Fish and Wildlife (CDFW) as a Species of Special Concern;
- designated by CDFW as Fully Protected under the California Fish and Game Code (Sections 3511, 4700, 5050, and 5515);
- designated as Forest Service Sensitive according to the Regional Forester's Sensitive Species Management Guidelines listed per USFS Memorandum 2670 (USFS 2011);
- designated as Bureau of Land Management (BLM) sensitive;
- designated as rare under the California Native Plant Protection Act (CNPPA); and/or
- included on CDFW's most recent Special Vascular Plants, Bryophytes, and Lichens List (CDFW 2020a) with a California Rare Plant Rank (CRPR) of 1, 2, 3, or 4.

Sensitive natural communities are defined as vegetation communities identified as critically imperiled (S1), imperiled (S2), or vulnerable (S3) on the most recent California Sensitive Natural Communities List (CDFW 2020b).

Stillwater ecologists queried databases on regional and local occurrences and spatial distributions of special-status species within the Sierra Valley Groundwater Basin. Spatial database queries included potential GDEs plus a 1-mile buffer. Databases queried include:

- California Natural Diversity Database (CNDDB) (CDFW 2020b);
- California Native Plant Society (CNPS) Manual of California Vegetation (2021);
- eBird (2021); and
- TNC freshwater species lists generated from the California Freshwater Species Database (CAFSD) (TNC 2021); and
- USFWS's Information for Planning and Consultation (IPaC) portal (USFWS 2021).

Stillwater reviewed the database query results and identified special-status species and vegetation communities that may occur within or be associated with the vegetation and aquatic communities in or immediately adjacent to potential GDEs. Stillwater ecologists then consolidated these special-status species and sensitive community types into a list, along with summaries of habitat preferences, potential groundwater dependence, and reports of any known occurrences.

Wildlife species were evaluated for potential groundwater dependence using determinations from the Critical Species Lookbook (Rohde et al. 2019) or by evaluating known habitat preferences, life histories, and diets. Species GDE associations were assigned one of three categories:

- Direct—species directly dependent on groundwater for some or all water needs (e.g., cottonwood with roots in groundwater, juvenile steelhead in dry season)

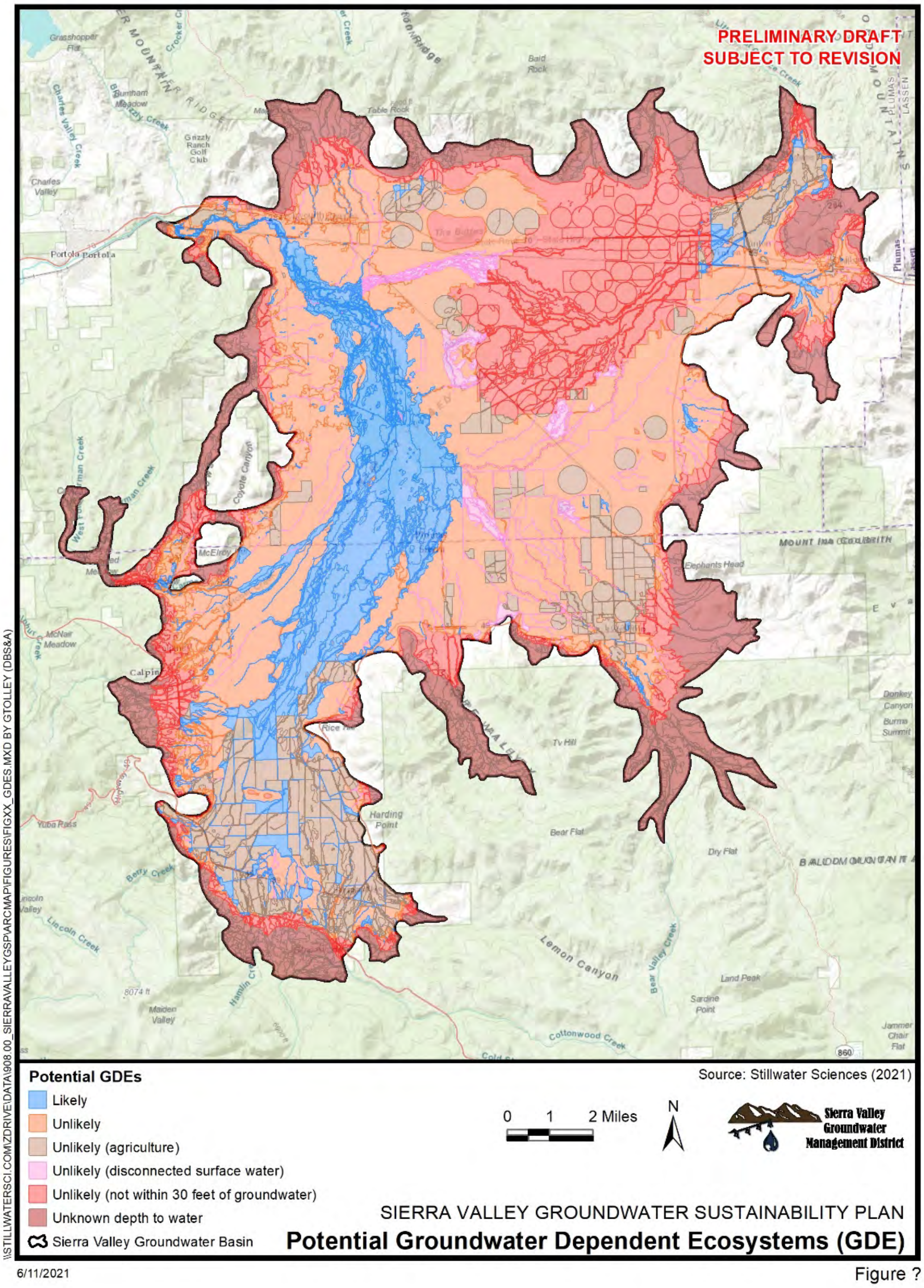
- Indirect—species dependent upon other species that rely on groundwater for some or all water needs (e.g., riparian birds)
- No known reliance on groundwater

