Note: Further refinements to this section are also anticipated during the Public DRAFT GSP review process.

SIERRA VALLEY GSP CHAPTER 2 PLAN AREA AND BASIN SETTING

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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 Sierra Valley (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 a long history of agriculture. It is a valley renowned for its beauty and is a nationally designated Important Bird Area. It is the largest wetland in the Sierra Nevada Mountains (FRLT, 2018), considered one of the most biodiverse landscapes in the United States (FRLT, 2018). It is also 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).

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[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.

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. However, there are tribal cultural influences throughout the Sierra Valley watershed as described further below.

The Northern Sierra Nevada Mountains contain the physical evidence of a rich and complex Native American history reaching back thousands of years. These landscapes are rooted deeply in tribal memory. The mountain valleys were central places from which long used trails radiated out following the ridgetops and the many water courses. The benches and terraces above the valleys were places where large encampments were established and maintained season after season. Sierra Valley presented an expansive base for settlement and held an array of valuable resources. The low elevation pass at the northeast end was a gateway for Great Basin populations to enter the mountains while the northwest arm of Sierra Valley and the outlet of the Middle Fork of the Feather River (Middle Fork) provided a natural pathway east from Northern Sierra Nevada (Elliott 2021).

Archaeological sites in this same vicinity show evidence of human occupation from as early as 5,500 years ago. As climate and ecosystems fluctuated from warmer and wetter to colder and drier conditions, Sierra Valley was continuously used for seasonal forays and settlement. Artifacts and cooking features present at multiple ancient campsites documented in the area suggests a strong emphasis on the processing and export of bulbs, roots and seeds. Hunting of the abundant waterfowl within the marsh-like lowlands, and rabbits and deer on the drier valley bottom and surrounding hills was also very important (Elliott 2021).

The Washoe to the east and the Mountain Maidu (or Northeastern Maidu) to the north and west met within Sierra Valley for uncounted generations. These tribes had different cultural backgrounds and very different languages. The pre-contact Washoe were a Great Basin tribe. Sierra Valley was at the northeastern edge of a large traditional territory that encompassed much of today’s Western Nevada. They gathered a variety of roots, bulbs and grasses from the valley but there was reportedly a particularly prized grass found here that they called *múćim* which was also the name they applied to the valley itself. The Washoe obtained resources through trade or access into Mountain Maidu territory (e.g., acorns and salmon) (Elliott 2021).

The pre-contact Mountain Maidu were adept at life in the Northern Sierra Nevada Mountains. Central to them was the upper reaches of the Middle Fork and the North Fork of the Feather

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

River including the fall salmon runs. A strong Mountain Maidu presence in Northwestern Sierra Valley is evident in the archaeological resources recorded in this vicinity. The Mountain Maidu also benefited in trade coming from the east obtaining resources not readily available in their traditional territory (e.g., obsidian) (Elliott 2021).

All of this was massively disrupted in the middle of the nineteenth century with Euro-American contact.While there are no known accounts confirming entry into Sierra Valley, early trappers were reportedly working along the Truckee River in the early 1830s (Elliott 2021). The pioneer ranches that began to be developed in the mid-1850s spelled the end of traditional lifeways of the Mountain Maidu and the Washoe within Sierra Valley. By the 1860s, large portions of the valley bottom were being drained and put under cultivation. Yet at least some of the mountain camps were still used by surviving families and groups. As late as November 1867, the *Mountain Messenger* noted that the tribes had once again engaged in their annual practice of fall burning in the hills surrounding Sierra Valley. Burning was routinely undertaken season after season but this period certainlymarked the end of the annual cycle. The remaining Native American population could no longer gain access to manage the ecosystem at a landscape level (Elliott 2021).

Figure 2.1.1-1 Sierra Valley Groundwater Subbasin

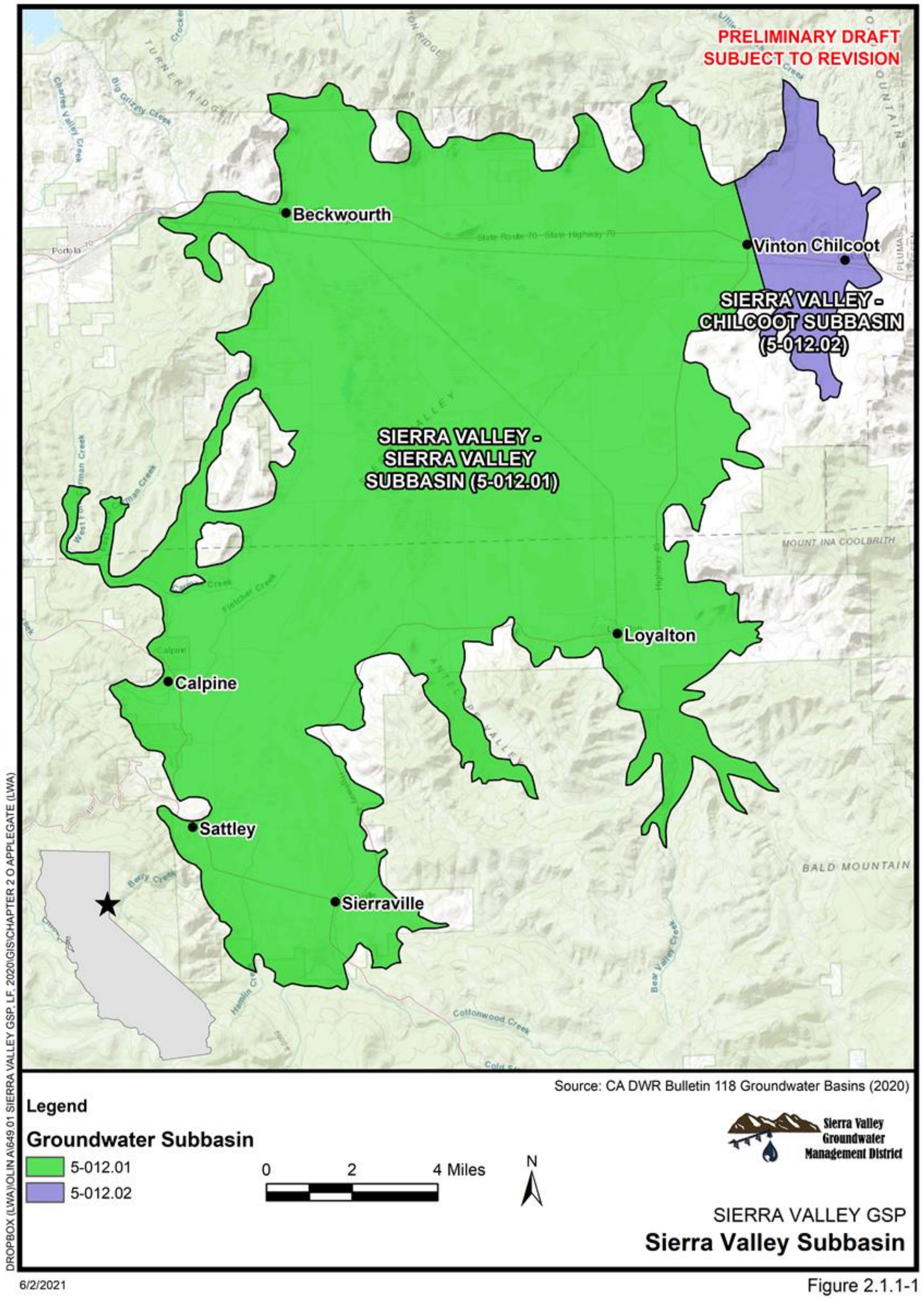

Figure 2.1.1-2 Sierra Valley Groundwater Sustainability Plan Area

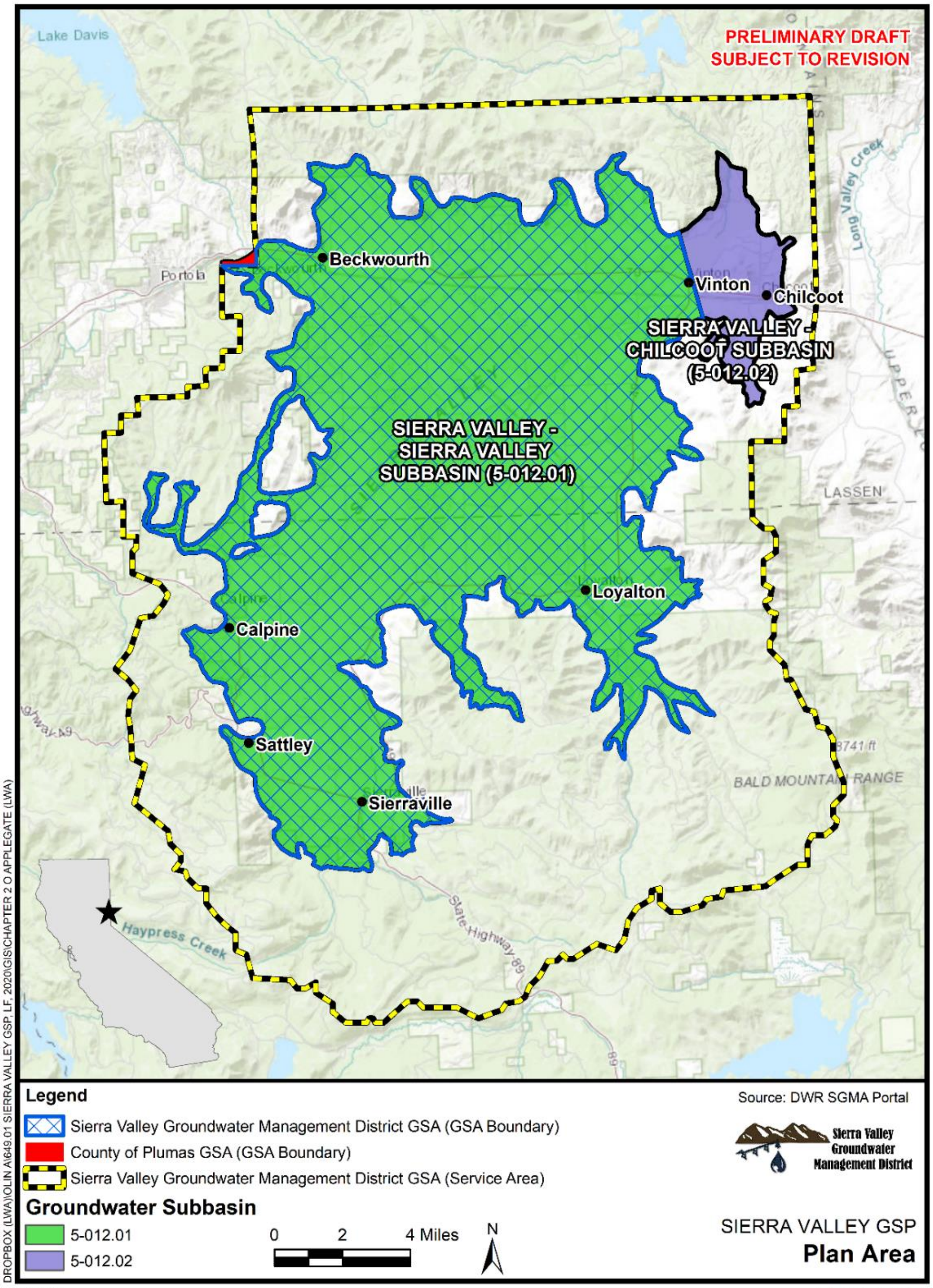

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Figure 2.1.1-2

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).

As listed in Table 2.1.1-1, the SV Subbasin contains federally owned lands of the U.S. Department of Agriculture, Bureau of Land Management, 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 (i.e., water use type not provided/available) 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.

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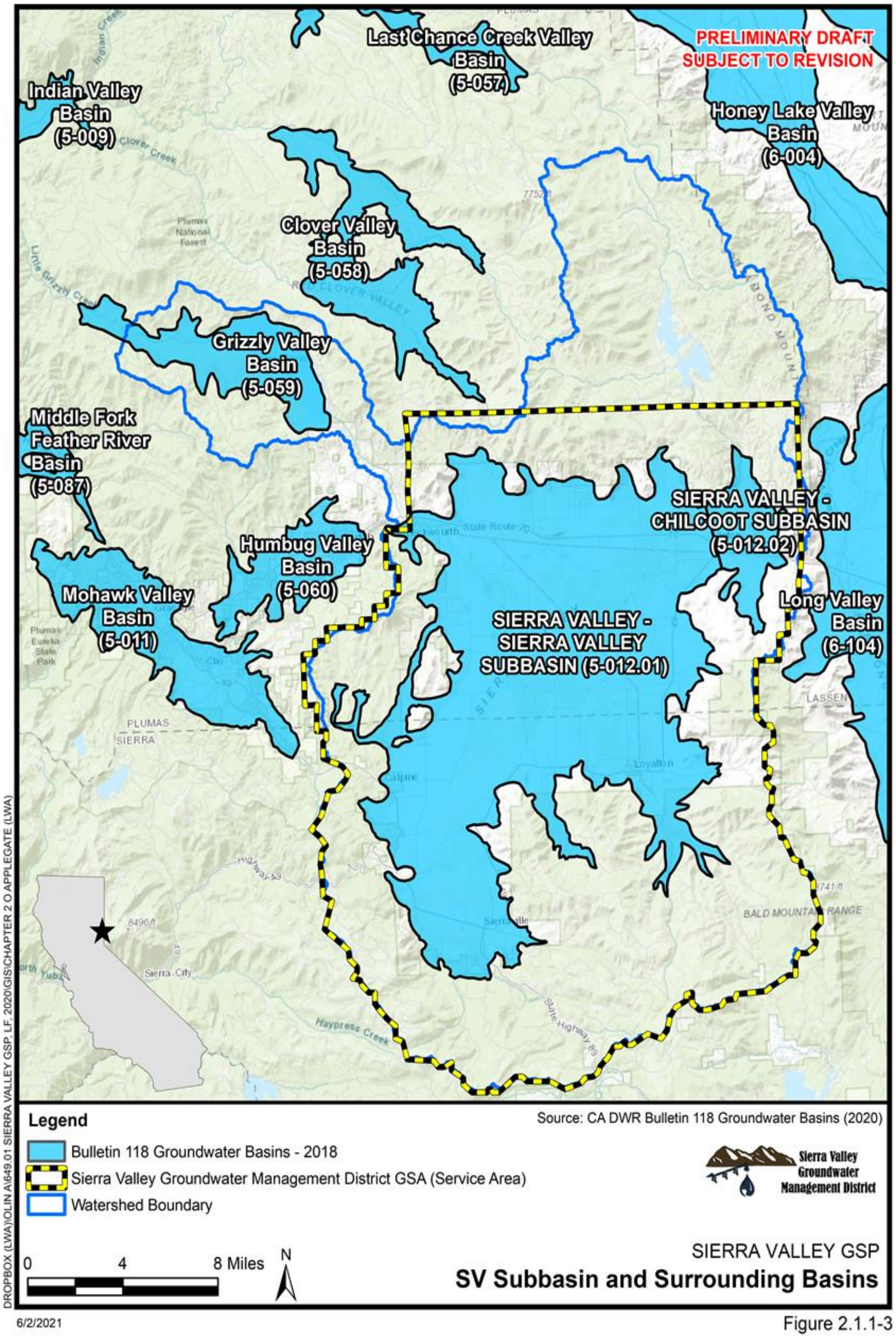
[3] https://www.fs.usda.gov/main/plumas/landmanagement/planning

[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



Source: CA DWR Bulletin 118 Groundwater Basins (2020)

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SV Subbasin and Surrounding 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

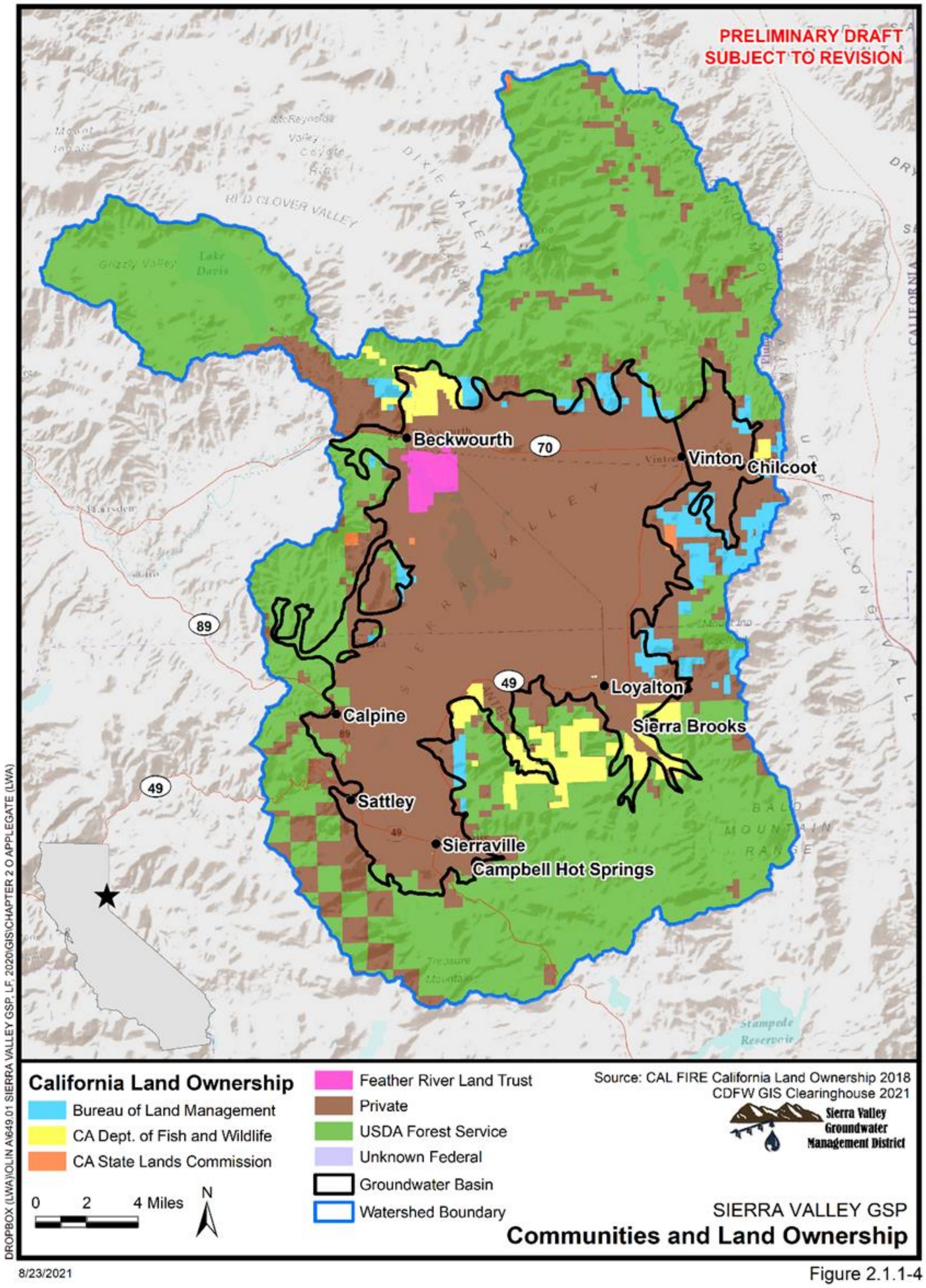
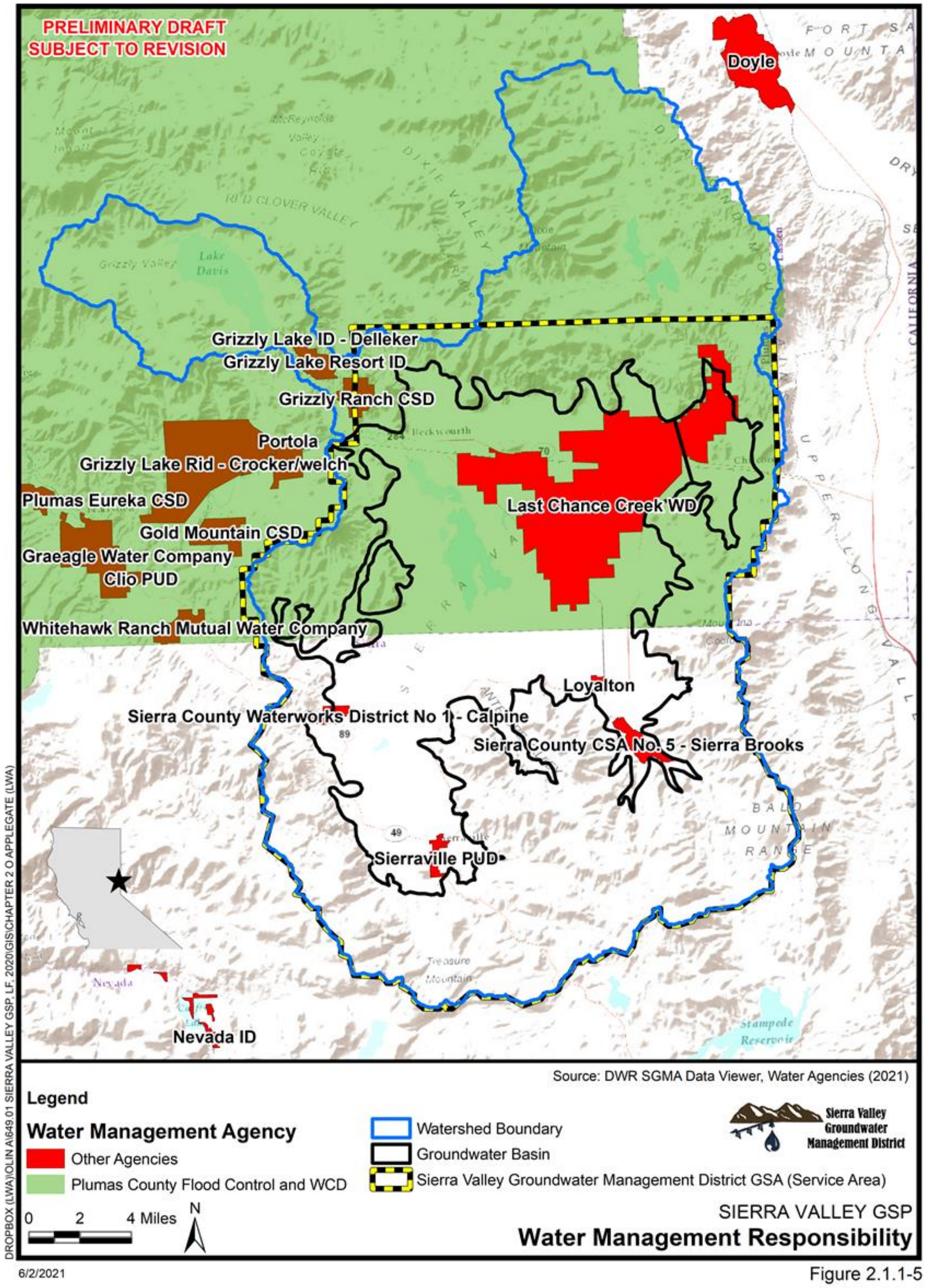