Sensitive natural communities were classified as either likely or unlikely to depend on groundwater based on species composition using the same methodology as vegetation communities (Section 2.1.3). Plant species were evaluated for potential groundwater dependence based on their habitat (Jepson Flora Project 2020) and association with vegetation communities classified as GDEs. Special-status plant GDE associations were assigned one of three categories: likely, possible, or unlikely. The "possible" category was included to classify plant species with limited habitat data or where a species may have an association with a vegetation community identified as a GDE (e.g., wet meadows, seeps, and springs). Database query results for local and regional special-status species occurrences were combined with their known habitat requirements to develop a list of groundwater dependent special-status species (Section 3.2) that satisfy the following criteria: (1) documented to occur within the GDE unit, or (2) known to occur in the region and suitable habitat present in the GDE unit.

2.2.2.7.2 Results

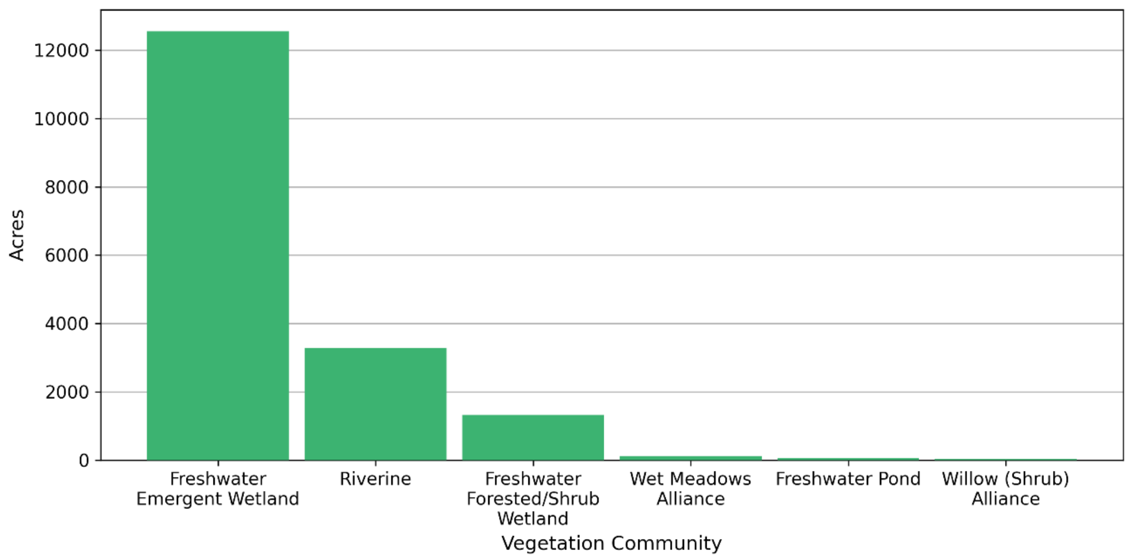
The Sierra Valley Groundwater Basin contains 17,355 acres of GDEs, approximately 15% of the total basin area (Figure 2.2.2-15). About 80% of the GDEs in the basin are associated with the large wetland complex in the western half of the groundwater basin. GDEs are primarily located along the western edge of the basin. The GDEs overlie clay-rich sediments with poorly drained soils. There are few wells near the GDEs, and the groundwater depths are somewhat uncertain.