Table 2.1.1-1 Sierra Valley Watershed Land Ownership

Owner	Total Acres	Percent of Watershed
Bureau of Land Management	11,590	3.1%
California Department of Fish and Wildlife	11,087	3.0%
California State Lands Commission	639	0.2%
Feather River Land Trust	2,540	0.7%
City of Loyalton	8	0.0%
Private	149,804	40.1%
County of Sierra	3	0.0%
Unknown Federal/Other Federal	2	0.0%
United States Forest Service	197,954	53.0%
Total	**373,627**	**100%**

Source: CAL FIRE, land ownership, last updated October 2018 (https://frap.fire.ca.gov/mapping/gis-data/) and California Department of Fish and Wildlife, GIS Clearinghouse (https://wildlife.ca.gov/Data/GIS/Clearinghouse)

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



Source: DWR SGMA Data Viewer, Water Agencies (2021)

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Water Management Responsibility

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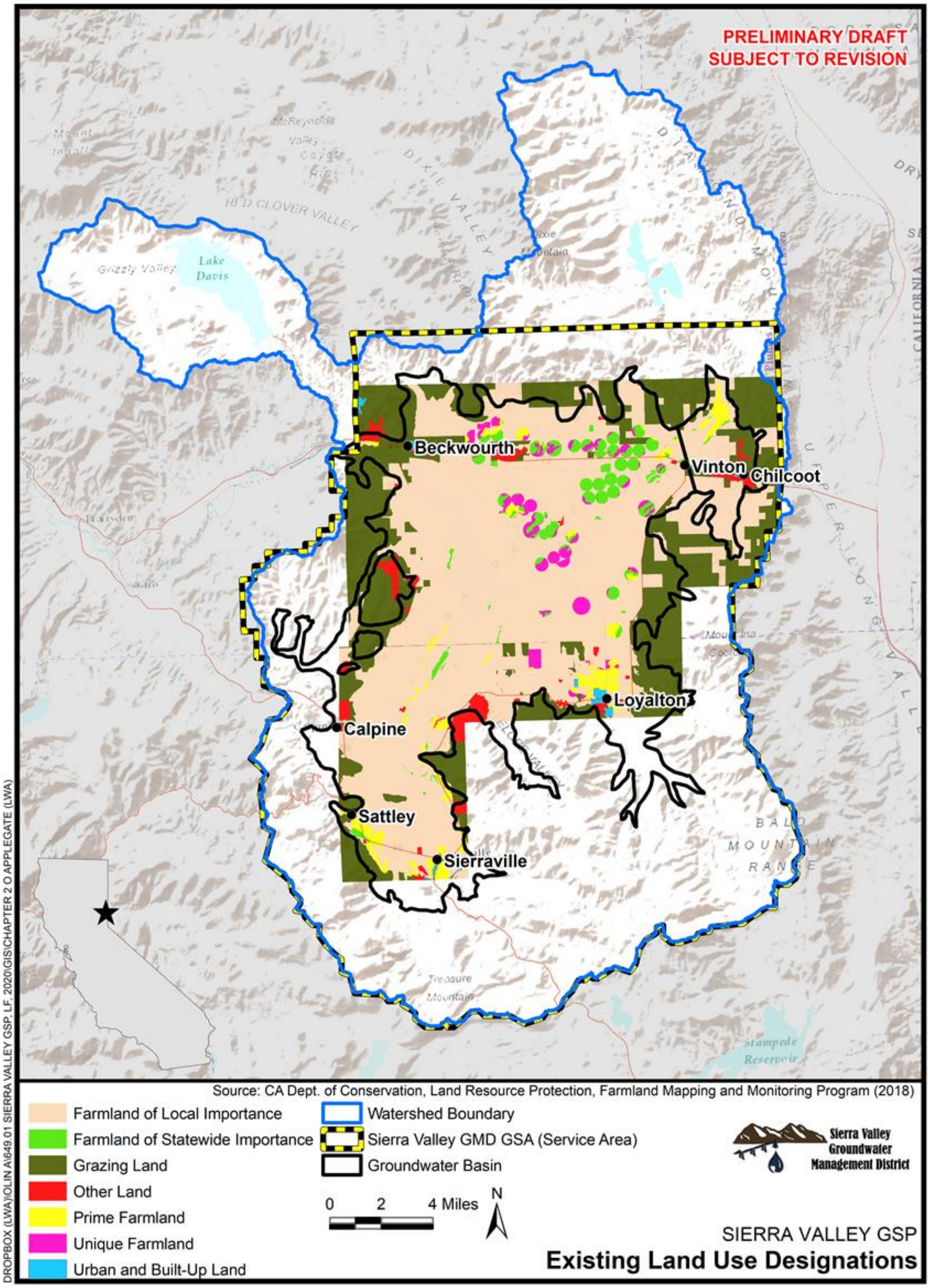
Figure 2.1.1-5

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



Source: CA Dept. of Conservation, Land Resource Protection, Farmland Mapping and Monitoring Program (2018)

6/2/2021

Figure 2.1.1-6

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)

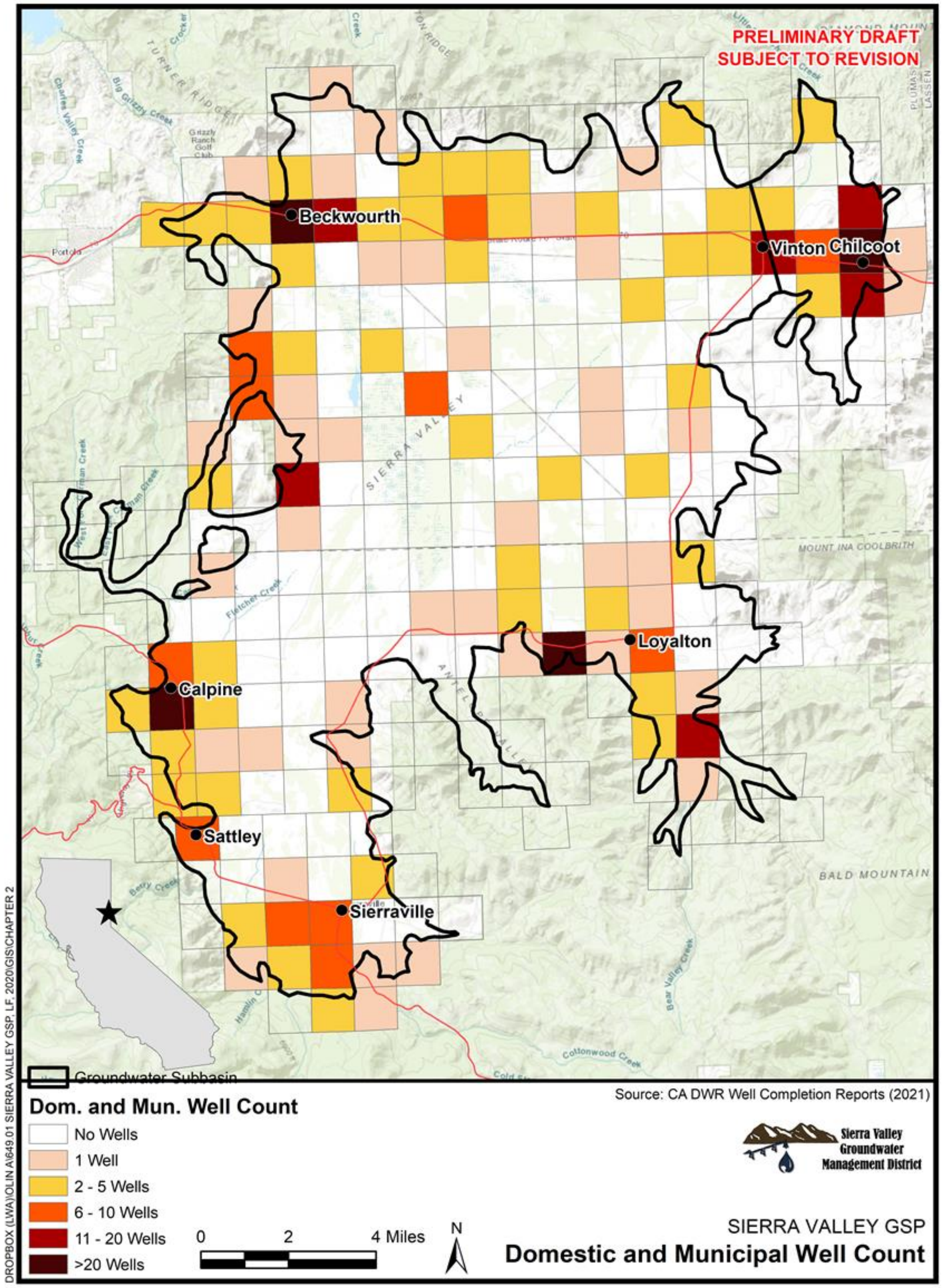


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Figure 2.1.1-7

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

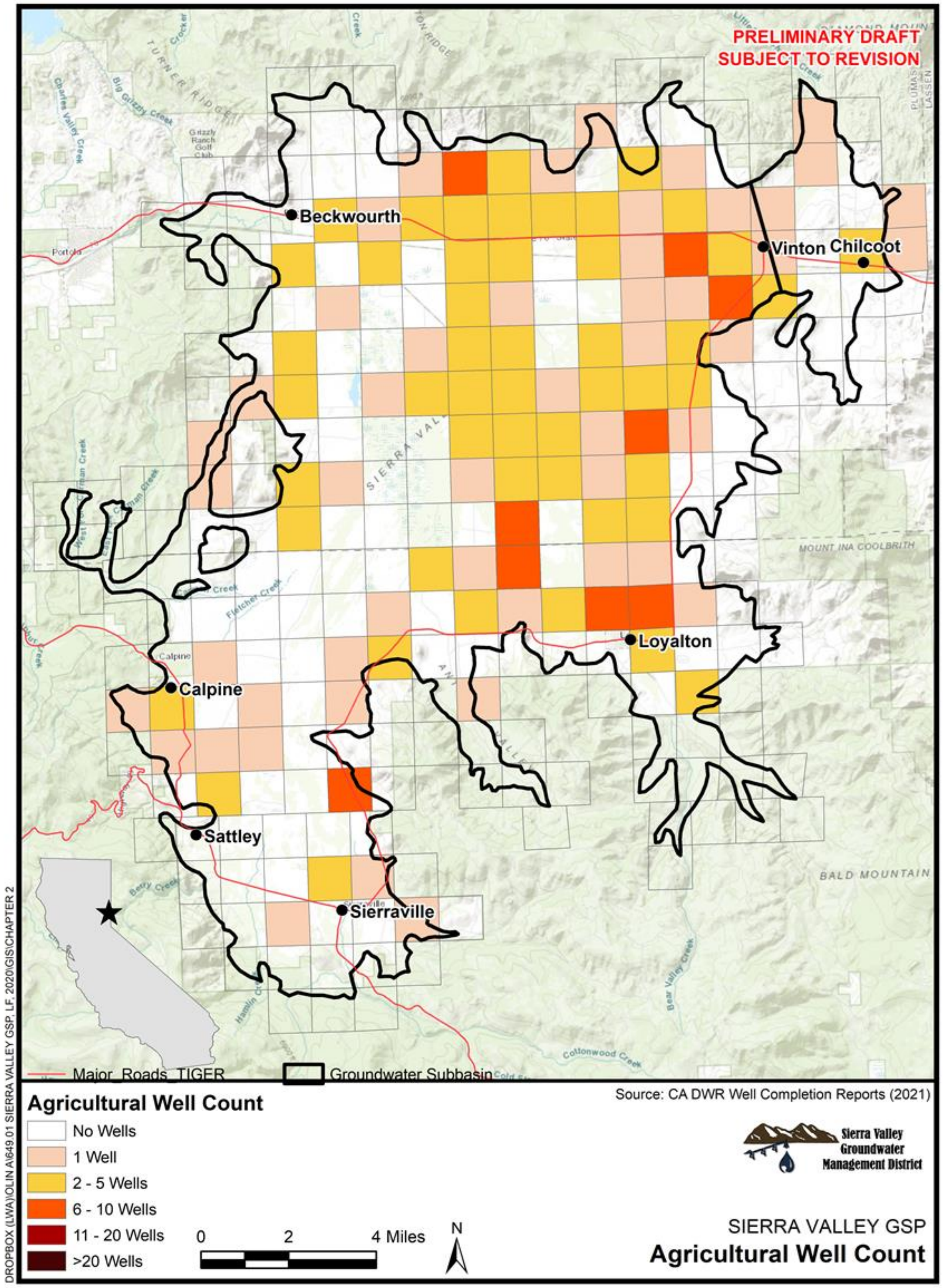

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Figure 2.1.1-8

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

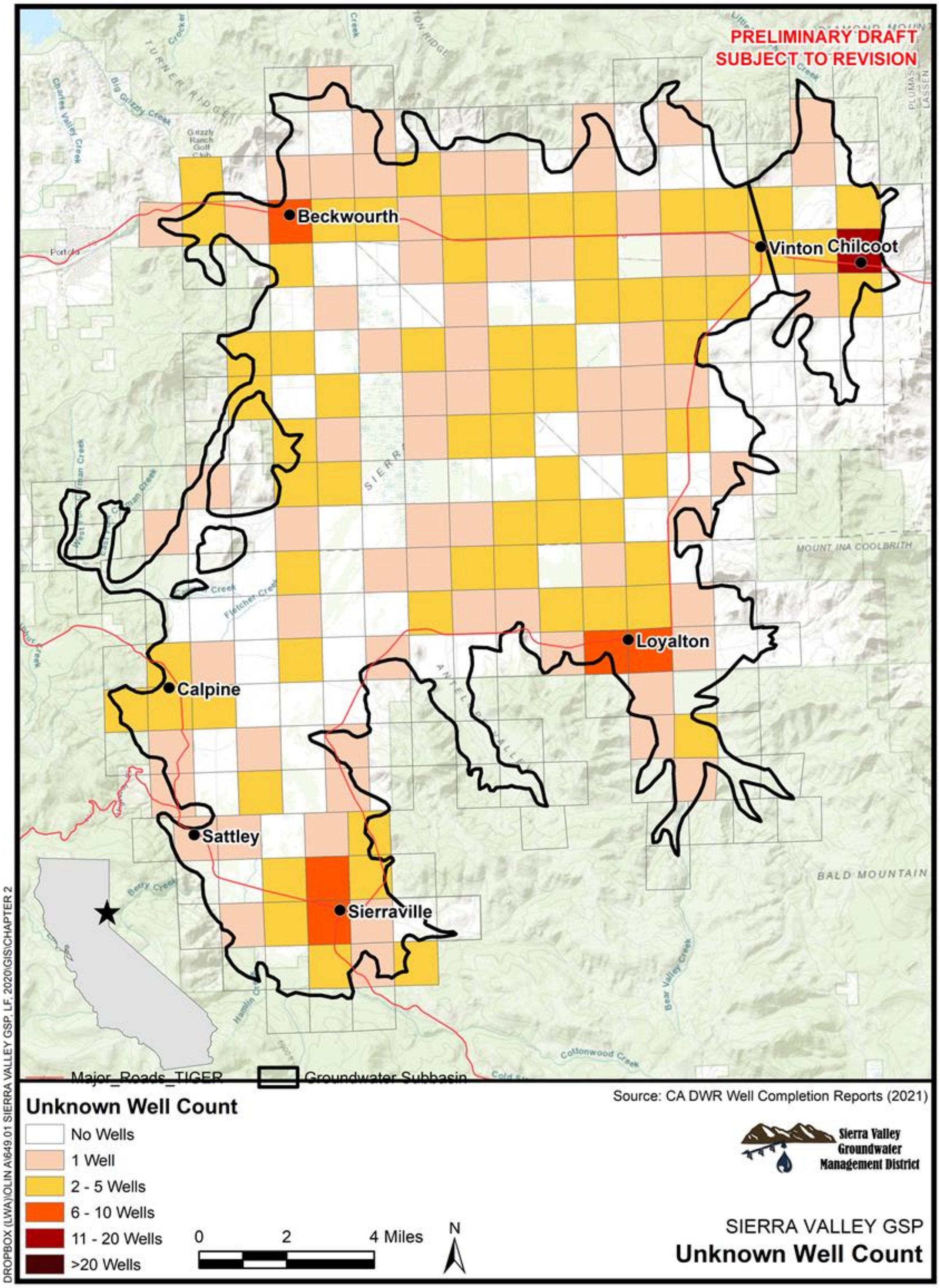

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Figure 2.1.1-9

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's Online System for Well Completion Reports, State Water Resources Control Board (SWRCB) and United States Geological Survey (USGS) Groundwater Ambient Monitoring Assessment (GAMA) GeoTracker, and SVGMD. Methods detailed in the Data Management System (DMS) Technical Memorandum, Appendix 2-1.

2.1.1.1 Plan Area, Exclusive Agencies, and Adjacent Basins

The 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 exclusively the Groundwater Sustainability Agency (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 jurisdictional areas for 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, Sierra County Waterworks District No. 1 Calpine, and Sierra Valley Mutual Water Company, see Figure 2.1.1-5.

2.1.1.4 Land Use and Water Sources

In 1850 James P. “Jim” Beckwourth entered Sierra Valley and recognized the advantage of the low elevation pass at the northeast end. He blazed a trail beginning at what is today Sparks, Nevada crossing the pass then continuing along the north end of Sierra Valley then through Grizzly Valley and American Valley to finally reach the settlement of Bidwell’s Bar; now below the waters of Oroville Reservoir. Between 1851 and 1854 some 1,200 emigrants used the trail leading 12,000 head of cattle, 700 sheep, and 500 horses into Northern California. While most emigrants continued on, being eager to realize the promise of gold, a hardy few remained behind to establish the first ranches and homesteads in Sierra Valley (Elliott 2021).

Beckwourth established a trading post, or what he named the War Horse Ranch, at the northwestern end of Sierra Valley where his cabin would be the first constructed house emigrants would see since the Utah territory. Beckwourth remained for several years journeying about the countryside on various errands while maintaining his trading post but he did not realize the profits he anticipated. His insatiable wanderlust along with conflicts with the growing number of ranchers in the area led to his departure from Sierra Valley. At what point he actually gave up his place is unclear but by the end of 1858 he had left California for good (Elliott 2021).

By the mid-1860s, several ranches were well established along the northwestern end of Sierra Valley including the Abraham Ede Ranch by ca. 1860, the George Mapes Ranch in 1863, and Peter Parish who was present by early 1860s in the area that would later include the town of Beckwith/Beckwourth. By 1867 Beckwourth's old ranch was owned by Alexander Kerby (sometimes recorded as the common spelling of Kirby). In 1870 John Ross established a ranch in a narrow arm of the valley southeast of the Kerby Ranch that still retains the name Ross Meadow. By 1872 the small valley just north of Kerby's, the Grizzly Creek arm, was under the ownership of David T. Jones, and the lower end of Jones' land holdings along the creek became known locally as Willow Glen (Elliott 2021).

During the first two decades of settlement in the northwestern end of the valley, the Beckwourth/KerbyRanch continued to be a stopping point on the main road. In the late 1860s the town of Beckwourth began to develop a little over two miles east of the ranch where the Red Clover Road intersected with the Quincy-Reno Road. In the early years Sierra Valley ranchers provided hay, butter, and beef to the mining communities in Sierra County including Downieville. Large quantities of hay, were delivered over high country trails by mule trains, and dairy products brought a high return if they could reach the Nevada markets (Elliott 2021).

On February 10, 1876, Kerby recorded a water claim on Grizzly Creek for domestic and gardening purposes. This historic water conveyance has been in use ever since this time to irrigate the fields below the ranch. By the mid-1880s, he had expanded his land holdings to 560 acres. Alex Kerby had a large family and was very well regarded in Eastern Plumas County. His ranch remained one of themost substantial in the area throughout the remainder of the nineteenth century (Elliott 2021).

Considerable Italian-Swiss immigration into Sierra Valley had been well underway by the 1880s. Many of the old pioneer ranches ultimately passed to Italian-Swiss families who made a name for themselves in the region and particularly in the dairy industry. One of many instances of this wasthe sale of the Kerby Ranch to Alfonso Ramelli on November 3, 1904. Alfonso and his brother David hadbeen active in the Beckwith area prior to the purchase of the Kerby Ranch. David Ramelli was active in the vicinity at least by 1896. Alfonso Ramelli purchased the old Ross Ranch land holdingsin 1902. From this point on, the old Kerby Ranch and acreage in Ross Meadow combined to become the Ramelli Ranch (Elliott 2021).

The area directly to the west and north of the Ramelli Ranch along Grizzly Creek continued to be known locally as Willow Glen. The Ramelli Ranch operations were continuous throughout the first half of the twentieth century. Alfonso relinquished the ranch to his son Guido in 1919. Dairy operations at the ranch finally ceased in the 1950s. Guido Ramelli managed the ranch until his death in 1955. Mrs. Guido Ramelli resided here through the 1970s while the ranch continued to be operated for haying and beef cattle. In September of 1980, 1,723 acres of agricultural land to the south and east of the ranch was purchased by the USDA Forest Service. In December of 1980, the water rights and a 10-foot wide easement from the old Grizzly Ice Dam extending to the outlet just above the Middle Fork were also deeded to the Forest Service which has been continually maintained and used (Elliott 2021).