Figure 2.2.2-15 Potential Groundwater Dependent Ecosystems in the Sierra Valley Groundwater Basin



Freshwater emergent marshland is the most prevalent vegetation community (12,552 acres, Figure 2.2.2-16 comprising 72% of all GDE area. Riverine (3,276) and freshwater forested/shrub wetland (1,322) vegetation communities are also prevalent, comprising 19% and 8%, respectively, of all GDE area.

Figure 2.2.2-16 Five most prevalent GDE vegetation communities in the Sierra Valley Groundwater Basin, by acreage



2.2.2.7.3 Hydrology near GDEs

Trends in the hydrology near the GDEs were assessed by comparing groundwater elevation contours through time. This analysis compared spring and fall groundwater levels independently but averaged over multiple years (either during fall or spring) to ensure that the contours are statistically robust. For GDEs, the spring levels define the highest elevation of the year and can help to define the GDEs, but the fall groundwater levels are crucial for maintaining health of most GDEs. In general, groundwater levels near GDEs declined during the 2012-2015 drought and subsequently recovered. Fall groundwater levels declined between 2006-2009 and 2012-2015 in the main wetland GDE area on the western side of the basin. The 2012-2015 period represents drought conditions. The decline in groundwater levels was greatest in the eastern portion of the main GDE (about 25 ft) and was smallest in the southern and western portions of the GDE. Groundwater levels rebounded to 2006-2009 levels by 2020.

Similar trends were observed outside of the main GDE area, although the magnitude of change varied. South of the main GDE, near Hamlin Creek at Sierraville groundwater levels declined by less than 5 feet between 2006-2009 and 2012-2015 before subsequently recovering. On the eastern side of the basin, near the mouth of Correco Canyon, groundwater levels declined by approximately 10 ft between 2006-2009 and 2012-2015 and have yet to recover to 2006-2009 levels. Near Little Last Chance Creek at Vinton, groundwater levels declined by approximately 15 ft and subsequently recovered to within five ft of 2006-2009 levels by 2020.

In summary, groundwater levels near the GDEs dropped during droughts but appeared to recover to their pre-drought levels in most of the GDEs.

There is not sufficient information in the vegetation mapping to assess the rooting depth of the plants relative to the depth of groundwater and predict the impact of these changes.

Interconnected surface water (Section 2.2.2.7) is the main surface water source to the GDE units, but the degree to which the GDEs are maintained by interconnected surface water or groundwater is not known.

2.2.2.7.4 Special-status Species

The Sierra Valley Groundwater Basin includes United States Fish and Wildlife Service (USFWS) designated critical habitat for one federally listed species: Webber's ivesia (*Ivesia webberi*) (2,094 acres) (USFWS 2014). The critical habitat is located on the eastern edge of the groundwater basin near Dyson Lane and Highway 49. Habitat for Webber's ivesia—sagebrush flats—is not a GDE community.

Twelve likely groundwater-dependent special-status plant species were documented in the Sierra Valley Groundwater Basin (Table 2.2.2-3). In addition, one likely groundwater-dependent sensitive natural community (montane freshwater marsh) occurs in the Sierra Valley Groundwater Basin (Table 2.2.2-3).

Table 2.2.2-3 Special-status plant species and sensitive natural communities with known occurrence within the Sierra Valley Groundwater Basin

Common name *Scientific name*	Status[1,2]	Association with GDE[2]	Habitat and occurrence[2]
Plants			
Lemmon's milk-vetch *Astragalus lemmonii*	1B.2, S2, G2	Likely	Moist, alkaline meadows, lake shores
Pulsifer's milk-vetch *Astragalus pulsiferae var. pulsiferae*	1B.2, S2, G4T2	Unlikely	Sandy or rocky soil, often with pines, sagebrush
Scalloped moonwort *Botrychium crenulatum*	2B.2, S3, G4	Likely	Saturated hard water seeps and stream margin
Mingan moonwort *Botrychium minganense*	2B.2, S3, G4G5	Likely	Meadows, open forest along streams or around seeps
Western goblin *Botrychium montanum*	2B.1, S2, G3	Possible	Shady conifer woodland, especially under *Calocedrus* spp. along streams
Watershield *Brasenia schreberi*	2B.3, S3, G5	Likely	Ponds, slow streams
Fiddleleaf hawksbeard *Crepis runcinata*	2B.2, S3, G5	Unlikely	Sagebrush scrub, pinyon-juniper woodland, wetland-riparian zones
Globose cymopterus *Cymopterus globosus*	2B.2, S1, G3G4	Unlikely	Sandy open flats
Nevada daisy *Erigeron eatonii var. nevadincola*	2B.3, S2S3, G5T2T3	Unlikely	Open grassland, rocky flats, generally in sagebrush or pinyon/juniper scrub

Common name *Scientific name*	Status[1,2]	Association with GDE[2]	Habitat and occurrence[2]
Alkali hymenoxys *Hymenoxys lemmonii*	2B.2, S2S3, G4	Possible	Roadsides, open areas, meadows, slopes, drainage areas, stream banks
Sierra Valley ivesia *Ivesia aperta var. aperta*	1B.2, S2, G2T2	Possible	Dry, rocky meadows, generally volcanic soils
Plumas ivesia *Ivesia sericoleuca*	1B.2, S2, G2	Likely	Dry, generally volcanic meadows
Webber's ivesia *Ivesia webberi*	1B.1, S1, G1	Unlikely	Rocky clay in sagebrush flats
Santa Lucia dwarf rush *Juncus luciensis*	1B.2, S3, G3	Likely	Wet, sandy soils of seeps, meadows, vernal pools, streams, roadsides
Seep kobresia *Kobresia myosuroides*	2B.2, S2, G5	Possible	Rocky seeps
Sagebrush loeflingia *Loeflingia squarrosa var. artemisiarum*	2B.2, S2, G5T3	Unlikely	Sand, gravel of hills, mesas, dunes, disturbed areas
Susanville beardtongue *Penstemon sudans*	4.3, S4, G4	Unlikely	Open, rocky, igneous soils in sagebrush scrub, yellow-pine, and montane forests
Modoc County knotweed *Polygonum polygaloides ssp. esotericum*	1B.3, S3, G4G5T3	Possible	Vernal pools, seasonally wet places, pinyon/juniper woodland
Sticky pyrrocoma *Pyrrocoma lucida*	1B.2, S3, G3	Possible	Alkaline clay flats, sagebrush scrub, open forest

Common name *Scientific name*	Status[1,2]	Association with GDE[2]	Habitat and occurrence[2]
Green-flowered prince's plume *Stanleya viridiflora*	2B.3, S2, G4	Unlikely	Cliffs, shale, clay knolls, steep bluffs, white ash deposits
Sensitive Natural Communities			
Montane Freshwater Marsh	S3.2, G3	Likely	Sites lacking significant current, permanently flooded by fresh water. Widely scattered throughout Montane California.

[1] Status codes:

G = Global

T = Subspecies or variety

State

S = Sensitive

Rank

1 Critically Imperiled—At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.

2 Imperiled—At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors.

3 Vulnerable — At moderate risk of extinction or elimination due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.

4 Apparently Secure — Uncommon but not rare; some cause for long-term concern due to declines or other factors.

5 Demonstrably Secure — Common; widespread and abundant.

Q Taxonomic questions associated with this name

Ranks such as S2S3 indicate a ranking between S2 and S3

California Rare Plant Rank (CRPR)

1B Plants rare, threatened, or endangered in California and elsewhere

2B Plants rare, threatened, or endangered in California, but more common elsewhere

4 Plants of limited distribution, a watch list

CRPR Threat Ranks:

0.1 Seriously threatened in California (high degree/immediacy of threat)

0.2 Fairly threatened in California (moderate degree/immediacy of threat)

0.3 Not very threatened in California (low degree/immediacy of threats or no current threats known)

[2] Source: CNDDB (CDFW 2019)

2.2.2.7.4.1 Terrestrial and aquatic wildlife

Twenty special-status terrestrial and aquatic wildlife species were identified during scoping as having the potential to occur within the Sierra Valley Groundwater Basin. Of these, fifteen were potentially groundwater dependent species: one amphibian species, nine bird species, and five mammal species. Additional information on these groundwater dependent species, including regulatory status and habitat associations, is provided Table 2.2.2-4.