For more information on the settlement and history of Sierra Valley, including historic photographs, see Appendix 2-2 (A Brief History of the Ramelli Ranch Vicinity, Sierra Valley, CA).

Present day land use is generally characterized by different 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 are 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. 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 and was 414 in 2019. Both Vinton and Chilcoot are unincorporated communities in Plumas County located near the northeast corner of the valley. They are both included in the CDP of Vinton-Chilcoot. 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 and was 422 in 2019/2020. 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 and 292 in 2019/20. 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 and 1093 in 2019. Campbell Hot Springs, also known as Sierra Hot Springs, is a small resort community located near the southern boundary of valley approximately 6 miles southeast of Sierraville, just southeast of the Sierraville Dearwater Airport. 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. 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 and 85 in 2019. 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 and was 86 in 2019. 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 and was 182 in 2019.

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.

As listed in Table 2.1.1-1, the USFS, BLM, California Department of Fish and Wildlife (CDFW), and State Lands Commission hold approximately 59 percent of land in the watershed. Of the 59 percent of the land held by federal agencies, the USFS is the biggest landholder with approximately 53 percent. There are three national forests in the Sierra Valley Watershed. Roughly half of national forest land in the watershed is either Tahoe National Forest, or Plumas National Forest. A small amount is comprised of Humboldt-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).

Crops are grown throughout Sierra Valley including alfalfa, improved pasture, meadow pasture, grain, 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 areas of human settlement in the Sierra Valley Watershed. Some 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, agritourism, birding 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 2.2.1.6 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 an important 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 a large extent groundwater dependent. 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. Sierraville obtains its municipal water supply from springs 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 (e.g., DWR [1963, 1973]) 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 and Carlton Hydrology (Bachand and Carlton, 2020) 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 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, seven 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 3.4.

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 2.2.3 (Water Budget). 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 minimus uses combined. As detailed in Section 2.2.3, having complete data records from 1989 through September 2020 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 sustainably 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. Inflows from Big Grizzly Creek are offset by outflows from MFFR via flow-routing in the model.

Water Master data dating back to 2011 was obtained by SVGMD in 2018 and additional data through 2020 was obtained in 2021 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 3.4.

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

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

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

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 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. A detailed description of the groundwater quality monitoring network and protocol and proposed improvements is provided in Section 3.4.

2.1.2.2 Existing Water Resources Management Programs

Several water resources management programs exist in 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, and groundwater management by SVGMD. This includes a large capacity well inventory, metering and tracking program, monitoring of new well applications and subdivisions proposals, and large capacity well moratorium in the overdrafted portion of the subbasin as described further in Section 2.1.3.4. The Upper Feather River Integrated Regional Water Management Plan addresses planning issues and priorities for the larger watershed encompassing SV subbasin. In addition, the Natural Resources Conservation Service has also worked with many ranchers (i.e, private landowners) in the SVGWMD to install projects and management tools to improve water resource management.

2.1.2.3 Indirect Groundwater Recharge

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 role in optimizing management/use of water resources 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, surface water is more abundantly and reliably available in the southern/western portions of the valley, where precipitation totals are

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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

higher 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 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.

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.

Another example of a potential recharge opportunity would be to work with US Forest Service to improve upland recharge through improved forest management. Approaches and benefits of upland forest management is described further in Chapter 4 (Projects and Management Actions).

Another promising conjunctive use opportunity 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 of surface irrigation and recharge in the SV Subbasin during the dry season, especially during years of below average precipitation. This is also described further in Chapter 4.

Over the course of the implementation of this Plan, the GSAs 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 into the GSP

The existing monitoring programs and networks provide data 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 3.4 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 involves extensive public review and environmental review under the California Environmental Quality Act (CEQA).

The Plumas County 2035 General Plan Vision & Planning Goals statement is to promote a healthy physical and aesthetic environment, a vital economy, and a supportive social climate that can accommodate the expected growth and change over the next 20 years. Specifically, seven vision goals are incorporated into the General Plan, as follows:

1. To preserve and promote a rich environment of arts, culture and heritage in Plumas County into the 21st century.
2. To create and retain jobs, and reinvest wealth through our economy, community and natural resources.
3. To increase the communications and technology capability of Plumas County to function successfully in the 21st century.
4. To promote a future for Plumas County citizens in which land use decisions balance social, economic, and natural resource health.
5. To improve the health and well-being of all Plumas County residents.
6. To provide a range of facilities, programs and activities for the health and enjoyment of residents and visitors.
7. To recognize the well-being of local youth as fundamental to the health of the community as a whole.

Additionally, the 2035 General Plan planning goals include, but are not limited to, support of the environment, economy, agriculture and forestry, and the community to:

- meet and sustain the basic needs of clean and available water;
- promote the economics of pure water resources (quality and quantity) development;
- protect and sustain agricultural and forest lands and encourages best management practices;
- define agricultural and forest lands with the intent of meeting the needs of the ranching and farming families;
- preserve and protect cultural, historical, and archaeological resources;
- protect natural habitats;

- promote economic development in harmony with surroundings;
- maintain Plumas County's status as a premier recreation area; and
- protect and sustain existing communities and supporting sustainable development.

Further, 2035 General Plan Goals and Policies speak to groundwater resources and management, such as:

- Protect areas identified as significantly contributing to groundwater recharge from uses that would reduce the ability to recharge or would threaten the quality of the underlying aquifers.
- Manage groundwater as a valuable and limited resource and ensure its sustainability as a reliable water supply sufficient to meet the existing and future needs of Plumas County.
- Encourage the use of alternate sources of water supply as appropriate and to the maximum extent feasible in an effort to reduce demand on key groundwater resources.

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 2.1.4). SVGMD approves applications where 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 large-capacity 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 in 2018 addressed existing inactive large-capacity wells in the valley. The ordinance/letter required residents 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 GSP 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 are 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 clarified 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 and possibly influenced by irrigation pumping in the northeast part of the

Subbasin. 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 accomplished by efforts to improve recharge through various projects and measures, including 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 GSP discuss replenishment efforts that exist or could be implemented in Sierra Valley in greater detail.

2.1.4.6 Conjunctive Use Programs and Groundwater Storage

Conjunctive use programs in Sierra Valley are described in Section 2.1.2.3. Based on best available data, it is expected that the majority of groundwater storage in the SV Subbasin is for domestic/fire purposes at private residences for which public water access is not available.

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 Sierra Valley.

Initial exploration of the feasibility of recharge projects was undertaken by Bachand (Bachand and Associates, 2019) to explore opportunities for improving recharge, including potential for pilot studies, possibility of groundwater injection, and more.

Diversion to storage in 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 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 help prevent converstion to land uses that may have increased water demands. Water conservation efforts include research on and support for efforts switching traditional irrigation systems to higher efficiency irrigation technologies (i.e., LESA/LEPA technologies). Other efforts for water conservation include agricultural producers 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 as described in Section 2.1.2.3 of this Plan.

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/agricultural/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

As discussed in Section 2.1.1.4, the USFS, BLM, CDFW, and State Lands Commission hold approximately 59 percent of land in the watershed. In addition, The U.S. Environmental Protection Agency (USEPA) Region 9, the State Board, Central Valley Regional Board, DWR, and CDFW are major regulatory agencies involved within Sierra Valley Basin.

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 GSP. More detailed studies on this topic are needed, as described in Sections 2.2.1.6 and 3.4.

2.1.5 Notice and Communication *(Reg. § 354.10)*

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 (C&E Plan) included as Appendix 2-3. The central objective of the C&E Plan is to provide a framework and identify options for stakeholder engagement in current and future SGMA activities in the SV Subbasin. A list of comments regarding the Plan received by the GSA and responses provided by the GSA is included as Appendix 2-4. Beneficial uses and users of groundwater in the SV Subbasin, a description of the GSAs decision-making process, and additional information on outreach and engagement is provided below.

2.1.5.1 Beneficial Uses and Users

Per California Code of Regulations (CCR) § 354.10(a), a description of the beneficial uses and users of groundwater in the basin is provided here, including the land uses and interests potentially affected by the use of groundwater in the basin, the types of parties representing those interests, and the nature of consultation with those parties.

Table 2.1.5-1 incorporates the following elements:

- beneficial uses of groundwater required, at a minimum, by the Central Valley Regional Water Quality Control Board's Basin Plan; and
- interests representing groundwater uses and uses, to be considered by GSAs as identified in California Water Code (CWC) § 10723.2 as "including but not limited to."

Stakeholder communication and engagement may be impacted by the economic status of the community. The Sierra Valley is generally considered a Disadvantaged Community (DACs) based on DWR criteria (https://gis.water.ca.gov/app/dacs/) in that the City of Loyalton and Chilcoot-Vinton and the City of Portola (nearby in Plumas County) are all classified by DWR as DACs

Table 2.1.5-1. Beneficial Groundwater Uses, Users, and Interests

Groundwater Uses	Groundwater Users	Representative Interests	How Involved
Domestic water supply[1]	Domestic well owners[2]	Disadvantaged communities[2] Broader community	TAC composition Interested parties email list Public workshops
Municipal water supply[1]	Municipal well operators[2] Public water systems[2]	• Town of Loyalton • Sierra Brooks Water System • Sierraville Public Utilities District	TAC composition
Agricultural supply[1]	Agricultural users[2]	• Ag Commissioner for Plumas and Sierra counties • Sierra Valley RCD • UC Cooperative Extension	TAC composition Interested parties email list Working sessions
Industrial service supply[1]	Industrial operations	(no active industrial uses in Sierra Valley)	Interested parties email list
Industrial process supply[1]	Industrial operation	(no active industrial uses in Sierra Valley)	Interested parties email list
Environmental supply	Environmental users of groundwater[2]; groundwater dependent ecosystems	• CA Dept. of Fish & Wildlife • US Forest Service • Feather River Land Trust • Plumas Audubon • Trout Unlimited	TAC composition Interested parties email list Public workshops
Interconnected surface water (ISW) supplies	ISW users	Surface water users, if there is a hydrologic connection between surface and groundwater bodies[2]	TAC composition Interested parties email list Public workshops
Other	California Native American Tribes[2]	• Estom Yumeka Maidu Tribe of the Enterprise Rancheria • Greenville Rancheria of Maidu Indians • Honey Lake Maidu • KonKow Valley Band of Maidu • Mechoopda Indian Tribe of Chico Rancheria • Mooretown Rancheria of Maidu Indians • Pyramid Lake Paiute Tribe • Reno-Sparks Indian Colony • Susanville Indian Rancheria • Tsi Akim Maidu • United Auburn Indian Community of the Auburn Rancheria • Washoe Tribe of NV and CA	Targeted Tribal outreach TAC emails

Groundwater Uses	Groundwater Users	Representative Interests	How Involved
Other	Land use managers: water managers; watershed systems	GSA – Sierra Valley Groundwater Mgmt. District GSA – Plumas County Sierra County Environmental Health Department Local land use planning agencies[2] Plumas County City of Loyalton Federal government[2] Plumas Nation Forest Tahoe National Forest Integrated Regional Water Mgmt. (IRWM) – Upper Feather River Watershed Grp Hinds Engineering Integrated Environmental Restoration Services Per CWC §10927, entities monitoring and reporting groundwater elevations…[2]	Planning Committee TAC composition Outreach from technical team and GSAs

[1] – as identified in Centra Valley Regional Water Quality Control Board Basin Plan

[2] - as identified in CWC § 10723.2

2.1.5.2 Decision-Making Processes

Decision-making authority and responsibility rests with the GSAs: Plumas County and Sierra Valley Groundwater Management District (SVGMD). The GSAs entered into a Memorandum of Understanding (MOU) in January 2019 "…to facilitate a cooperative and ongoing working relationship to develop a single Sierra Valley GSP that will allow compliance with SGMA and state law…" Additionally, the MOU states that "… all actions taken and/or contemplated under the GSP will be based on sound groundwater science and local expertise…"

The approach for developing and implementing the GSP is informed by a collaborative planning approach as described in the following section.

2.1.5.3 Collaborative Planning and Public Engagement Process

As part of the technical planning approach for developing the GSP, the GSAs established a collaborative planning approach. As described in the Communication and Engagement Plan, Appendix 2-3, opportunities for public involvement featured:

- convening of a Technical Advisory Committee, consisting of an array of stakeholder interests that met on a monthly basis;
- periodic Public Workshops, which provided information on planning efforts and received feedback an input from local participants;
- presentations and updates at monthly SVGMD Board meetings; and

- regular email communication and updates to interested parties.

Planning Committee

An internal Planning Committee was established to track project management and ensure compliance with SGMA requirements. Members included representatives from each GSA, the technical team and the DWR SGMA liaison.

The Planning Committee provided planning guidance and review of materials for TAC meetings, public workshops, informational emails to interested parties, and updates to the SVGMD Board.

Technical Advisory Committee (TAC)

The Technical Advisory Committee was comprised of individuals representing the following organizations or interests:

- Agricultural Commissioner for Plumas and Sierra Counties
- City of Loyalton
- Feather River Land Trust
- Feather River Trout Unlimited
- Hinds Engineering
- Integrated Environmental Restoration Services
- Plumas Audubon
- Plumas County Planning Department
- Plumas County Environmental Health
- Sierra Brooks Water System
- Sierra County Environmental Health
- Sierra Valley Groundwater Management District
- Sierra Valley Resource Conservation District
- Sierraville Public Utility District
- UC Cooperative Extension
- Upper Feather River Watershed Group (IRWM)
- USFS – Plumas National Forest
- USFS – Tahoe National Forest

In developing the GSP, the TAC met 17 times to address specific GSP elements as reflected in Table 2.1.5-2. Meetings were generally conducted in person, with an option for remote participation. Due to COVID-19, some meetings were virtual only. A link to a visual recording and all meeting summaries and related materials were posted for each TAC meeting on the GSP webpage at: https://www.sierravalleygmd.org/gsp-meetings.

Table 2.1.5-2. List of Sierra Valley TAC Meetings through December 31, 2021

Date	Location	Agenda Items
11/2/2020	Beckwourth, CA	Overview: SGMA, GSPs, Community Involvement; Sustainable Management Criteria (SMCs); Subsidence
12/7/2020	Virtual only	Overview: Website; Assessing Sustainability; Groundwater Quality
1/11/2021	Virtual only	Pre-meeting Orientation: Data Portal Modeling Approach Data Management
2/8/2021	Beckwourth, CA	SMCs: Subsidence, Water Quality Groundwater Dependent Ecosystems
3/8/2021	Virtual only	Groundwater Levels and Unreasonable Conditions
4/12/2021	Virtual only	Preliminary Sierra Valley Water Budget Groundwater Levels and SMCs
5/10/2021	Beckwourth, CA	Groundwater Levels; Brainstorming of Projects / Mgmt. Actions; GDEs, Interconnected Surface Water
6/21/2021	Beckwourth, CA	Sierra Valley Water Budget Interconnected Surface Water
7/19/2021	Beckwourth, CA	Sierra Valley Water Budget Projects & Management Actions (PMAs)
8/16/2021	Beckwourth, CA	Funding for GSP Implementation Sierra Valley Water Budget
9/8/2021 Working Session	Beckwourth, CA	Dedicated brainstorming of PMAs
9/13/2021	Virtual only	Discussion of PMAs: Ag Efficiency Improvements; Water Conservation and Demand Management; Watershed Mgmt. and Restoration; Voluntary Managed Land Repurposing
9/20/2021	Virtual only	Sustainability Goal; SMCs, PMAs, SMC Implementation
10/18/2021		
11/29/2021		
12/20/2021		

Additionally, two ad hoc TAC work teams were created to refine the discussion on Groundwater Dependent Ecosystems and a proposal for a Watershed Restoration PMA.

Public Workshops

Public workshops were held to share information and receive feedback on GSP content. These workshops were designed to maximize opportunities for public input during key points in the GSP process. The following table recaps the workshops held during 2018, 2019 and 2021. All workshops were noticed through traditional media, social media and the Interested Parties email list. In May 2021, the workshop was conducted twice to maximize opportunities to participate.

Table 2.1.5-3. List of Sierra Valley GSP Public Workshops

Workshop Number	Workshop Dates	Agenda Topics
1	10/25/18	• SGMA overview and milestones; implementation activities to date, • GSP planning process timeline/work plan overview • Identification of opportunities for stakeholders to participate in GSP planning
2	12/3/19	• Update the community on the planning grant, work plan, and schedule • Basin conditions and other elements related to description of preliminary basin setting • Solicit community input on preliminary basin setting results
3	5/8/21 5/10/21	• Description of conditions relating to Sustainability Indicators • Input on groundwater conditions and undesirable results • Initial ideas about projects and management actions
4	10/17/21	• Presentation on Public Draft GSP and Reviewers; Guide • Initial input on GSP

Public input and responses have been used to guide the development of the Sierra Valley GSP, including sustainable management criteria and potential projects and management actions. Public input will continue to be used to shape adaptive management and refinement of this Plan throughout the implementation horizon.

2.1.5.4 Outreach Activities

To encourage active involvement of diverse social, cultural, and economic elements of the population within the basin, SVGMD uses a variety of traditional and web-based communication tools to keep stakeholders informed and engaged, including:

- Print and on-line media/newspaper announcements: Mountain Messenger; Portola Reporter; Sierra Booster and www.sierraville.org
- Outreach partners' newsletters, websites, and social media accounts
- GSA websites, with posting of TAC meeting minutes, materials and recordings on the SVGMD website
- Interested parties email lists
- Posting of public workshop flyers at local establishments
- Distributing surveys using multiple formats: hard copies at workshops, posted as PDFs, and links to online versions

Dedicated Tribal Outreach

SGMA requires GSAs to consider the interests relating to the uses and users of groundwater. These interested parties comprise a wide range of entities including California Native American tribes (federally recognized and non-federally recognized) (WC Section 10723.2).

While there are no Tribal Trust Land Tracts (U.S. Department of Interior, Bureau of Indian Affairs) within SV Subbasin boundary based on information and data published by DWR, [10] the SV Subbasin and immediate watershed is located within California Native American traditional lands, including the Maidu, Paiute, and Washoe Tribes.

A small portion of the SV Subbasin is located outside of the SVGMD boundary, but within Plumas County, and is commonly referred to as the sliver. This sliver area is the responsibility of the Plumas County GSA, is known to have significant Tribal cultural connections, is entirely comprised of federal lands owned by Plumas National Forest, and is a hydrologically important area located along the federally designated Wild and Scenic River corridor of the Middle Fork Feather River. Accordingly, Plumas County served as the lead entity for SGMA Tribal outreach.

Plumas County utilized the DWR Engagement with Tribal Governments[11] document, which is intended to provide general guidance to GSAs regarding how and when to engage with Tribal governments. As part of DWR's guidance document, the recommended communication and engagement procedures for Tribes starts with contacting the Native American Heritage Commission (NAHC) to identify the appropriate Tribal entities for notification and engagement outreach. Additionally, Plumas County worked with a local Native American contact and the Plumas National Forest.

The NAHC was contacted by Plumas County and a list of Tribes with traditional lands or cultural places located within the SVGMD boundary, SV Subbasin boundary, and watershed boundary was provided. Those Tribes include:

- Estom Yumeka Maidu Tribe of the Enterprise Rancheria
- Greenville Rancheria of Maidu Indians
- Mooretown Rancheria of Maidu Indians
- Susanville Indian Rancheria
- Tsi Akim Maidu
- United Auburn Indian Community of the Auburn Rancheria
- Washoe Tribe of Nevada and California

In addition, the following Tribes were also contacted, as they may have traditional lands or cultural places or knowledge of cultural Tribal resources within the boundaries of the SVGMD, SV Subbasin, and watershed:

- Pyramid Lake Paiute Tribe
- Reno-Sparks Indian Colony
- Mechoopda Indian Tribe
- KonKow Valley Band of Maidu
- Honey Lake Maidu

Communications by email, phone, and/or mail were made to these twelve Tribes to notify them of the SGMA SV Subbasin GSP planning process, to invite them to participate, and to confirm

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[10] https://gis.water.ca.gov/app/boundaries/

[11] DWR Guidance Document for the Sustainable Management of Groundwater, Engagement with Tribal Governments (January 2018)

that Tribal engagement is directed by individual Tribes, with interested Tribes communicating their preferred methods of contact and pathways of engagement. For example, engagement could solely be in the form of informational updates as an interested party or could be more involved with direct participation on a committee or during meetings or while attending public workshops. Follow up with individual Tribes was conducted and tailored to the specific Tribal responses received.

2.1.5.5 Informing the Public on GSP Implementation Progress

The public was kept informed on GSP development progress through progress summary presentations provided during public workshops as documented in the CE Plan and through information and documents posted on the District's website. To keep the public informed on GSP implementation progress, information will continue to be posted on the website and updates will be provided at Board meetings. In addition, the status of projects and management actions will be included in the annual evaluation and reporting to be facilitated by SVGMD and performed. Updates and an assessment of GSP progress will be presented annually in the fall or winter subsequent to completion of the annual reports, as described in the C&E Plan. In the event of undesirable results occurring which necessitate timely implementation of management actions, notices will be distributed via the tools listed above and in accordance with the CE Plan.

The Sierra Valley TAC seeks to ensure timely implementation of an expanded monitoring network and GSP projects and management actions. To support this objective, continued engagement of TAC members and Interested Parties should be maintained throughout GSP implementation. This could be achieved through a variety of means: a standing agenda item on District Board meetings to report on GSP implementation on a recurring basis (e.g., every third month), email updates using a newsletter format, ad hoc working groups to advance specific PMAs, and/or periodic GSP implementation reviews (e.g., every six months) as part of Board meetings.

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 2-5) are addressed and new information becomes available.

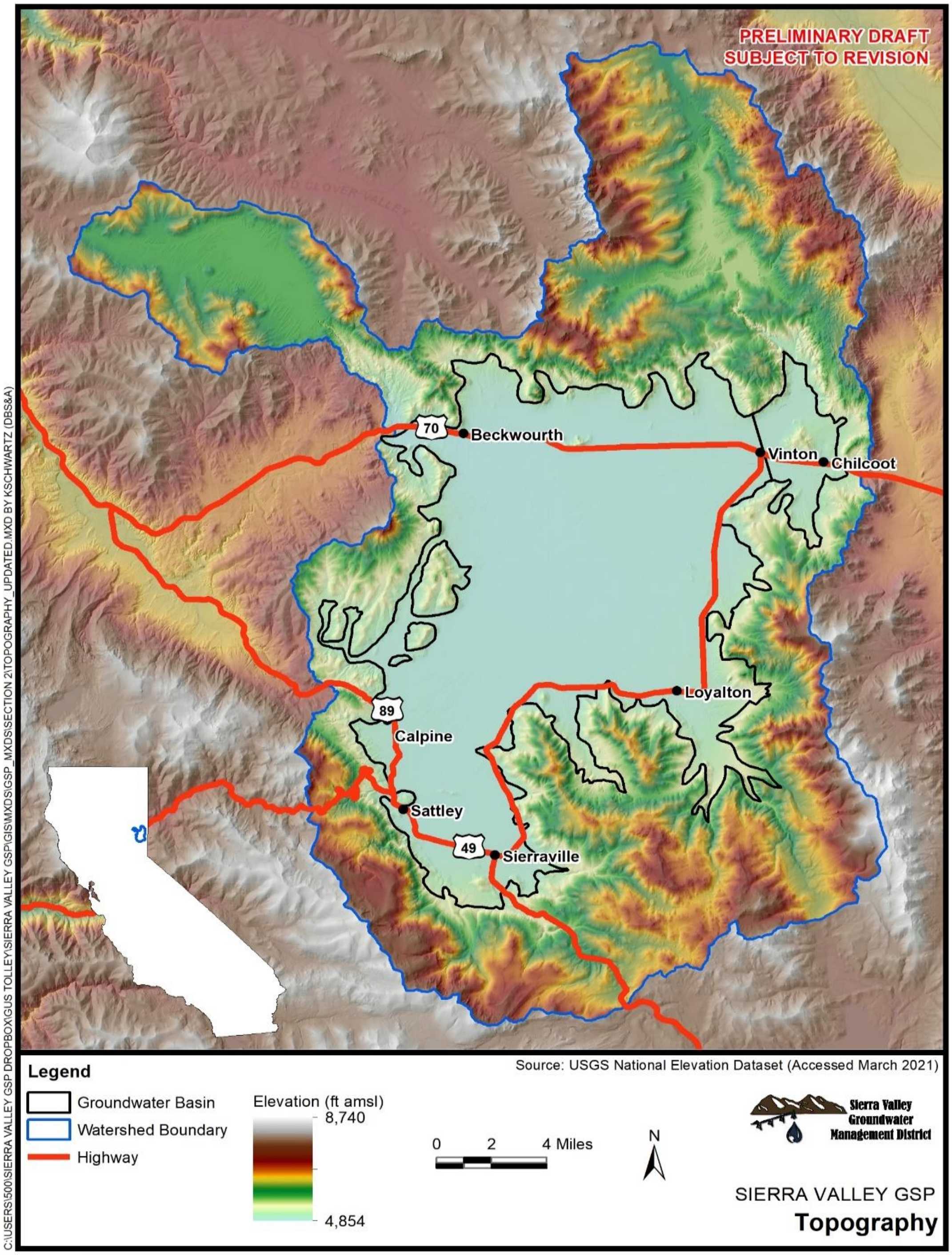
Several geologic and water resource studies have been conducted in Sierra Valley since the 1960s. A detailed review of all previous work is beyond the scope of this report, but all relevant information was reviewed during development of the Sierra Valley HCM. The sections below summarize information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



Source: USGS National Elevation Dataset (Accessed March 2021)

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5/25/2021

Figure 2.2.1-1

Stream channels cutting through the steep slopes of the surrounding mountains drain precipitation and snowpack into the Sierra Valley form 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 4,975 feet above amsl), show freezing temperatures typically occur from September until May, while some surrounding higher elevations experience freezing temperatures throughout the year. In addition, freezing temperatures will also occur on the valley floor for a few days each 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, snowfall is common. 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, pasture land and alfalfa grown for hay are the dominant irrigated crops. 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 (e.g., Santa

Lucia dwarf rush and Modoc County knotweed) 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 competes 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 makes up the majority of the vegetation in Sierra Valley and is found along the valley floor and the slopes along the north and east sides of the valley (Harnach 2016). Ponderosa Pine Alliance and Eastside Pine Alliance (comprised of a mix of ponderosa and Jeffrey pines, Douglas fir, and white fir) occur along the edge of the southern portion of the valley, particularly in hillslopes with northern aspects (USDA 2014, Harnach 2016). Oak woodlands also occur in the northern portion of the valley and into the uplands. Red fir forests occur in the highest elevations above the valley (6,000 to 9,000 feet) along the southwest watershed's border, with white fir below (5,000 to 6,000 feet), and greenleaf manzanita and snow brush in open, undisturbed areas. The Sierran Mixed Conifer forest in the watershed includes white fir, ponderosa pine, sugar pine, incense~~d~~ cedar, and Douglas fir (in certain areas above Calpine). The upland areas of the watershed also contain wet meadows, montane riparian aspen, and other hardwood vegetation types including Black Oak woodland. Wildfires have historically burned 44,000 acres of upland vegetation within the watershed since 1994 (Vestra, 2005), and more recently, burned over 150,000 acres in the Loyalton Fire and Beckwourth complex.

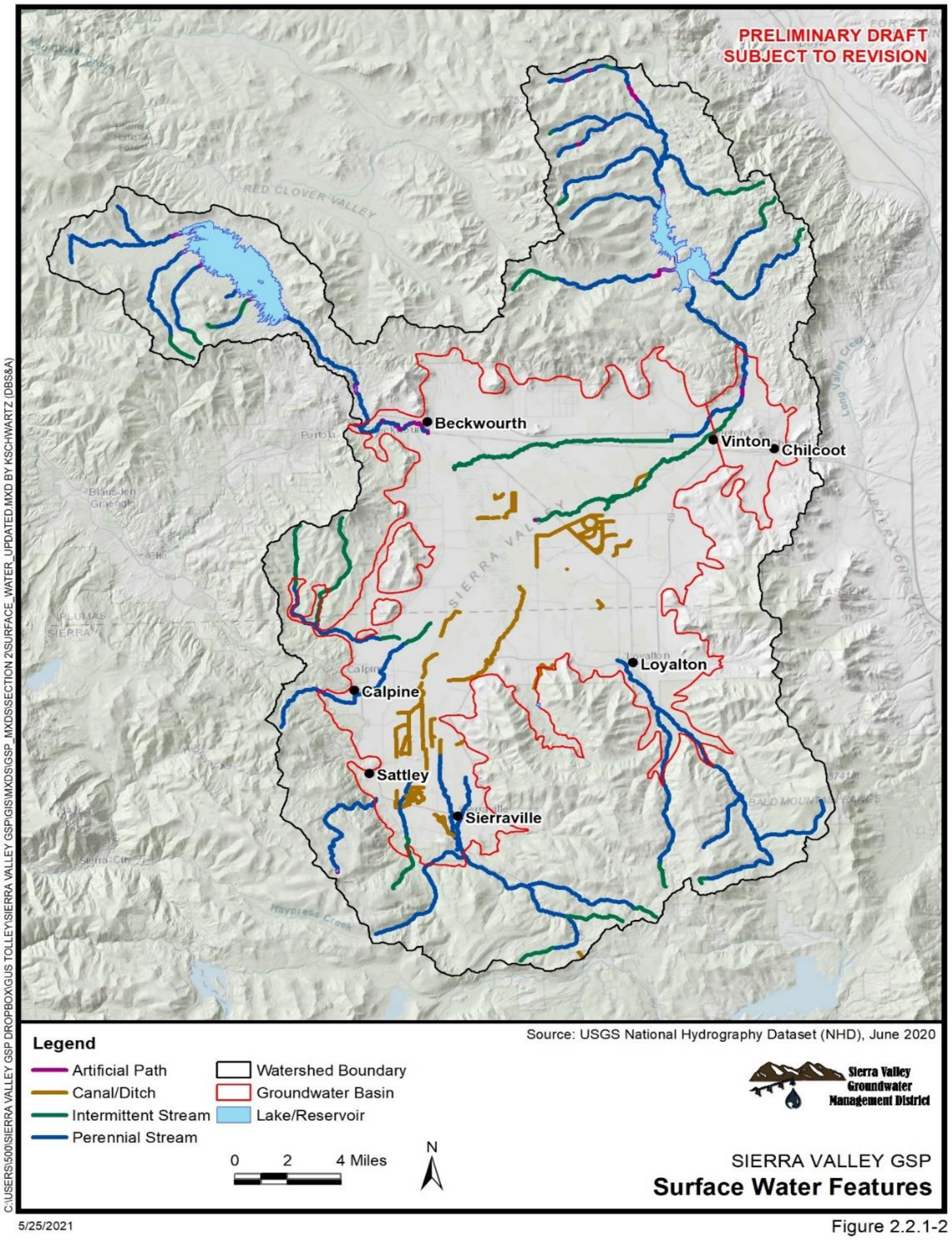
Climate, fire, invasive species, timber management, agricultural production and water management systems have changed the composition of the Sierra Valley watershed vegetation (Vestra, 2005). The impact of wildfires and drought in 2021 will also have a significant but yet to be evaluated effect on the watershed.

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.

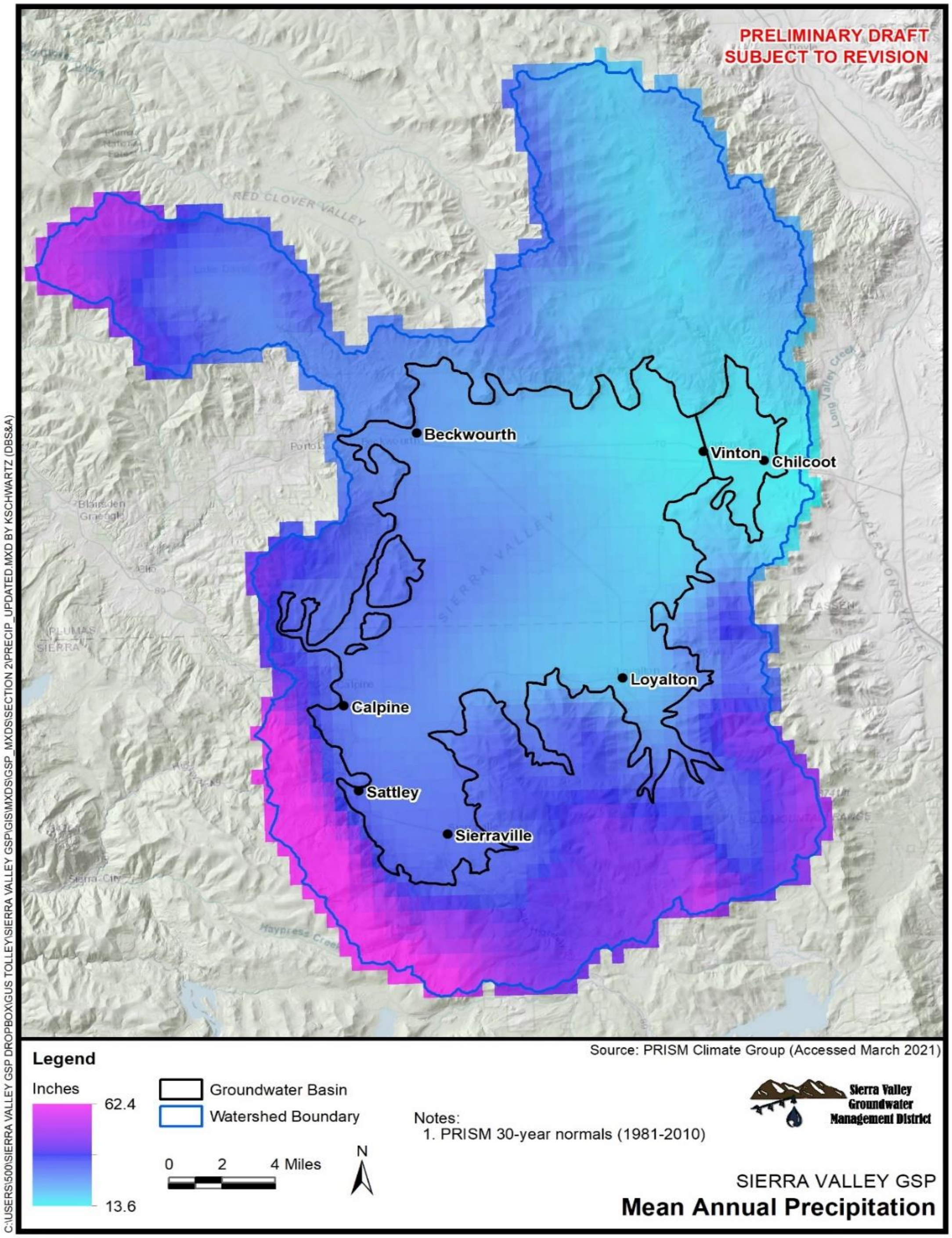
Soils within the Sierra Valley Watershed vary considerably in productivity, depth, and use based on parent material, topography, and precipitation. A total of 2,499 unique soil map units were identified within the Sierra Valley watershed with 1,071 units overlying the groundwater basin. Figure 2.2.1-6 shows a general summary of these map units classified by soil type defined by the 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.

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



Note: The USGS NHD dataset for surface water features is an industry standard used in hydrological reports, yet commonly has potential for improvement that can be addressed by submitting recommended changes to the USGS on their NHD webpage.

Figure 2.2.1-3 Mean Annual Precipitation



Source: PRISM Climate Group (Accessed March 2021)

Notes:
1. PRISM 30-year normals (1981-2010)

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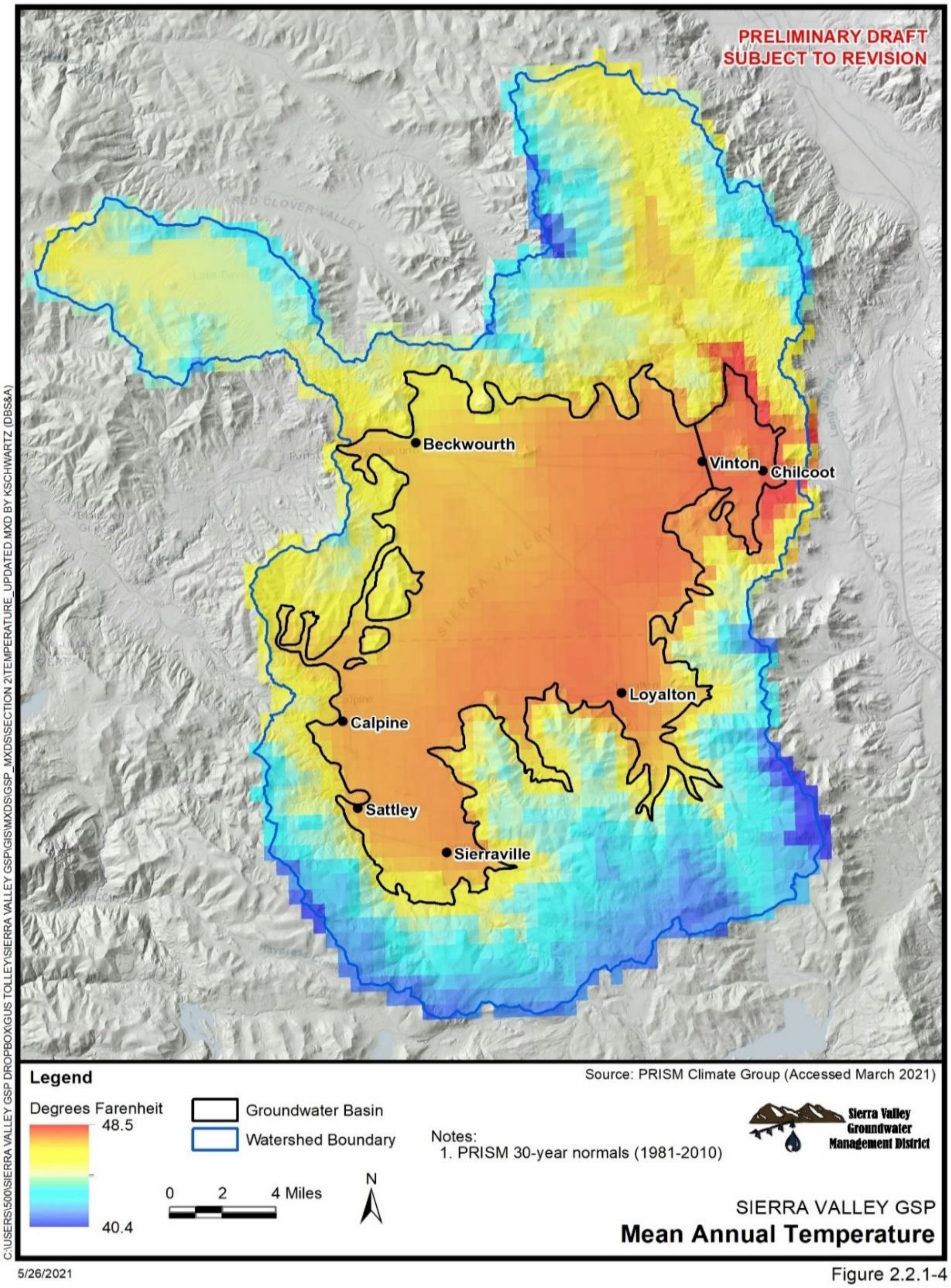
Figure 2.2.1-3

Figure 2.2.1-4 Mean Annual Temperature



Source: PRISM Climate Group (Accessed March 2021)

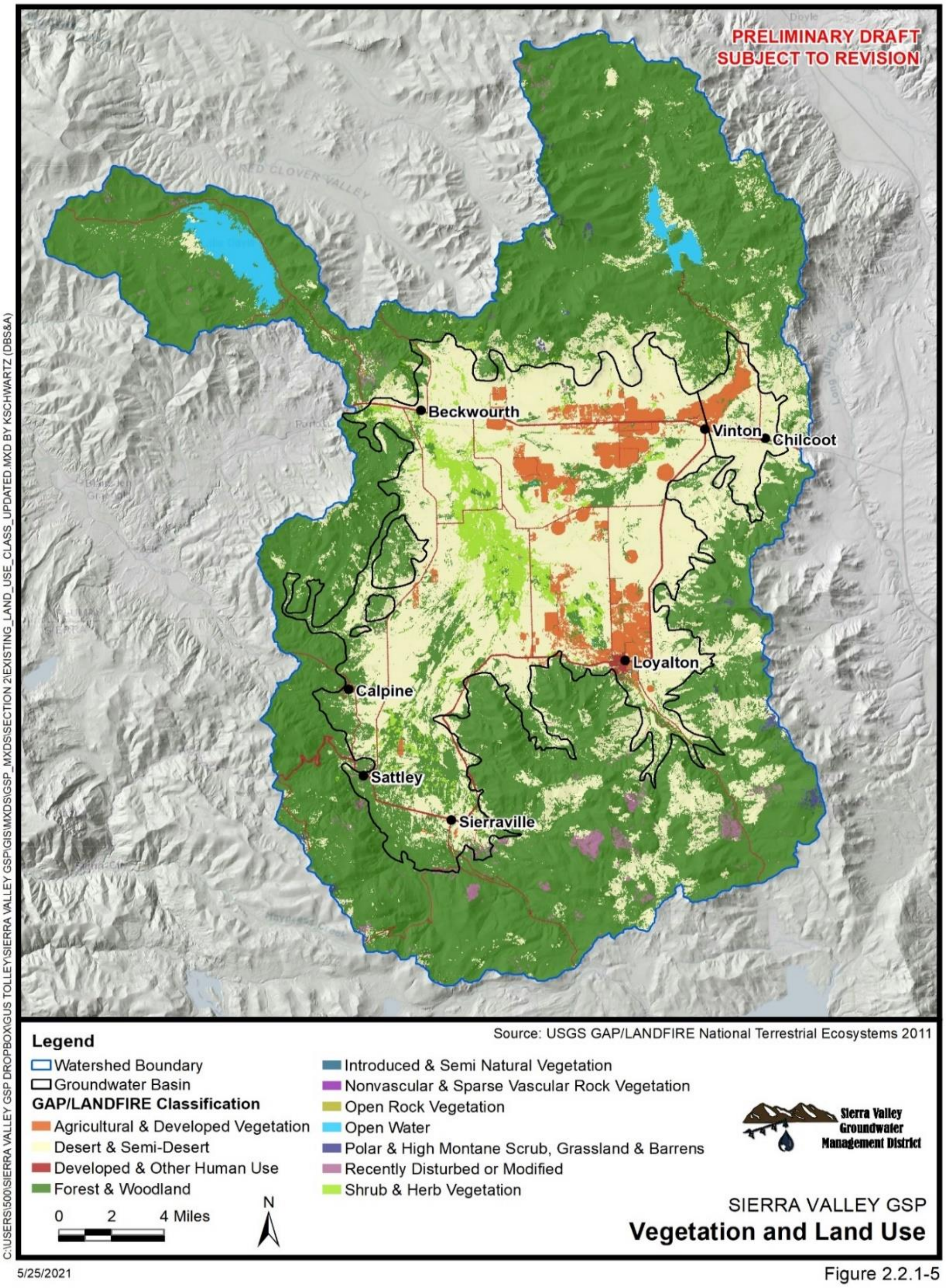
Notes:
1. PRISM 30-year normals (1981-2010)