Sierra Valley Groundwater Basin, including GDEs, provides high quality habitat that is utilized by birds for breeding, foraging, migrating, and over-wintering. Over 230 bird species frequent Sierra Valley, including waterfowl, raptors, and shorebirds (McCormick et al. 1996). Habitat within the Sierra Valley Groundwater Basin includes a large montane wetland that supports large breeding colonies (e.g., White-faced Ibis [*Plegadis chihi*]) and bird species not found breeding in managed wetlands (e.g., Black Tern [*Chlidonias niger*]) (NAS 2008). Sierra Valley provides essential rare habitat for bird populations, including habitat critical for breeding; therefore, it is designated as an Important Bird Area by the National Audubon Society.

Table 2.2.2-4 Groundwater-dependence of special-status terrestrial and aquatic wildlife species with potential to occur or suitable habit in the Sierra Valley Groundwater Basin

Common name *Scientific name*	Status[1] Federal/State	Potential to occur in the Sierra Valley Groundwater Basin[2]	Query source[3]	GDE. association[4]	Habitat and documented occurrences in Sierra Valley Groundwater Basin
Invertebrates					
Western bumble bee *Bombus occidentalis*	FSS/SCE	Possible	CNDDB	No known reliance on groundwater	Uses flowering plants in meadows and forested openings; abandoned rodent burrows are used for nest and hibernation sites for queens.
Amphibian					
Southern long-toed salamander *Ambystoma macrodactylum sigillatum*	–/SSC	Likely	CNDDB	Direct	Inhabits coniferous forest, oak, woodland, alpine, sagebrush, and marshlands. Live underground in moist places including rotten logs and animal burrows. Utilize ponds, lakes, and streams for breeding. Adults prey on small invertebrates (e.g., worms, mollusks, insects, and spider). Larvae eat small crustaceans.
Sierra Nevada Yellow-legged frog *Rana sierrae*	FE, FSS/ST	Unlikely	CAFSD, IPAC	Direct	Found in high elevation lakes, ponds, and streams in montane riparian, lodgepole pine, subalpine conifer, and wet meadow habitats. Typical elevation ranges from 4,500 to over 12,000 feet elevation.
Bird					
American White Pelican *Pelecanus erythrorhynchos*	–/SSC	Likely	CAFSD, eBird	Indirect	Salt ponds, large lakes, and estuaries; loafs on open water during the day; roosts along water's edge at night. Forages for small fish in shallow water on inland marshes.
Bald eagle *Haliaeetus leucocephalus*	FD, BLMS, FSS, BGEPA/ SE, SFP	Likely	CAFSD, IPAC, eBird	Indirect	Large bodies of water or rivers with abundant fish, uses snags or other perches; nests in advanced-successional conifer forest near open water (e.g., lakes, reservoirs, rivers). Bald eagles are reliant on surface water that may be supported by groundwater and/or groundwater-dependent vegetation (Rhode et al. 2019).

Common name *Scientific name*	Status[1] Federal/State	Potential to occur in the Sierra Valley Groundwater Basin[2]	Query source[3]	GDE. association[4]	Habitat and documented occurrences in Sierra Valley Groundwater Basin
Bank swallow *Riparia riparia*	BLMS/ST	Likely	CAFSD, eBird	Indirect	Nests in vertical bluffs or banks, usually adjacent to water (i.e., rivers, streams, ocean coasts, and reservoirs), where the soil consists of sand or sandy loam. Feeds on caterpillars, insects, frog/lizards, and fruit/berries. Relies on surface water that may be supported by groundwater (Rohde et al 2019).
Black tern *Chlidonias niger*	–/SSC	Likely	CAFSD, eBird	Indirect	Nests semi-colonially in protected areas of marshes with floating nests. Feeds on insects.
Greater sandhill crane *Antigone canadensis tabida*	BLMS, FSS/ST, SFP	Likely	CNDDB, CAFSD, eBird	Direct	Roosts in shallow ponds, flooded agricultural fields, sloughs, canals, or lakes; nests are generally built-in shallow water or on dry land near a wetland. Forages in freshwater marshes and grasslands as well as harvested rice fields, corn stubble, barley, and newly planted grain fields. Feeds on tubers and aquatic plant seeds. Relies on freshwater wetlands that may be supported by groundwater (Rohde et al 2019).
Northern goshawk *Accipiter gentilis*	BLMS, FSS/ SSC	Likely	CNDDB, eBird	No known reliance on groundwater	Mature and old growth stands of coniferous forest, middle and higher elevations; nests in dense part of stands near an opening. May hunt in riparian corridors. Preys on birds, mammals, and reptiles.
Redhead *Aythya americana*	–/SSC	Likely	CAFSD, eBird	Indirect	Freshwater emergent wetlands with dense stands of cattails (*Typha* spp.) and bulrush (*Schoenoplectus* spp.) interspersed with areas of deep, open water; forages and rests on large, deep bodies of water. Summer resident in southern California.