SIERRA VALLEY GSP
Mean Annual Temperature

5/26/2021

Figure 2.2.1-4

1100 Figure 2.2.1-5 Vegetation and Land Use



Source: USGS GAP/LANDFIRE National Terrestrial Ecosystems 2011

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Figure 2.2.1-5

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Figure 2.2.1-6 Soil Types

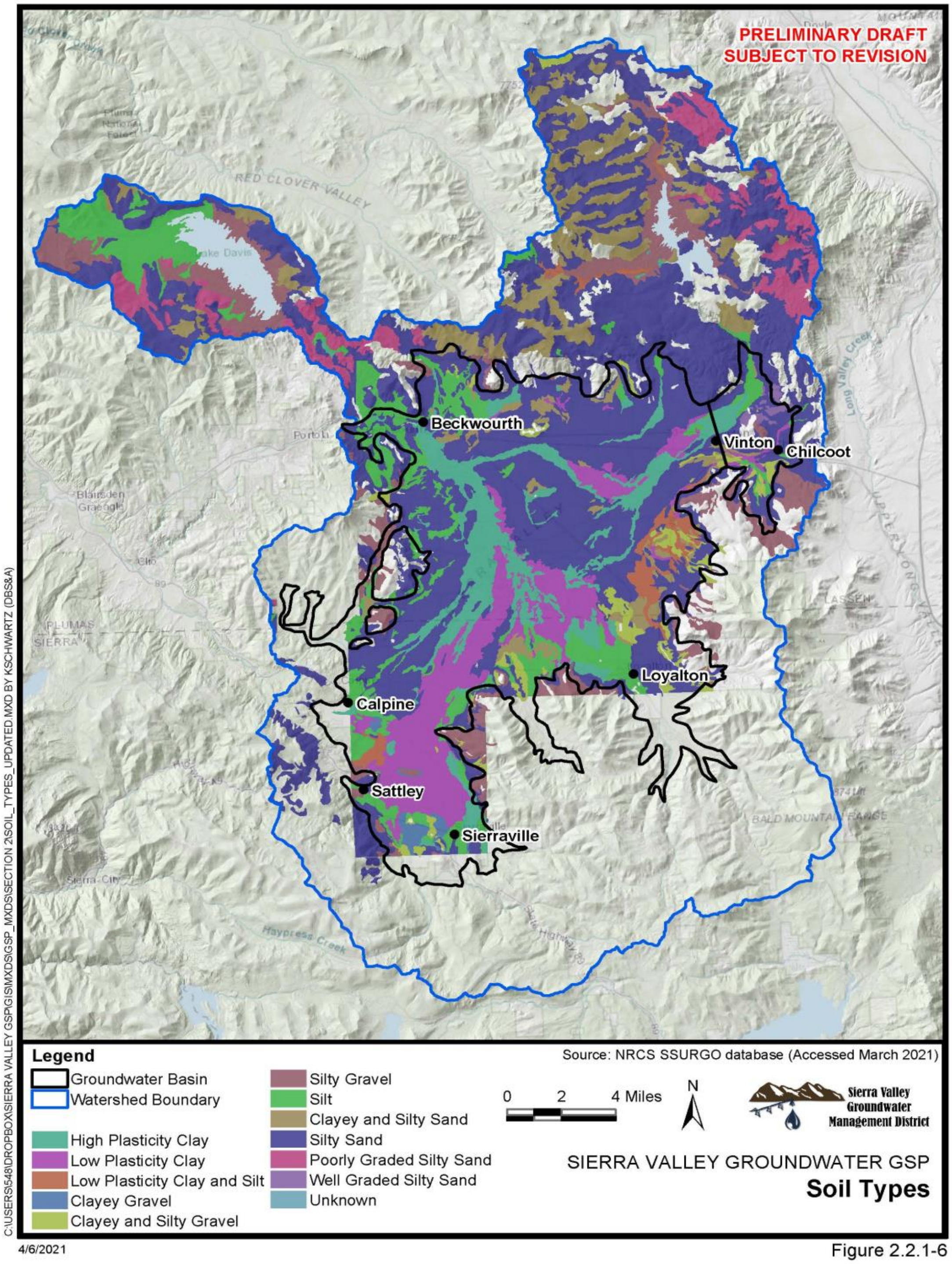


Table 2.2.1-1 Summary of groundwater basin soil texture composition

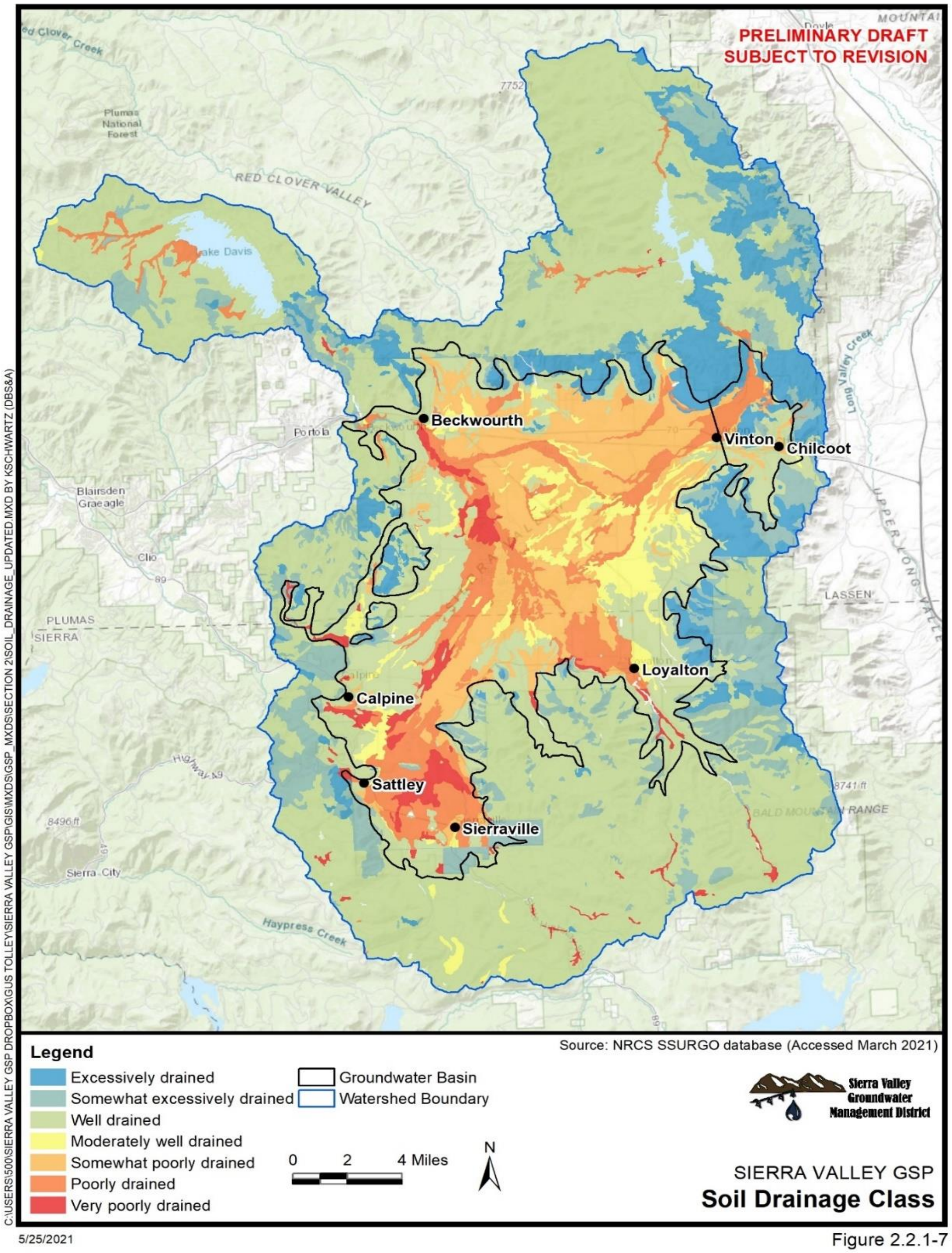
Soil Type	Area (Acres)	Area (%)
Silty Sand	51,333.5	41.10
Low Plasticity Clay	17,549.4	14.05
High Plasticity Clay	15,751.2	12.61
Silt	13,276.0	10.63
Unknown	12,446.9	9.97
Clayey and Silty Sand	4,047.6	3.24
Clayey and Silty Gravel	4,012.0	3.21
Low Plasticity Clay and Silt	2,703.3	2.16
Silty Gravel	2,323.3	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, are 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 surrounding mountains 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 is 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



1129 **Figure 2.2.1-8 Soil Saturated Hydraulic Conductivity**

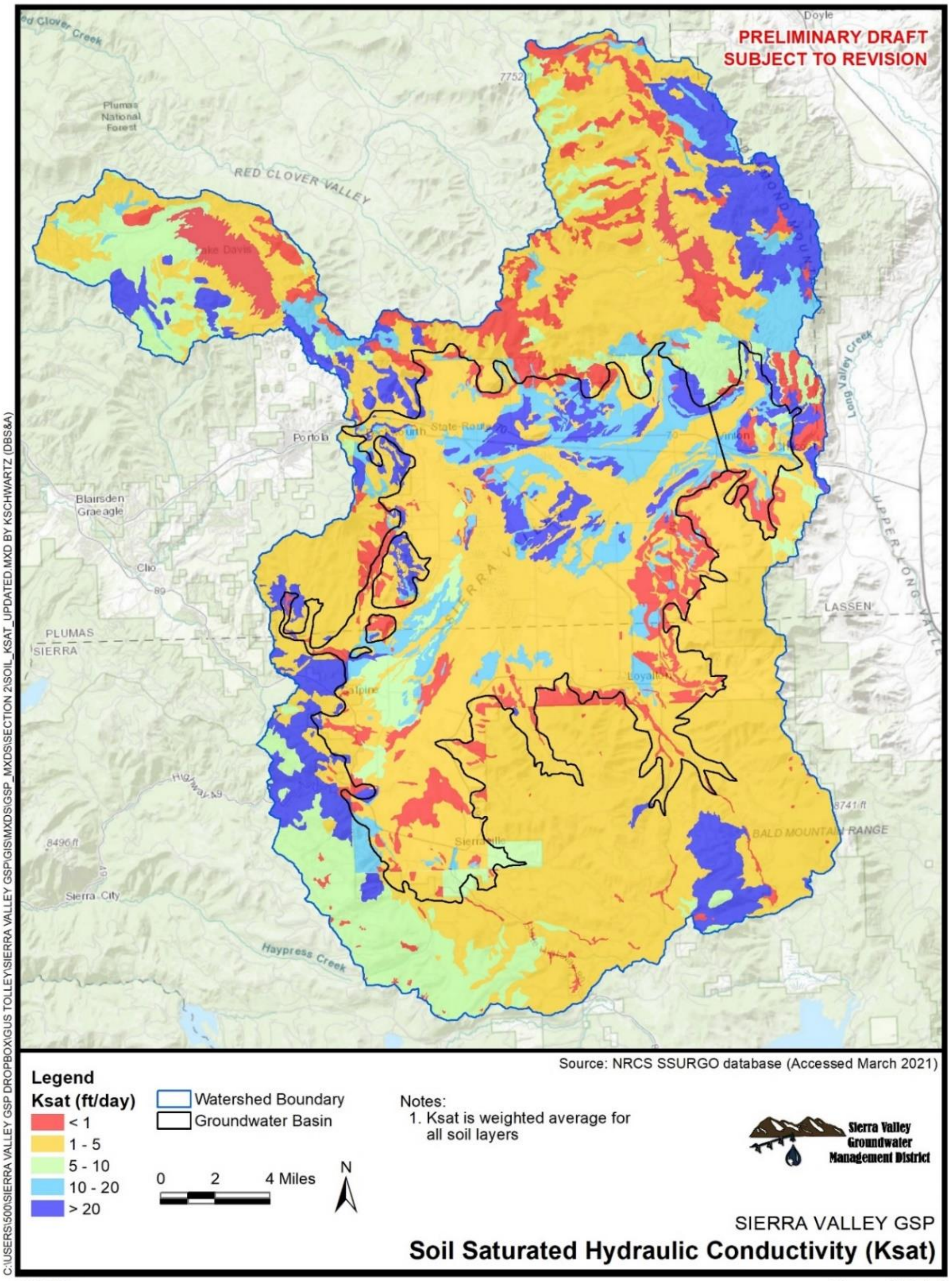


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Figure 2.2.1-8

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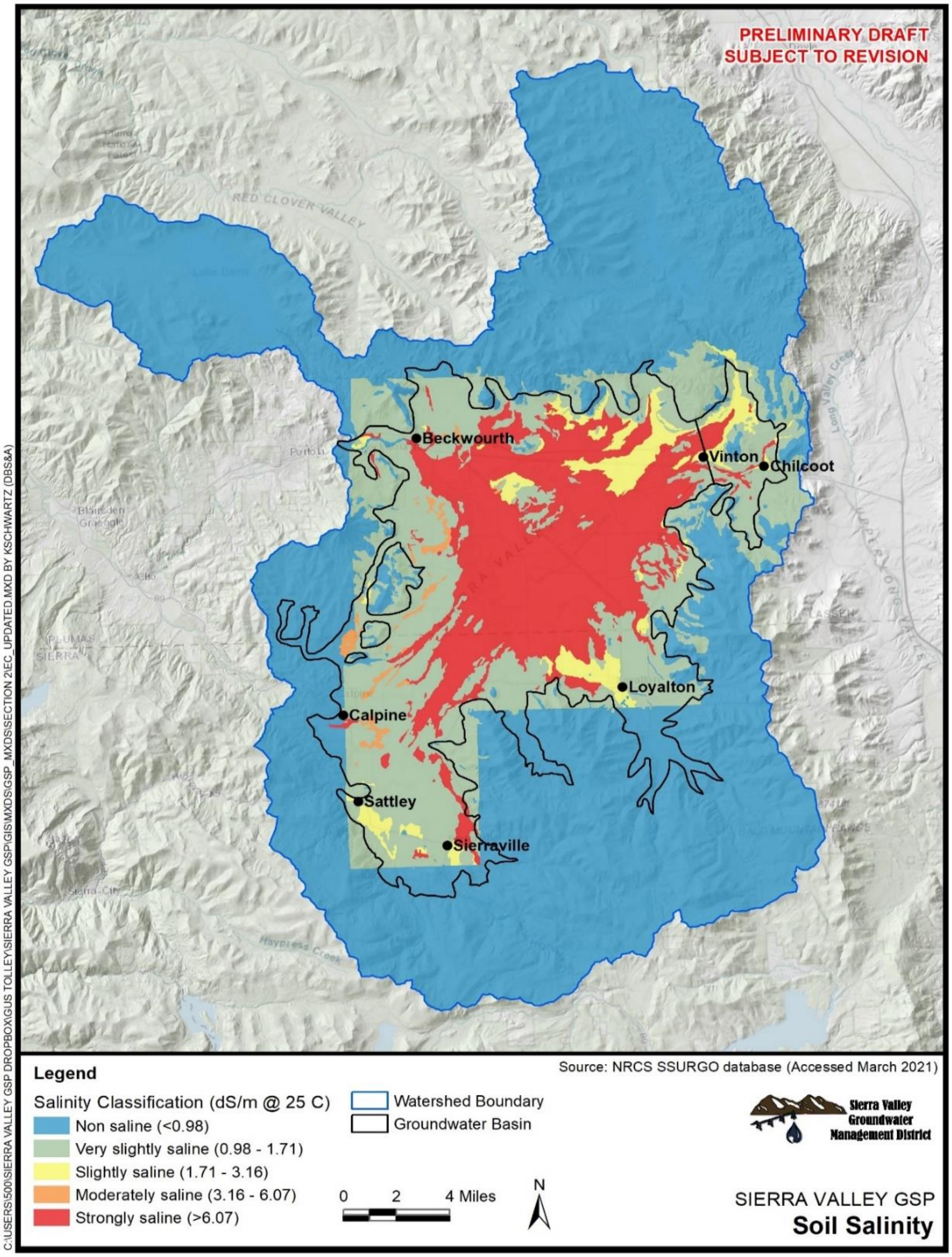
Figure 2.2.1-9 Soil Salinity



Source: NRCS SSURGO database (Accessed March 2021)

5/25/2021

Figure 2.2.1-9

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 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 the 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.

Figure 2.2.1-10 Geology

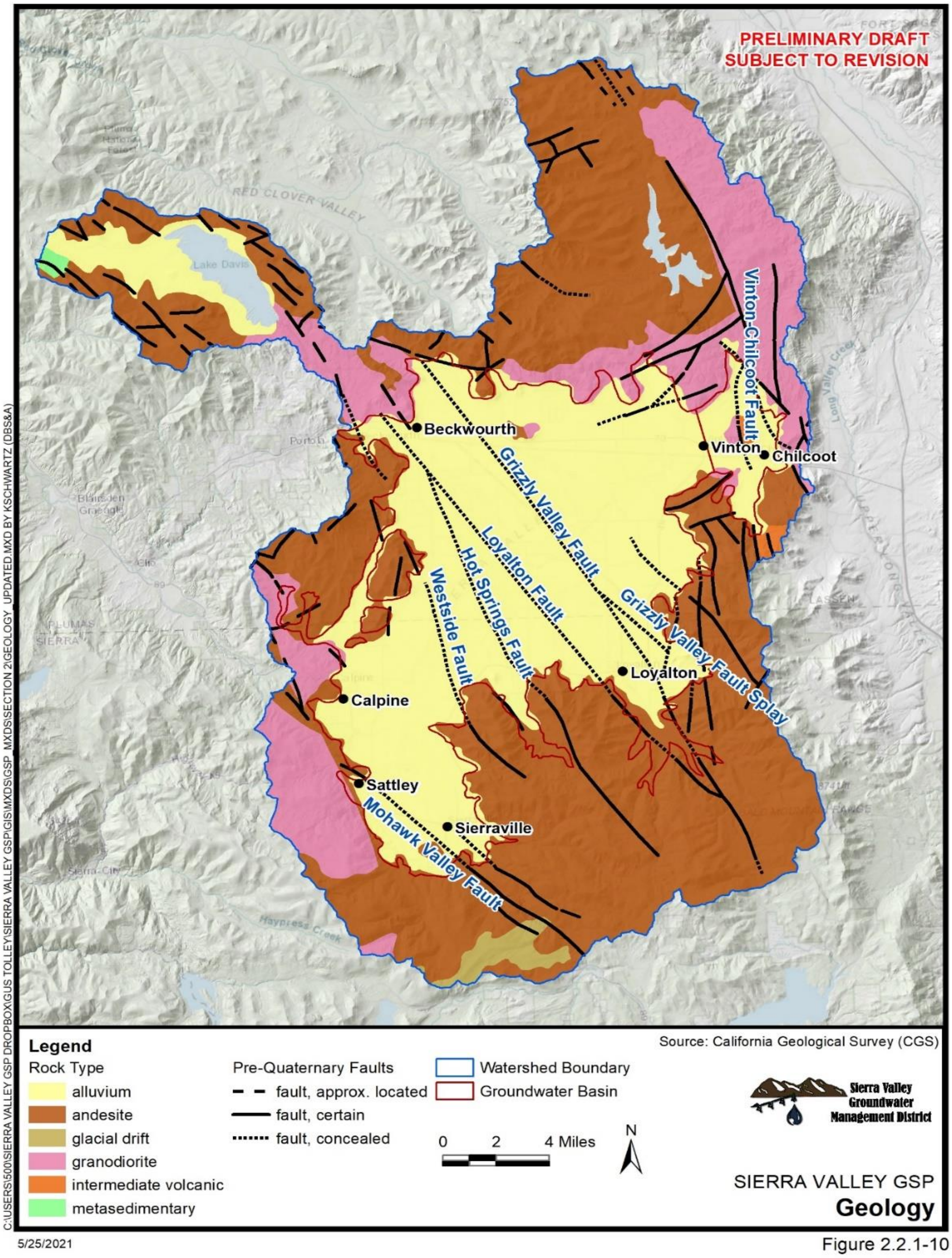
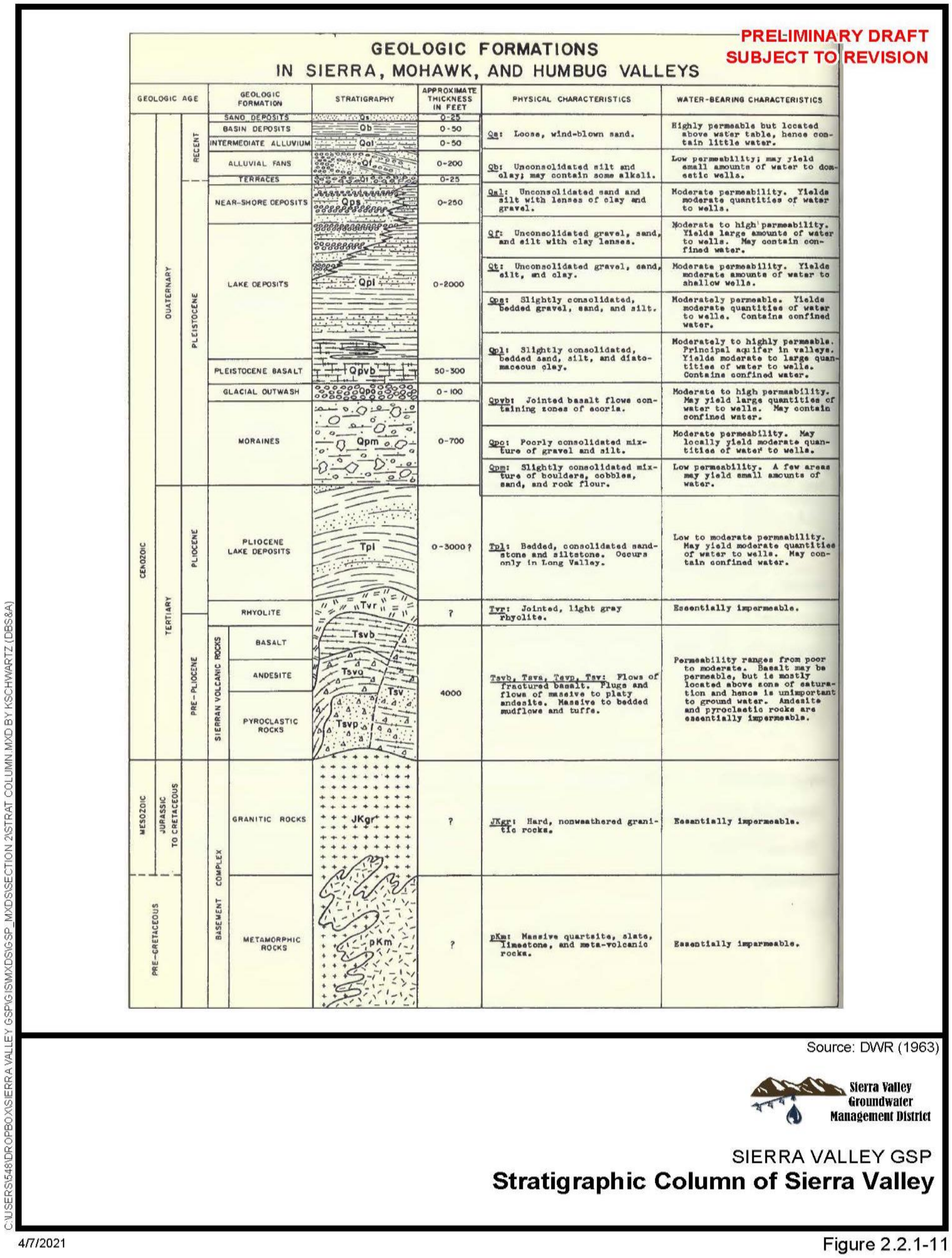


Figure 2.2.1-11 Stratigraphic Column of Sierra Valley



PRELIMINARY DRAFT SUBJECT TO REVISION

GEOLOGIC FORMATIONS
IN SIERRA, MOHAWK, AND HUMBUG VALLEYS

GEOLOGIC AGE				GEOLOGIC FORMATION	STRATIGRAPHY	APPROXIMATE THICKNESS IN FEET
CENOZOIC	QUATERNARY	RECENT		SAND DEPOSITS	Qs	0-25
				BASIN DEPOSITS	Qb	0-50
				INTERMEDIATE ALLUVIUM	Qal	0-50
				ALLUVIAL FANS	Qf	0-200
				TERRACES	Qt	0-25
		PLEISTOCENE		NEAR-SHORE DEPOSITS	Qps	0-250
				LAKE DEPOSITS	Qpl	0-2000
				PLEISTOCENE BASALT	Qpvb	50-300
				GLACIAL OUTWASH	Qpo	0-100
				MORAINES	Qpm	0-700
	TERTIARY	PLIOCENE		PLIOCENE LAKE DEPOSITS	Tpl	0-3000 ?
				RHYOLITE	Tvr	?
		PRE-PLIOCENE	SIERRAN VOLCANIC ROCKS	BASALT	Tsvb	4000
				ANDESITE	Tsva Tsv	
				PYROCLASTIC ROCKS	Tsvp	
MESOZOIC	JURASSIC TO CRETACEOUS		BASEMENT COMPLEX	GRANITIC ROCKS	JKgr	?
PRE-CRETACEOUS				METAMORPHIC ROCKS	pKm	?