Common name *Scientific name*	Status[1] Federal/State	Potential to occur in the Sierra Valley Groundwater Basin[2]	Query source[3]	GDE. association[4]	Habitat and documented occurrences in Sierra Valley Groundwater Basin
Swainson's hawk *Buteo swainsoni*	BLMS/ST	Likely	CNDDB, eBird	Indirect	Nests in oaks or cottonwoods in or near riparian habitats; forages in grasslands, irrigated pastures, and grain fields. Swainson's hawks rely on groundwater-dependent vegetation in riparian woodland areas for nesting (Rohde et al 2019). Preys on mammals and insects.
Willow Flycatcher *Empidonax traillii*	FSS/SE	Likely	CNDDB, CAFSD, eBird	Indirect	Dense brushy thickets within riparian woodland often dominated by willows and/or alder, near permanent standing water. Reliant on groundwater-dependent riparian vegetation, including for nest sites that are typically located near slow-moving streams, or side channels and marshes with standing water and/or wet soils (Rohde et al 2019). Feeds on insects, fruits, and berries.
Yellow-headed blackbird *Xanthocephalus xanthocephalus*	–/SSC	Likely	CAFSD, eBird	Indirect	Breeds almost entirely in open marshes with relatively deep water and tall emergent vegetation, such as bulrush (*Schoenoplectus* spp.) or cattails (*Typha* spp.); nests are typically in moderately dense vegetation, in colonies; forage within wetlands and surrounding grasslands and croplands. Feeds primarily on insects and seeds, foraging in marshes, fields, or sometimes catching prey in the air.
Mammals					
American badger *Taxidea taxus*	–/SSC	Likely	CNDDB	No known reliance on groundwater	Shrubland, open grasslands, fields, and alpine meadows with friable soils.
Fringed myotis *Myotis thysanodes*	BLMS, FSS/–	Likely	CNDDB	Indirect	Roosts in crevices found in rocks, cliffs, buildings, underground mines, bridges, and large trees; found in open habitats that have nearby dry forests and an open water source. Forages along streams.

Common name *Scientific name*	Status[1] Federal/State	Potential to occur in the Sierra Valley Groundwater Basin[2]	Query source[3]	GDE. association[4]	Habitat and documented occurrences in Sierra Valley Groundwater Basin
Long-eared myotis *Myotis evotis*	BLMS/–	Likely	CNDDB	Indirect	Most common in woodland and forest habitats above 4,000 feet, but also found in chaparral, coastal scrub, Great Basin shrub habitats, from sea level to 11,400 feet. Feeds on flying insects, primarily moths, over water and open habitats. Drinks water, feeds over water, and may be found in riparian habitat. Facultatively groundwater dependent (TNC 2019a).
Pallid bat *Antrozous pallidus*	BLMS, FSS/SSC	Likely	CNDDB	No known reliance on groundwater	Roosts in rock crevices, tree hollows, mines, caves, and a variety of vacant and occupied buildings; feeds in a variety of open woodland habitats. Habitat and prey (e.g., insects and arachnids) not associated with aquatic ecosystems.
Sierra marten *Martes caurina sierrae*	FSS/–	Likely	CNDDB	No known reliance on groundwater	Moist, multi-storied, dense coniferous forests with lots of coarse woody debris; forest meadow edges; riparian corridors for travel ways. Sierra martens prey heavily on squirrels but will also eat other small mammals, birds, reptiles, fish, insects, seeds, and fruit
Sierra Nevada red fox *Vulpes vulpes necator*	FPE, FSS/ST	Possible	CNDDB	Indirect	Depends on ground-water dependent vegetation for its habitat and foraging habitat (Rhode et al. 2019). Prefers wet meadows to forested areas; high-elevation conifer forest, and sub-alpine woodlands; dense vegetation and rocky areas for den sites. Preys on small mammals and lagomorphs (e.g., rabbits and pikas). Elevational distribution is 5,000 to 7,000 ft.
Spotted bat *Euderma maculatum*	BLMS/SSC	Likely	CNDDB	Indirect	Highly associated with cliffs and rock crevices, although may occasionally use caves and buildings; inhabit arid deserts, grasslands, and mixed coniferous forests. Feeds on moths over water and along washes. Drinks water.