PHYSICAL CHARACTERISTICS	WATER-BEARING CHARACTERISTICS
Qs: Loose, wind-blown sand.	Highly permeable but located above water table, hence contain little water.
Qb: Unconsolidated silt and clay; may contain some alkali.	Low permeability; may yield small amounts of water to domestic wells.
Qal: Unconsolidated sand and silt with lenses of clay and gravel.	Moderate permeability. Yields moderate quantities of water to wells.
Qf: Unconsolidated gravel, sand, and silt with clay lenses.	Moderate to high permeability. Yields large amounts of water to wells. May contain confined water.
Qt: Unconsolidated gravel, sand, silt, and clay.	Moderate permeability. Yields moderate amounts of water to shallow wells.
Qps: Slightly consolidated, bedded gravel, sand, and silt.	Moderately permeable. Yields moderate quantities of water to wells. Contains confined water.
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.
Qpvb: Jointed basalt flows containing zones of scoria.	Moderate to high permeability. May yield large quantities of water to wells. May contain confined water.
Qpo: Poorly consolidated mixture of gravel and silt.	Moderate permeability. May locally yield moderate quantities of water to wells.
Qpm: Slightly consolidated mixture of boulders, cobbles, sand, and rock flour.	Low permeability. A few areas may yield small amounts of water.
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.
Tvr: Jointed, light gray rhyolite.	Essentially impermeable.
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.
JKgr: Hard, nonweathered granitic rocks.	Essentially impermeable.
pKm: Massive quartzite, slate, limestone, and meta-volcanic rocks.	Essentially impermeable.

Source: DWR (1963)

Sierra Valley Groundwater Management District

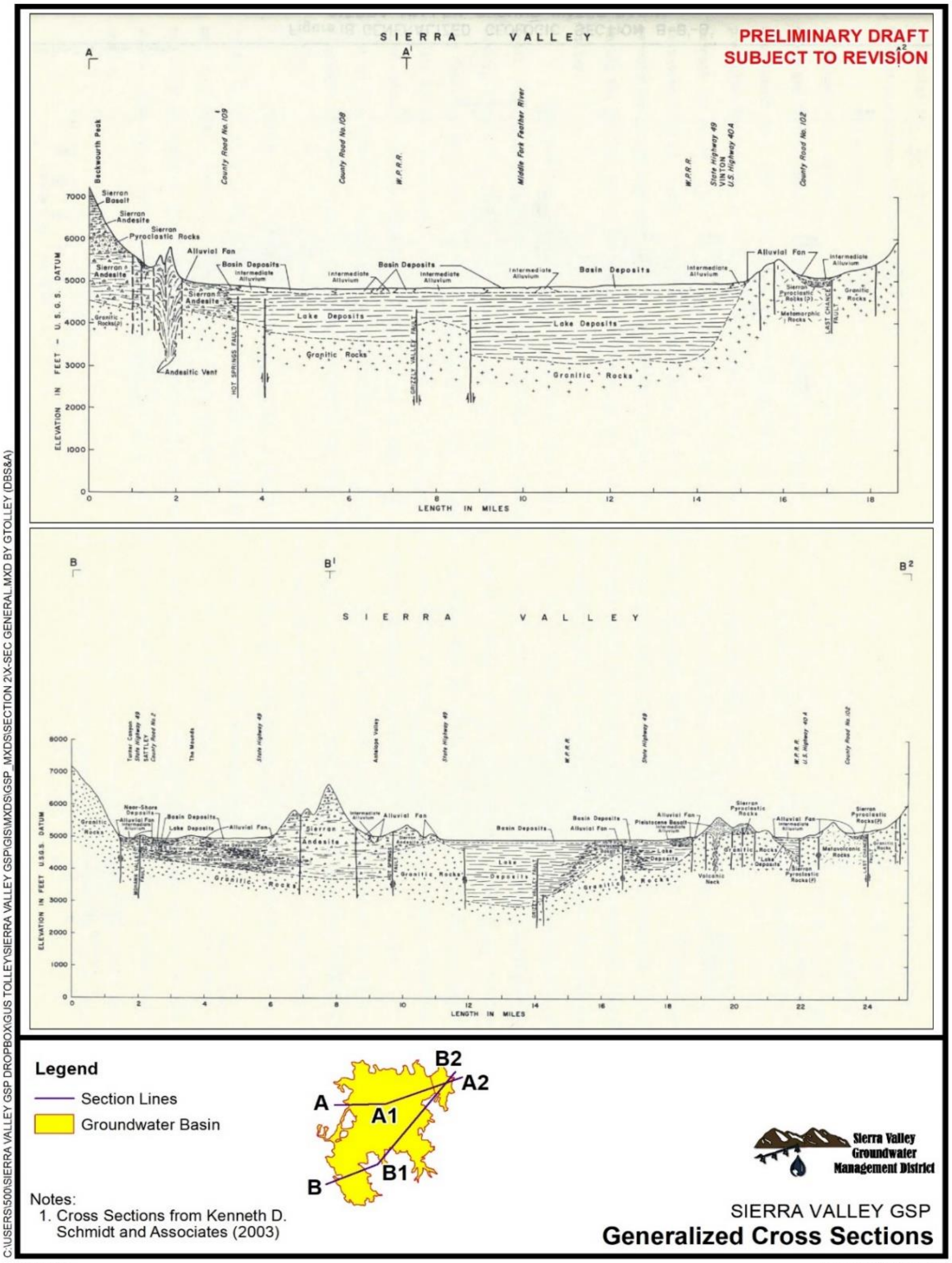
SIERRA VALLEY GSP
Stratigraphic Column of Sierra Valley

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

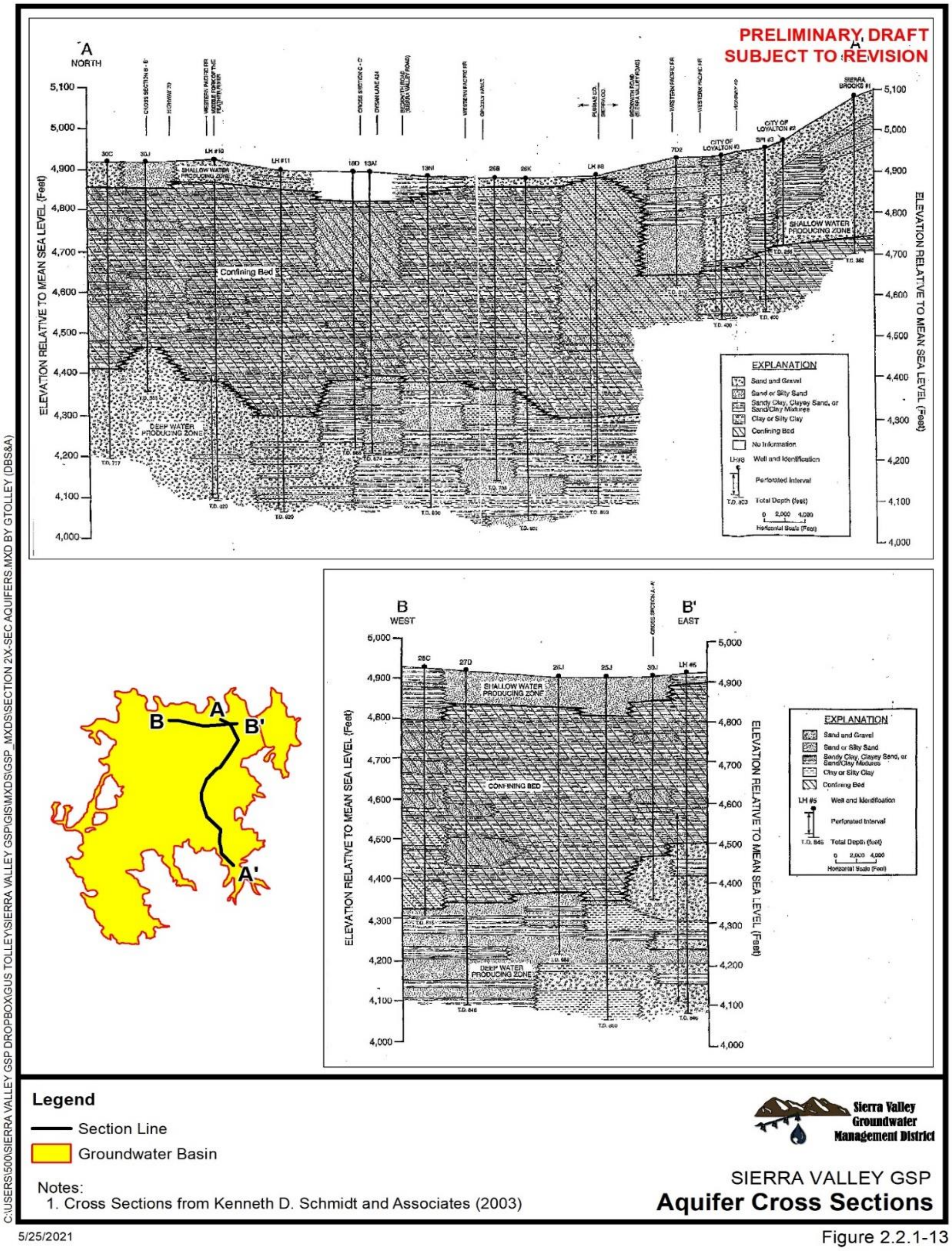


Notes:
1. Cross Sections from Kenneth D. Schmidt and Associates (2003)

5/25/2021

Figure 2.2.1-12

Figure 2.2.1-13 Aquifer Cross Sections



Notes:
1. Cross Sections from Kenneth D. Schmidt and Associates (2003)

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 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 a left lateral high angle normal fault striking northwest. It divides the basin into a southwestern one-third section and northeastern two-thirds section 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 provide 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 and irrigation canal 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 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
Little Last Chance Creek	20.4	14,770		2000 - 2020	DWR
Big Grizzly Creek	34.7	25,100	14%	1926 - 1931, 1951 - 1952, 1955 - 1979	USGS
Big Grizzly Creek	10.7	7,737		2000 - 2020	DWR
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. This table was modified from Bachand and Carlton (2020) to include flows measured since 2000 by DWR at Frenchman reservoir to Little Last Chance Creek and at Davis reservoir to Big Grizzly Creek. 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 and Carlton, 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 annually contribute approximately 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) is commonly inundated with water well into summer.

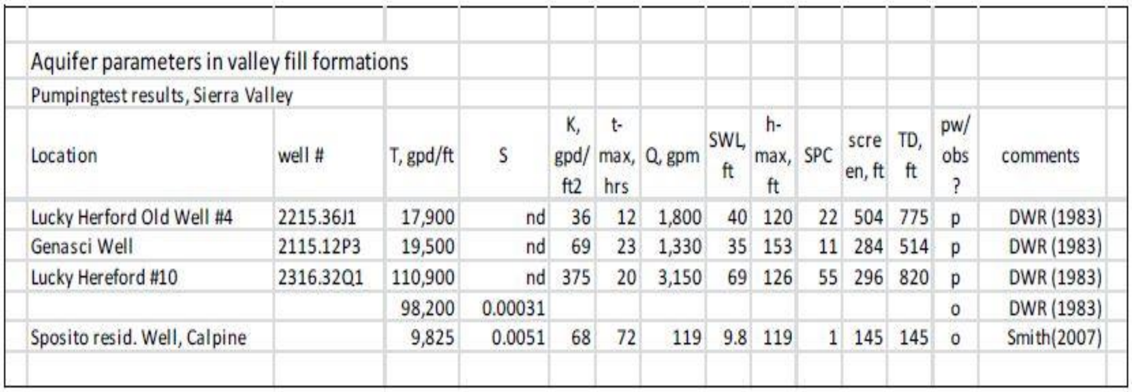
Inflows to the Sierra Valley groundwater system are primarily sourced from infiltration of surface-water in the alluvial fans at the periphery of the valley from adjacent uplands and flow from the fractured bedrock in contact with the shallow and deep aquifers (Bohm, 2016). A small amount of recharge 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 comprise 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. These two hydrostratigraphic units will be referred to as the "basin fill unit" and "bedrock unit" for the purpose of this report. 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. 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 are 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

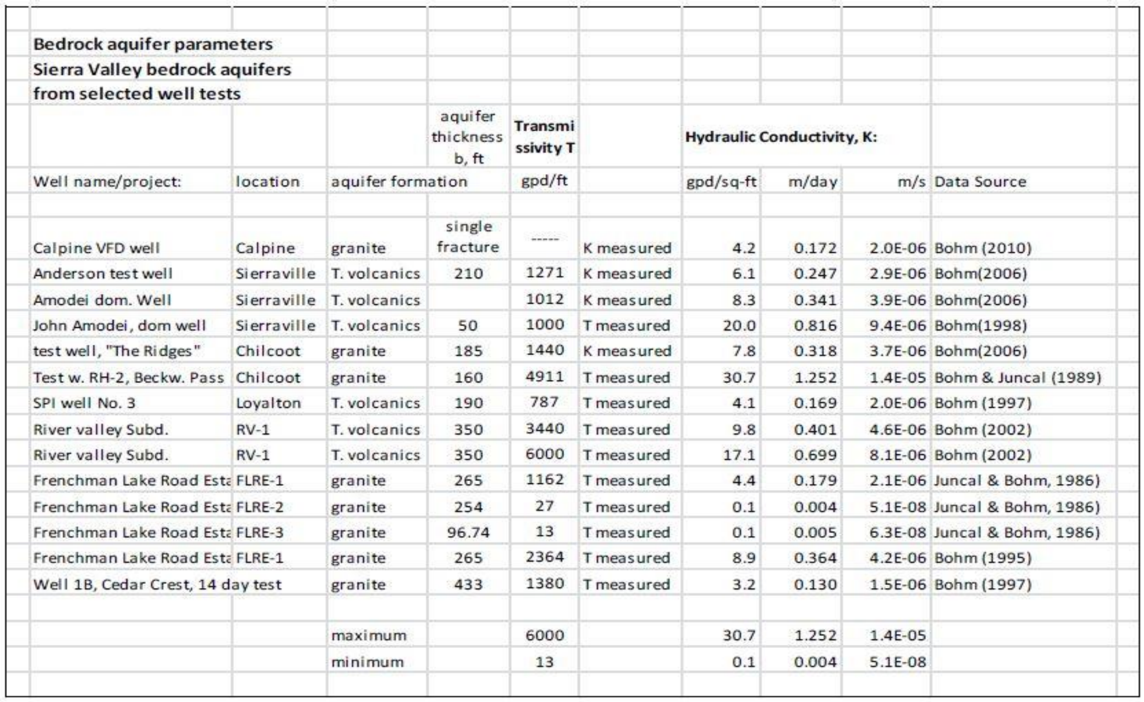
Pumpingtest results, Sierra Valley

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 tests in the bedrock have been conducted in the basin periphery. Aquifer parameters determined are highly variable dependent on the 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 the 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 suggests the northwest trending Grizzly Valley Fault Zone impedes 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**			aquifer thickness b, ft	**Transmissivity T**		**Hydraulic Conductivity, K:**			
Well name/project:	location	aquifer formation		gpd/ft		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 9,150 acre-feet for irrigation use occurred between 2008 and 2019 based on data from SVGMD. 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 670 acre-feet based on data spanning 2008 through 2019 from SVGMD. 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

2.2.1.6.1 Summary of available surface water data[Figure numbers need to be changed]

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 2.2.1-14 and Figure 2.2.1-15 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 2.2.1-5 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 presented earlier in Table 2.2.12. 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 2.2.1-5 summarizes the data collected by the Sierra Valley Watermaster since 2007.

Figure 2.2.1-14 Streams monitored by the Sierra Valley Watermaster during the irrigation season