Common name *Scientific name*	Status[1] Federal/State	Potential to occur in the Sierra Valley Groundwater Basin[2]	Query source[3]	GDE. association[4]	Habitat and documented occurrences in Sierra Valley Groundwater Basin
Yuma myotis *Myotis yumanensis*	BLMS/–	Likely	CNDDB	Indirect	Uses a variety of habitats, including riparian, agriculture, shrub, urban, desert, open forests, and woodlands. Distribution is strongly associated with water; drinks water and forages near or over waterbodies.

[1] **Status codes:**

Federal		State	
FD	Federally delisted	SE	Listed as Endangered under the California Endangered Species Act
FE	Listed as endangered under the federal Endangered Species Act	ST	Listed as Threatened under the California Endangered Species Act
FPE	Federally proposed as endangered	SCE	State Candidate Endangered
BGEPA	Federally protected under the Bald and Golden Eagle Protection Act	SSC	CDFW Species of Special Concern
FSS	Forest Service Sensitive species	SFP	CDFW Fully Protected species
BLMS	Bureau of Land Management Sensitive Species		

[2] **Potential to Occur:**

Likely: the species *has* documented occurrences and the habitat is high quality or quantity
Possible: no documented occurrences and the species' required habitat is moderate to high quality or quantity
Unlikely: no documented occurrences and the species' required habitat is of low to moderate quality or quantity

[3] **Query source:**

CAFSD: California Freshwater Species Database (TNC 2021)
CNDDB: California Natural Diversity Database (CDFW 2020b)
eBird: (eBird 2021)
iPAC (USFWS 2021)

[4] **Groundwater Dependent Ecosystem (GDE) association:**

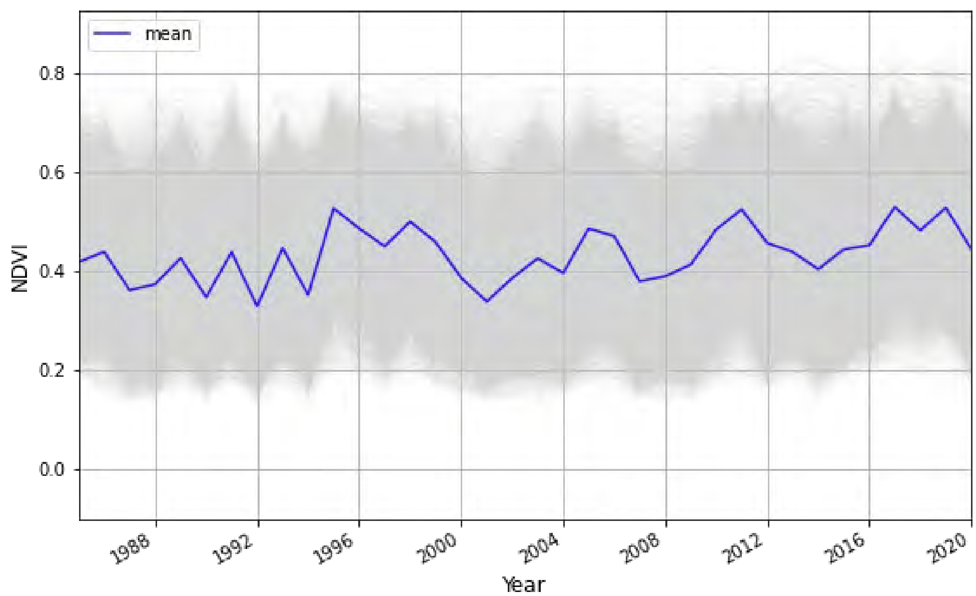
Direct: Species directly dependent on groundwater for some or all water needs
Indirect: Species dependent upon other species that rely on groundwater for some or all water needs

2.2.2.7.5 Changes in Vegetation Health

We used the Normalized Difference Vegetation Index (NDVI) to assess changes in vegetation health. NDVI, which estimates vegetation greenness was generated from surface reflectance corrected multispectral Landsat imagery from July 1 to September 30 of each year, which represents the summer period when GDE species are most likely to use groundwater (Klausmeyer et al. 2019). Vegetation polygons with higher NDVI values indicate increased density of chlorophyll and photosynthetic capacity in the canopy, an indicator of vigorous, growing vegetation. NDVI is a commonly used proxy for vegetation health in analyses of temporal trends in health of groundwater-dependent vegetation (Rouse et al. 1974 and Jiang et al. 2006 as cited in Klausmeyer et al. 2019).