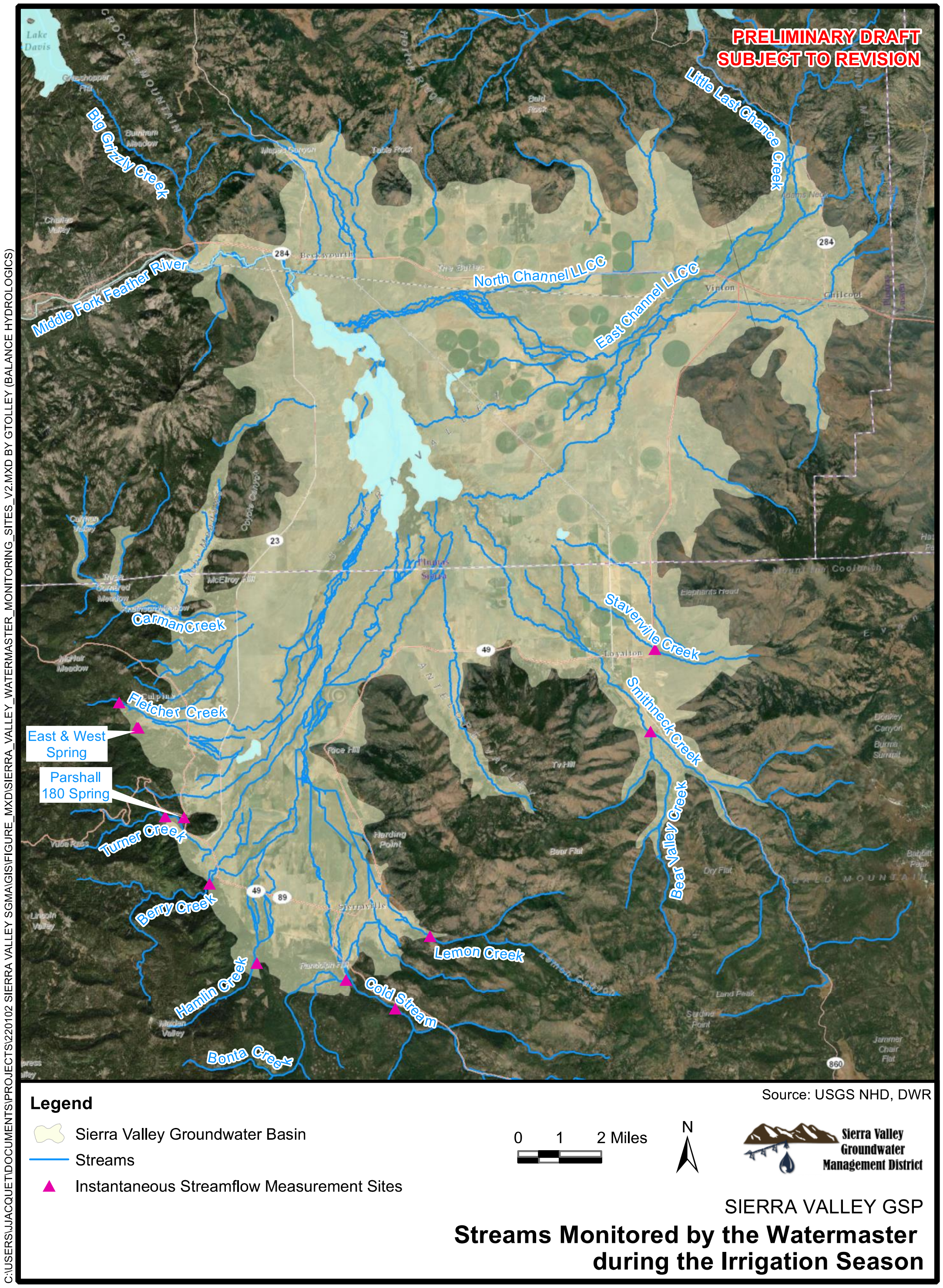


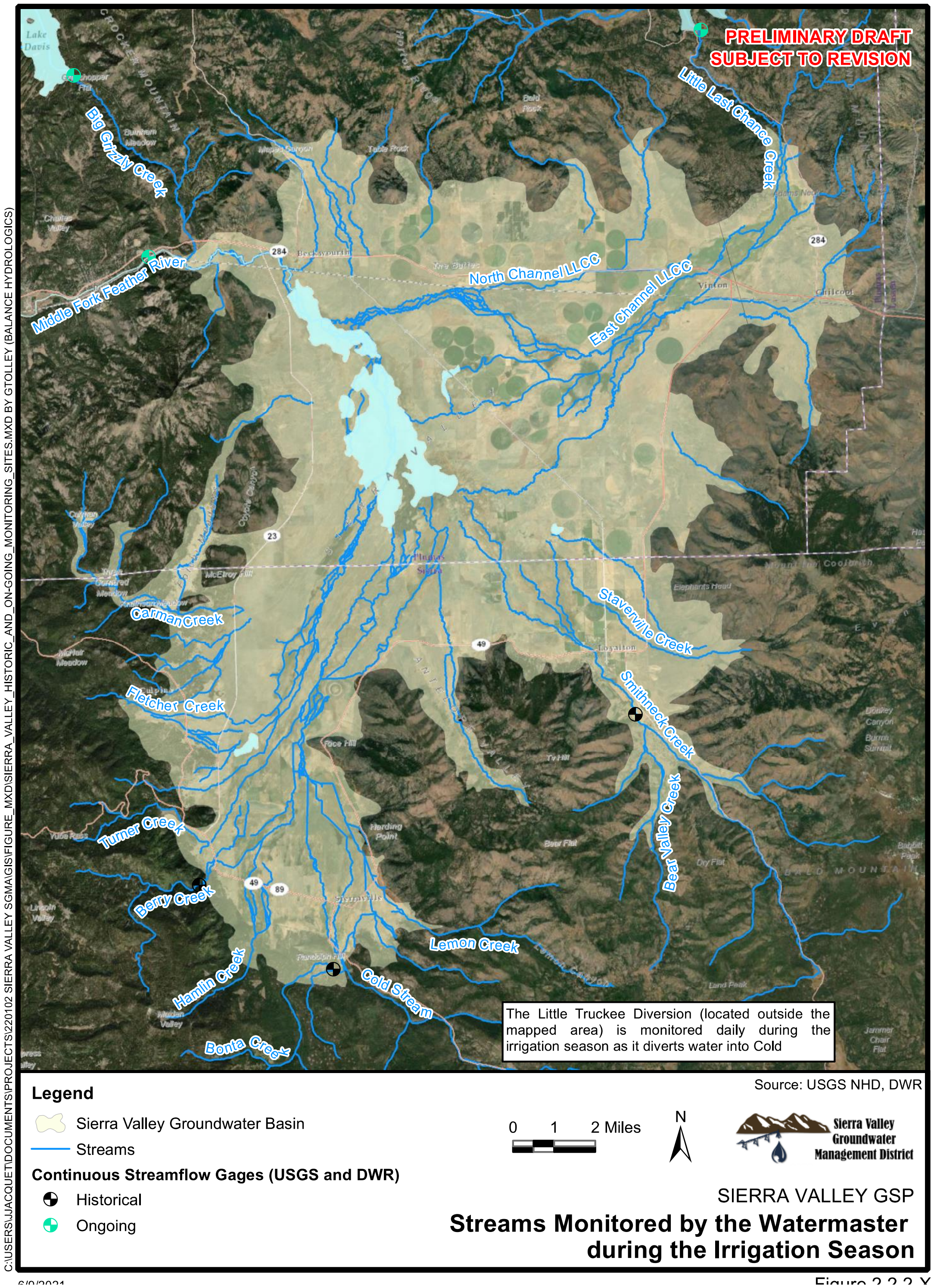
Table 2.2.1-5 Streamflow Measurements

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 2.2.1-15 Ongoing and historical continuous streamflow gaging or reservoir outflow for the Sierra Valley



The Little Truckee Diversion (located outside the mapped area) is monitored daily during the irrigation season as it diverts water into Cold

Source: USGS NHD, DWR

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
- 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.

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 for tracking 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 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 well levels 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. More recent dry conditions can be compared to these levels as the data becomes available. 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 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

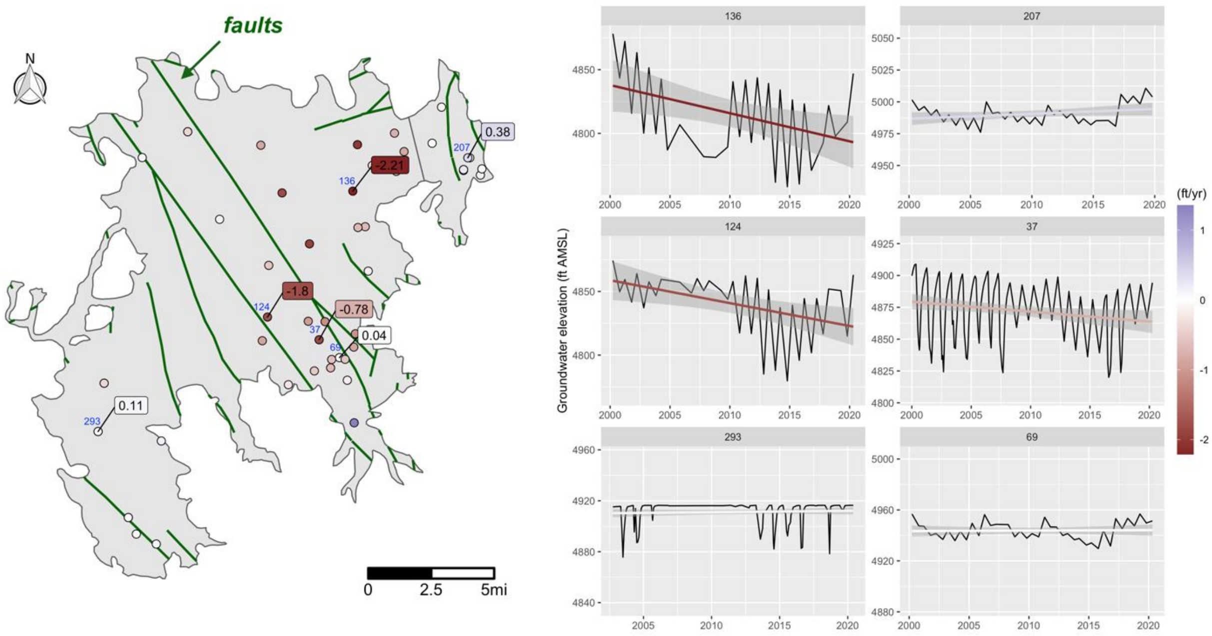


Figure 2.2.2-2 Sierra Valley Groundwater Level Trends for Deep and Shallow Wells

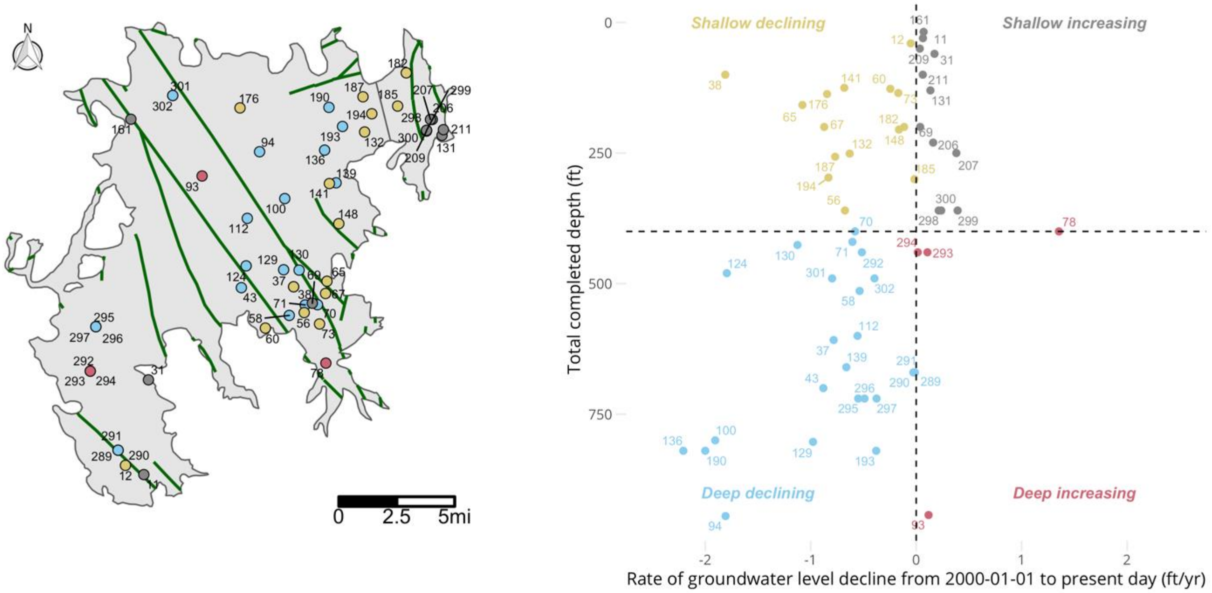


Figure 2.2.2-3 2013-2016 Spring Average Sierra Valley Groundwater Levels

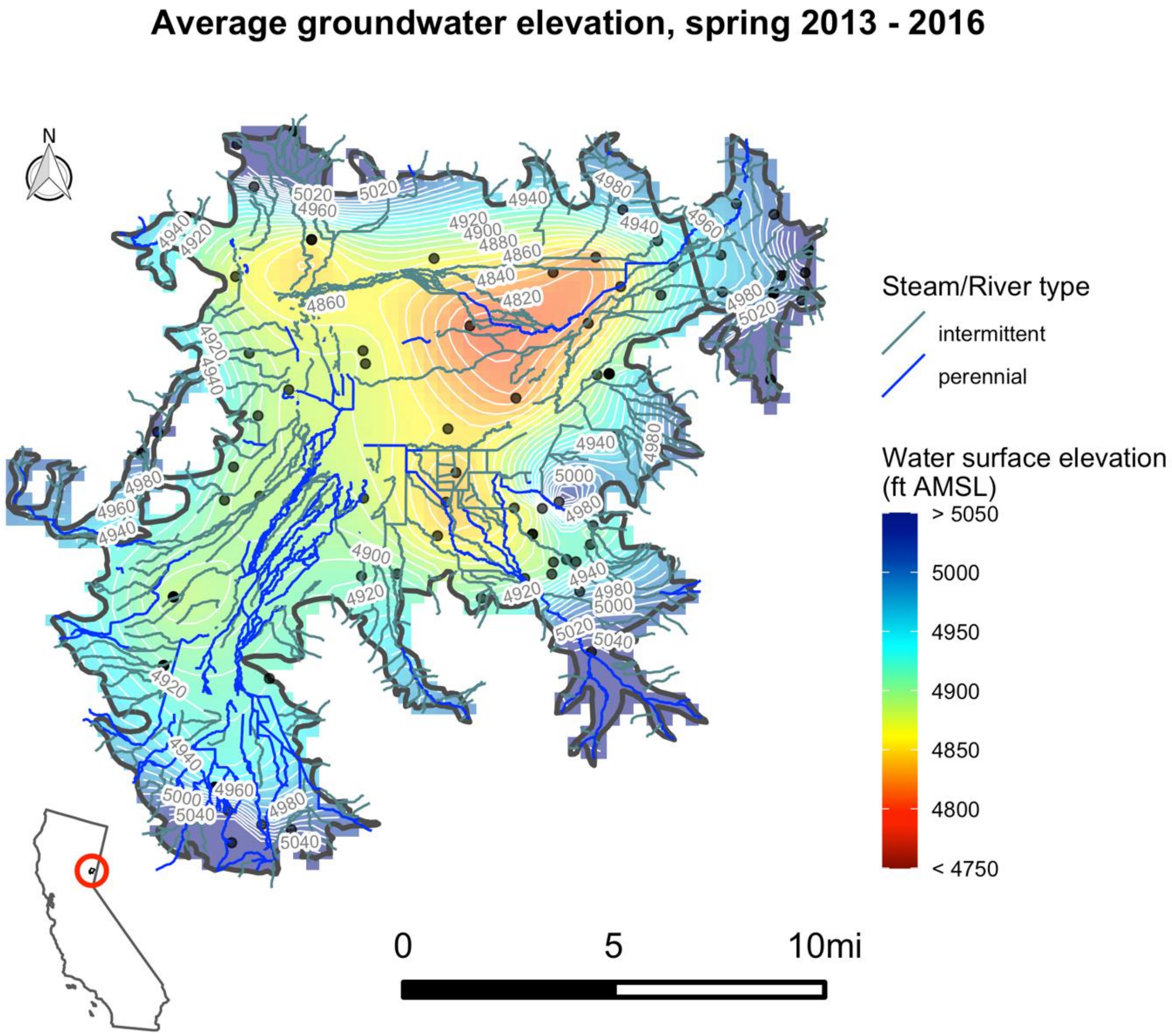
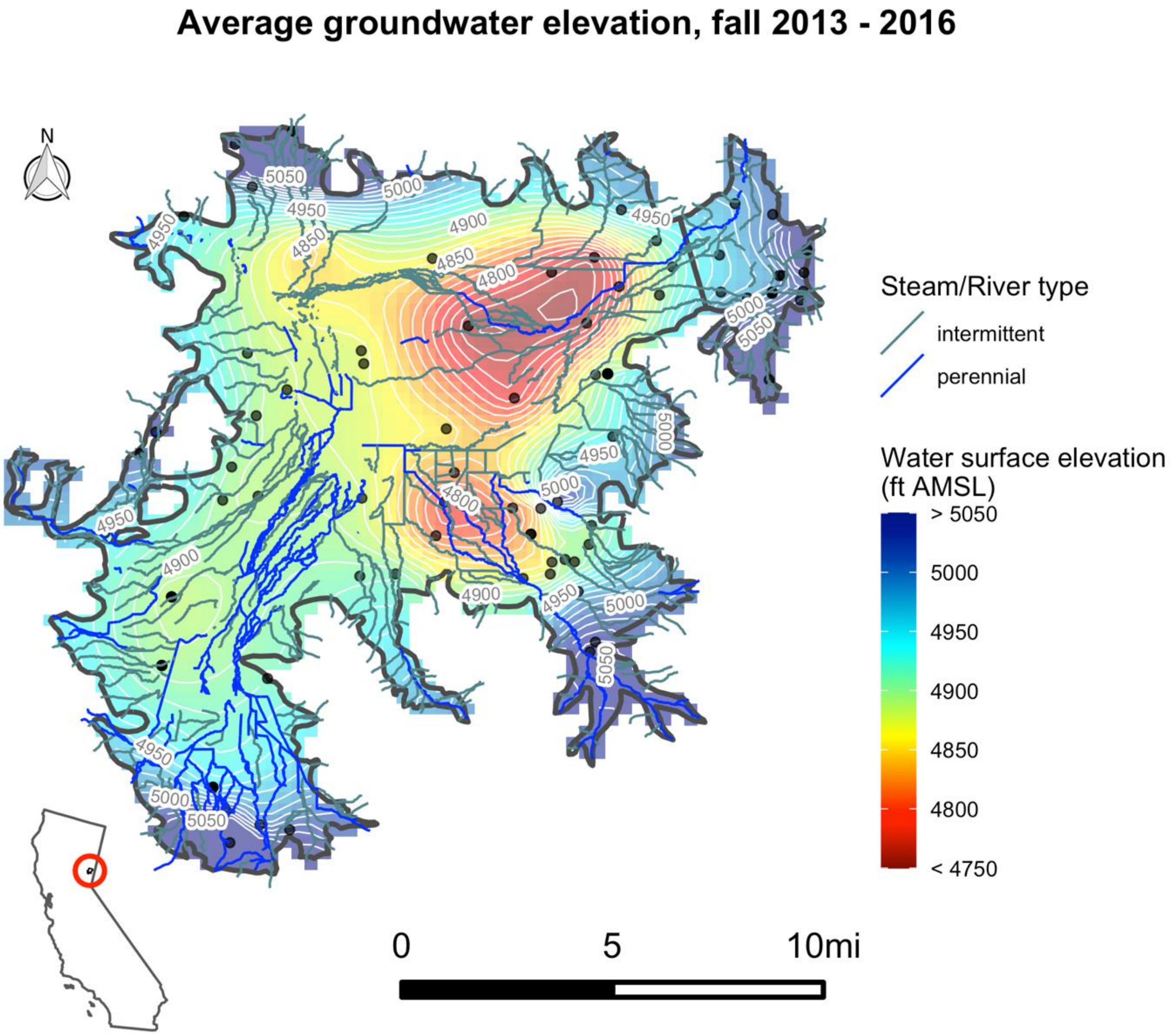


Figure 2.2.2-4 2013-2016 Fall Average Sierra Valley Groundwater Levels



2.2.2.2 Estimate of groundwater storage

[placeholder – to be completed]

2.2.2.3 Seawater intrusion conditions

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

2.2.2.4 Groundwater quality

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.

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. The high-quality water is derived from the large amount of snowmelt runoff from the surrounding mountains that recharges the groundwater aquifer and the limited amount of industry in the Subbasin. A wide range of water types exist in the Subbasin, 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 Subbasin ranges from comparatively low percentages of chloride, sulfate, sodium, and potassium plotting in the southwest to high percentages of the same constituents in the northeast. As described in more detail below and in Appendix 2-6 (Water Quality), TDS ranges between about 100 and 865 mg/L. Chloride and sulfate concentrations range between 1 to 230 mg/L and 1 to 360 mg/L, respectively. Nitrate as nitrogen concentrations are generally low, with no concentrations exceeding 5 mg/L since 1990.

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 Subbasin 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).

A recent groundwater quality assessment that analyzed 10 domestic wells and 5 agricultural irrigation wells for nitrate, boron, arsenic, and TDS was conducted in April of 2021 (UCCE, 2021). The assessment, which sampled each well once, found water to generally be of good quality. All nitrate samples were below the regulatory standard of 10 mg/L; 1 domestic well produced a boron result just above the California Notification Level; and 2 domestic wells resulted in TDS concentrations above the recommended secondary maximum contaminant level (SMCL) of 500 mg/L. Of the 15 wells, one domestic well produced elevated levels of arsenic above the primary MCL. This high concentration was attributed to the volcanic geology of the northern portion of the Subbasin in which it is located. Explanation of regulatory standards for water quality is provided in Section 2.2.2.4.4.

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 2-6 – Water Quality Assessment.

2.2.2.4.2 Existing Water Quality Monitoring Networks

Most wells in the Subbasin are not regularly monitored for water quality, and it is uncommon for a well to be tested consistently between 1990 - 2020 for multiple constituents. Monitoring is most often driven by regulatory programs, and wells that are monitored on a regular basis (e.g., annually) are often municipal supply wells or monitoring wells. These wells are often located near the populated areas of Loyalton, Beckwourth, and Sierraville. As described in the following subsection, data collected through multiple agencies is used for analysis of water quality in the Subbasin.

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 2-6 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 (1º 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 (2º 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 2-6. 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 2-6 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 2-6 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 2-6.

The approach described above was used to consider all constituents of interest and characterize groundwater quality in the Subbasin. Appendix 2-6 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 (Recommended) 1000 (Upper)	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 Beckwourth. 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 2-6). 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 as the recommended level, 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 2-6).

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 and the Department of Health and Human Services, 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 2-6). 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[12] (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. Boron concentrations above the Notification Level primarily occur in the central region of the Subbasin and extend to the west. The area east of Loyalton is the only region to detect low concentrations of Boron. 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 2-6).

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.

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[12] 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.

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 Beckwourth. 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 2-6).

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 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 Beckwourth 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 2-6). 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 Beckwourth, 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 2-6). 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

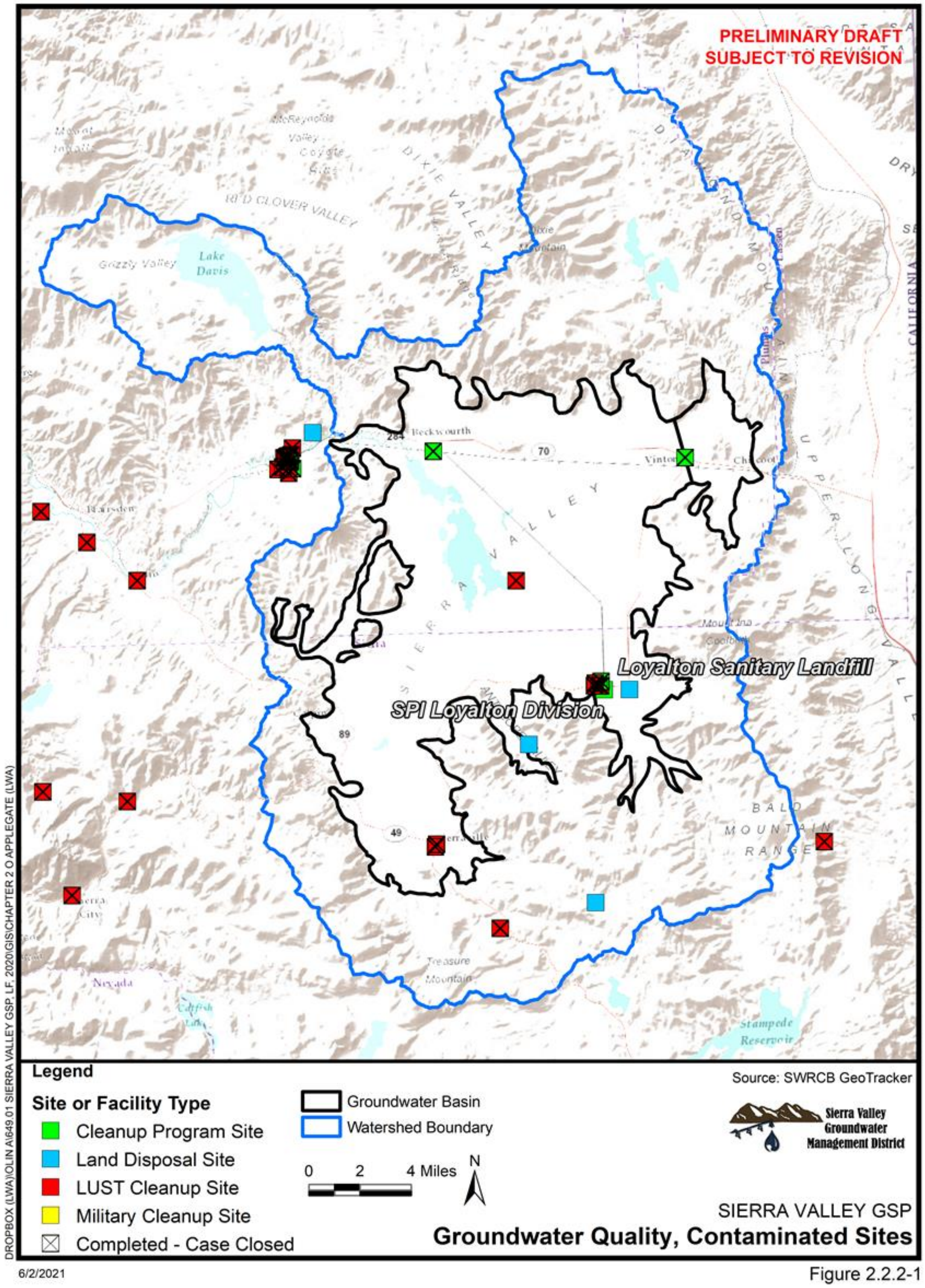
The case (No. 5A460300001) for this cleanup site was opened in January of 1965. This site is a Title 27 municipal solid waste landfill site. Substances released from the site, and contaminants of concern are not specified by GeoTracker.