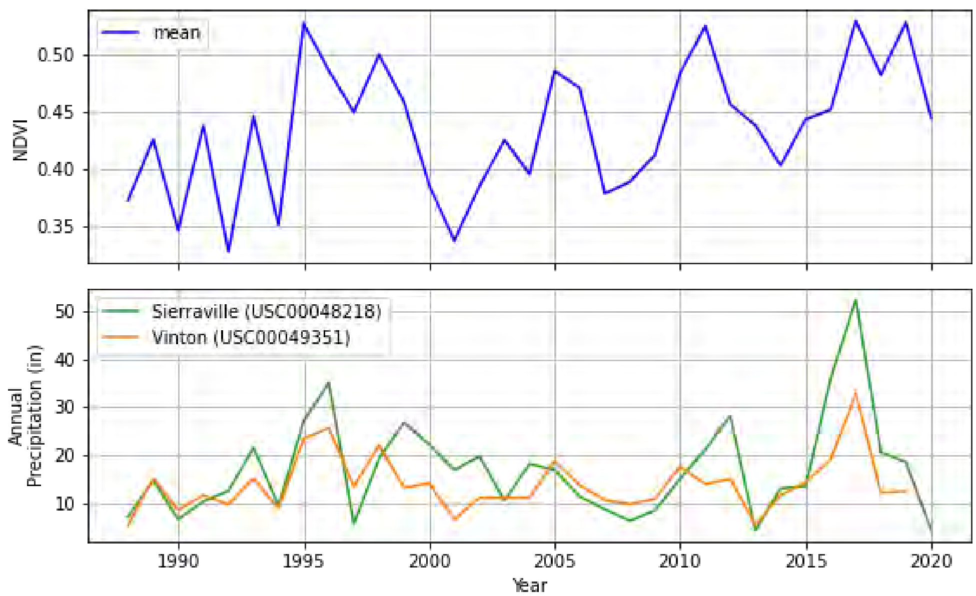
The mean Summer NDVI in the basin ranges from 0.33 to 0.53 (Figure 2.2.2-17). No long-term trends are apparent in Summer NDVI for the basin. Short-term changes are not systematically tied to precipitation.

Figure 2.2.2-17 Summer NDVI changes through time in the Sierra Valley Subbasin. The blue line is the mean value of the GDE polygons



Short-term changes in NDVI are generally tied to precipitation at the Sierraville (USC00048218) and Vinton (USC00049351) stations (Figure 2.2.2-18).

Figure 2.2.2-18 Mean summer NDVI and annual precipitation at Sierraville and Vinton



2.2.2.7.6 Ecological Value

The ecological value of GDEs within the Sierra Valley Subbasin was characterized by evaluating the presence and groundwater-dependence of special-status species and ecological communities, and the vulnerability of these species and their habitat to changes in groundwater levels (Rohde et al. 2018). In addition, the presence of natural or near-natural conditions and ecosystem function was also considered. Based on these parameters, the ecological value of GDEs in the Sierra Valley Groundwater Basin is high because there are 12 likely groundwater dependent special-status plants and 15 special status wildlife species.

2.2.2.7.7 Data Gaps

There are gaps in available data that make assessing the extent and sensitivity of GDEs to groundwater management. In particular, available vegetation maps lack sufficient detail to determine the rooting depth of vegetation to compare with groundwater depth. Instead, we need to use general rooting depths with large error bars. This is compounded by uncertainty in the depth to groundwater near the GDEs due to limited well data. Both of these data gaps can be filled in the first five years after the GSP is implemented. Expanded surface water and groundwater gages should decrease the uncertainty of groundwater depth. In addition, an updated and more detailed vegetation map was begun by CDFW, who are awaiting additional funding to complete. If this map is completed by the five-year update, it can be used to better assess the species assemblages, the source of water, and their maximum rooting depth.

2.2.3 Water Budget Information *(Reg. § 354.18)*

- Description of inflows, outflows, and change in storage
- Quantification of overdraft (as applicable)
- Estimate of sustainable yield
- Quantification of current, historical, and projected water budget

- Description of surface water supply used or available for use for groundwater recharge or in-lieu use

2.2.4 Management Areas (as Applicable) *(Reg. § 354.20)*

- Reason for creation of each management area
- Level of monitoring and analysis
- Description of management areas
- Explanation of how management of management areas will not cause undesirable results outside the management area

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