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.

Figure 2.2.2-5 Contaminated Sites



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.

In April 2021, the California Department of Transportation Office of Geotechnical Design North assessed anomalous roadway cracking on State Route 70, just east of its intersection with State Route 49 (postmiles 85.9, 87.5, and 89.35 in Plumas County). During a field visit, cracks with 1 inch of vertical subsidence, and extension of 1.5 inches were observed. The location of the cracking is in an area that underwent 0.25 to 0.5 ft of subsidence from June 2015 to September 2019 based on DWR’s SGMA data viewer. Based on lack of evidence linking the roadway pavement fractures to tectonic or surficial water processes, it was determined that it is highly probable that the fractures are the result of subsidence resulting from groundwater pumping (CalTrans, 2021).

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.

2.2.2.5.2 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.

To produce the subsidence dataset, NASA JPL obtained and analyzed data from the European Space Agency's (ESA) 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). 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 of Sierra Valley, 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 (TRE) InSAR dataset represents measurements of vertical ground surface displacement. Vertical displacement estimates are derived from Interferometric Synthetic Aperture Radar (InSAR) data that are collected by ESA Sentinel-1A satellite and processed by TRE, under contract with DWR as part of its SGMA technical assistance. 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.

Both TRE and JPL process the same satellite data using different techniques, resulting in results that can be similar but not the same. InSAR data reports on changes in levels of the ground surface without distinguishing between elastic (temporary) or inelastic (permanent) subsidence. 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.

2.2.2.5.3 DWR/TRE Altamira InSAR subsidence data quality

InSAR results are within approximately 1.2 inches of continuous GPS data (95% confidence level). The full report from DWR describing this effort is included in Appendix 2-7 (subsidence appendix).

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

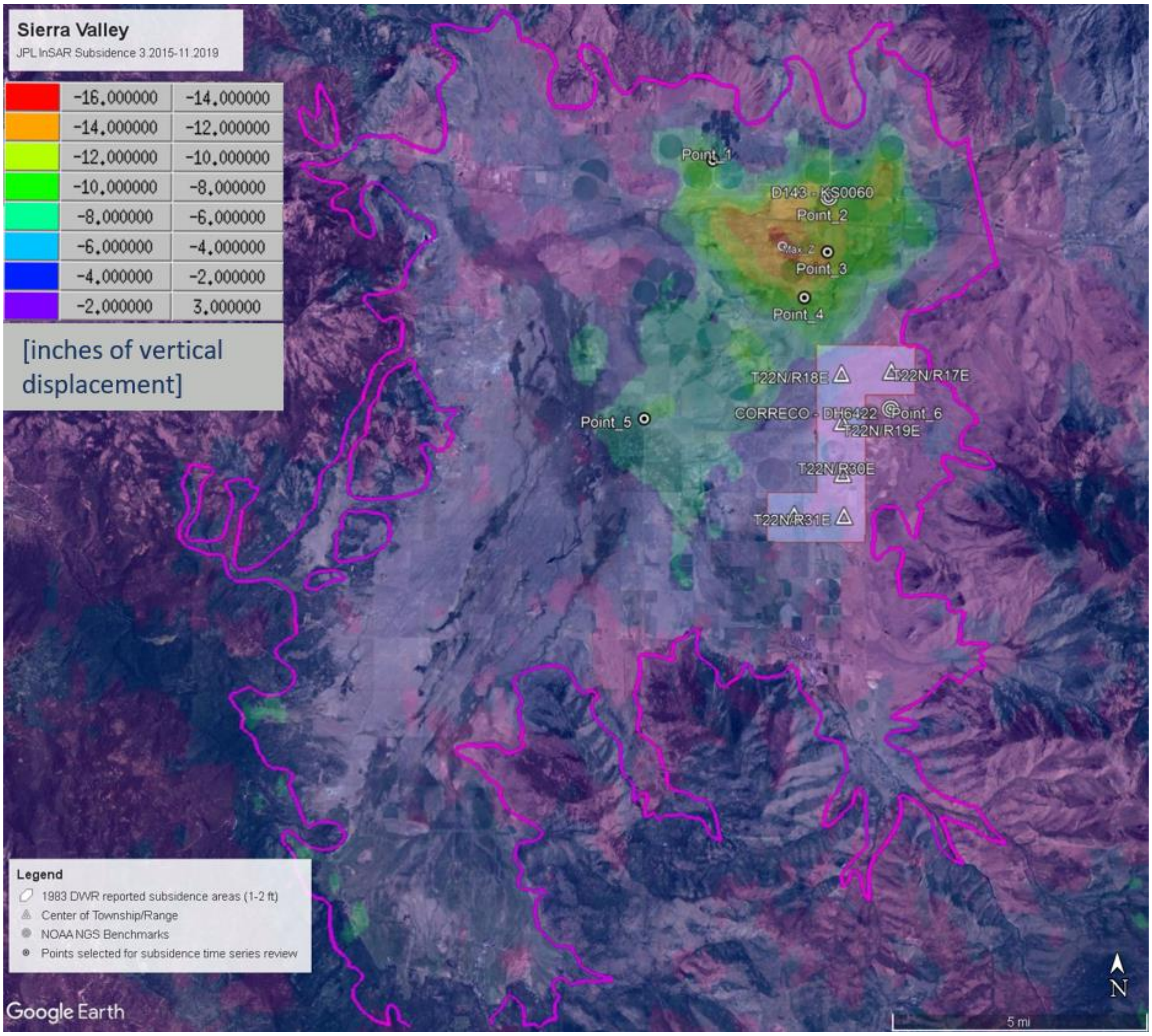


Figure 2.2.2-7 InSar-based land subsidence for the period of March 2015 to November 2019, focused on the portion of the subbasin with the greatest measured subsidence

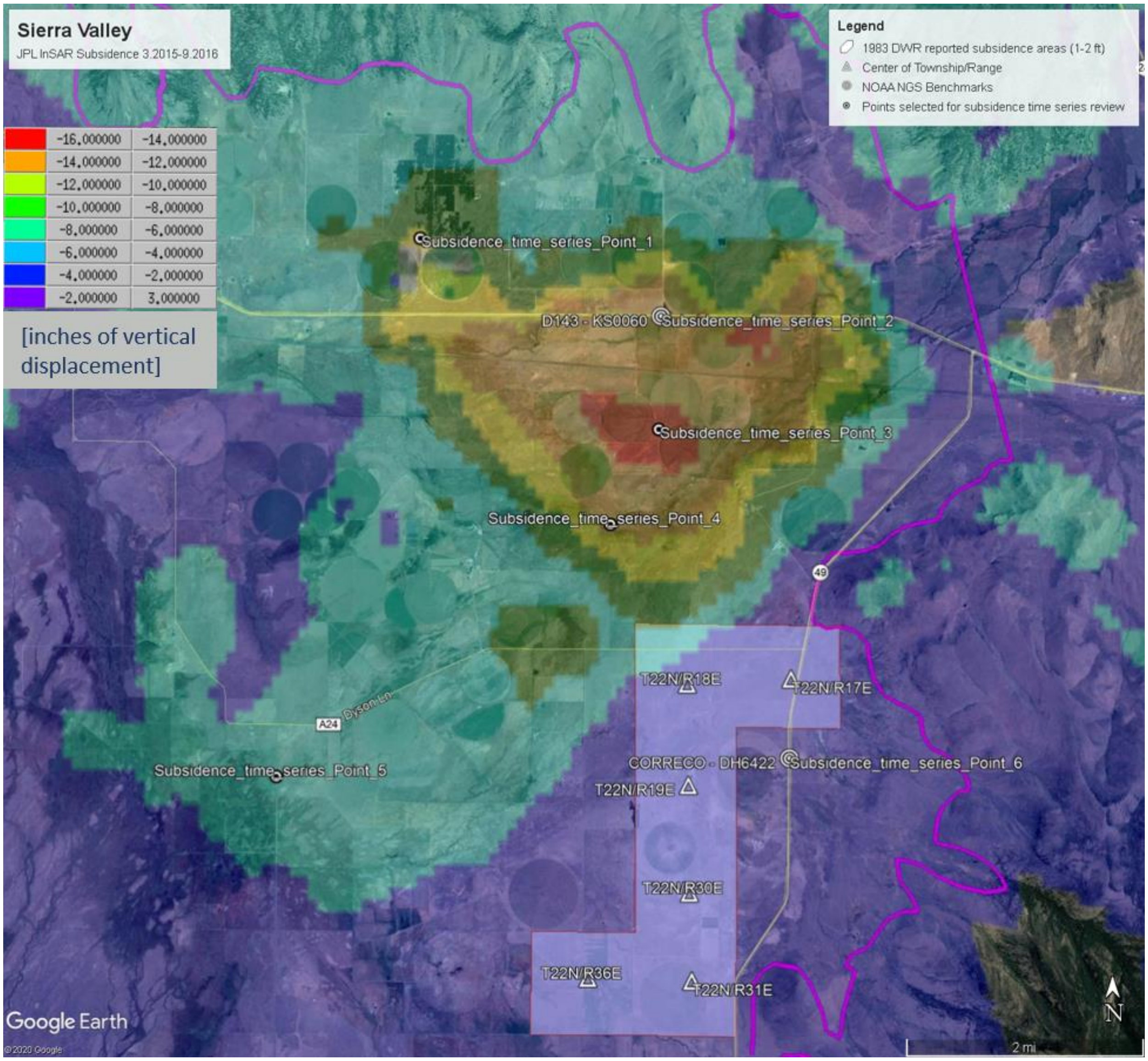


Figure 2.2.2-8 Time series of JPL InSAR land subsidence data for the locations called out in Figure 2.2.2-3

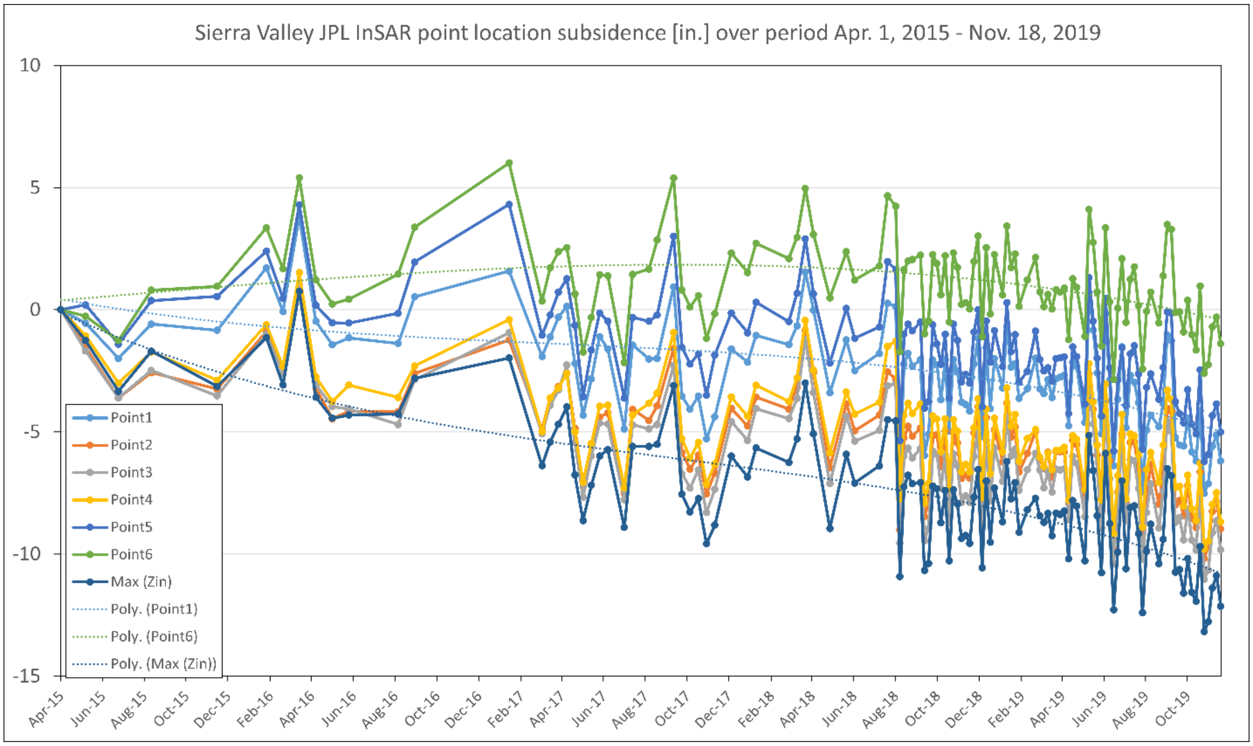
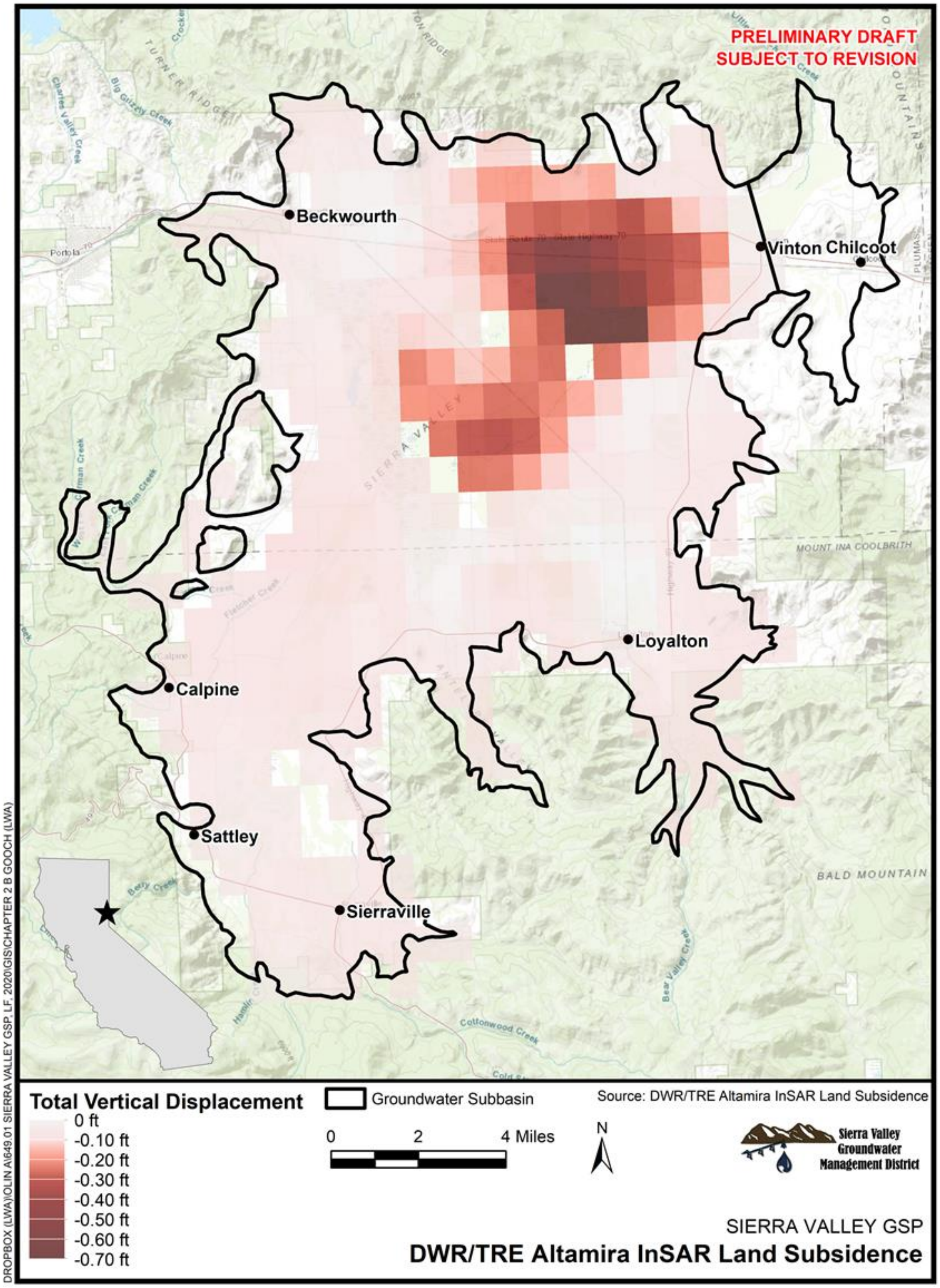


Figure 2.2.2-9 DWR/TRE Altamira InSAR land subsidence for the period June 2015 to September 2019



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. The potential exists for interconnected surface water where surface water features and shallow groundwater coincide. Section 351 (o) of the GSP Regulations defines 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 discussed above in Section 2.2.1.6, 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. Why was this deleted?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. Why was this deleted?For identification of ISW, the average of monitoring well data from the Spring seasons from 2017 to 2020 was used. 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. The average standard deviation of the depth to groundwater map across the groundwater basin is approximately 55 feet. Given the level of uncertainty, a conservative approach was taken when excluding any streams from ISW classification. For those streams that were classified as disconnected, a shallow groundwater well no greater than 0.5 miles from the stream was used to verify the groundwater depth.

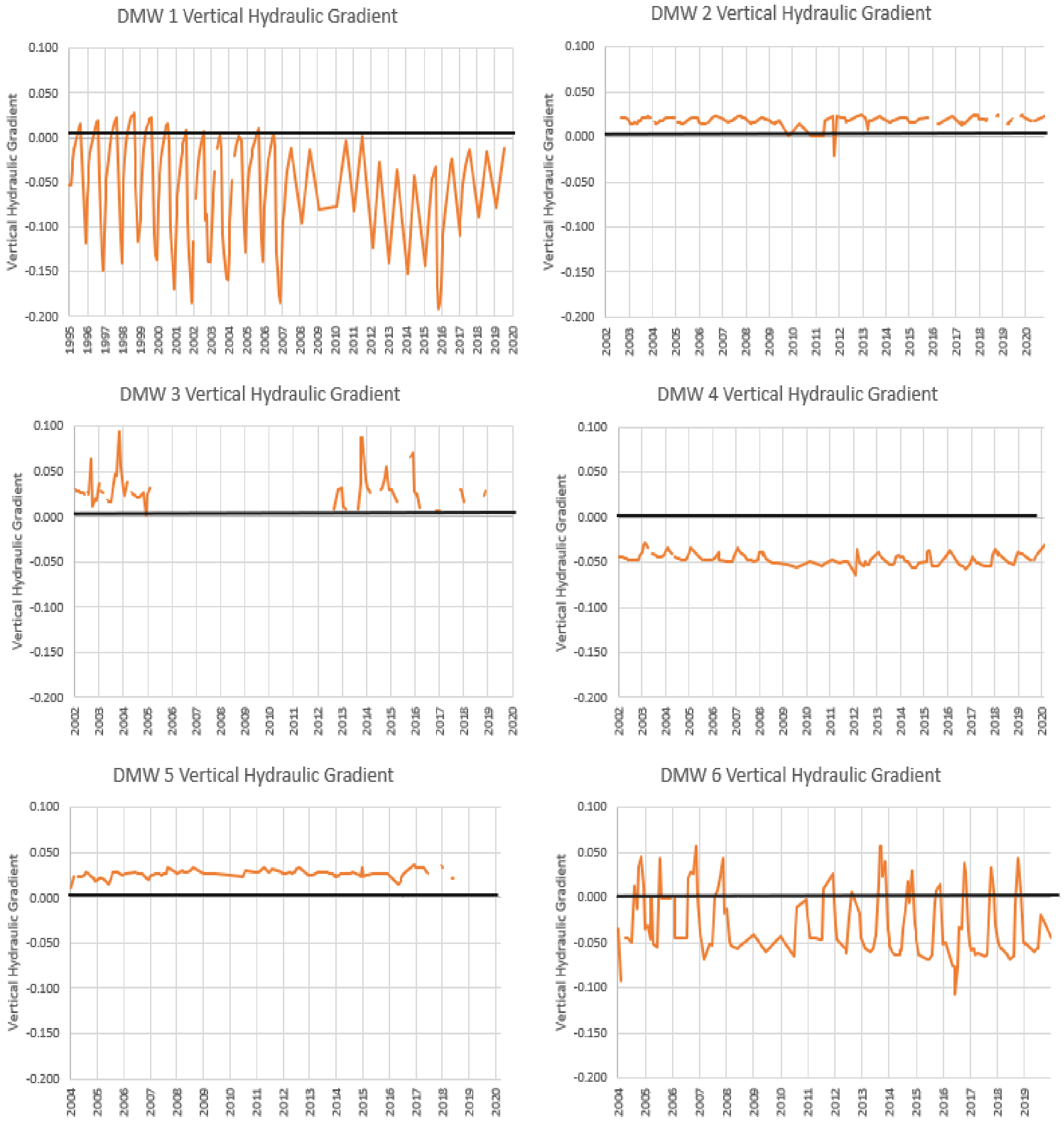
2.2.2.6.3 Identification of Interconnected Surface Water

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.

2.2.2.6.4 Nested Monitoring Wells

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 for each screened depth. 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.

2095 **Figure 2.2.2-10 Calculated vertical hydraulic gradients between deep and shallow nested**
2096 **district monitoring wells**



2097 [13]

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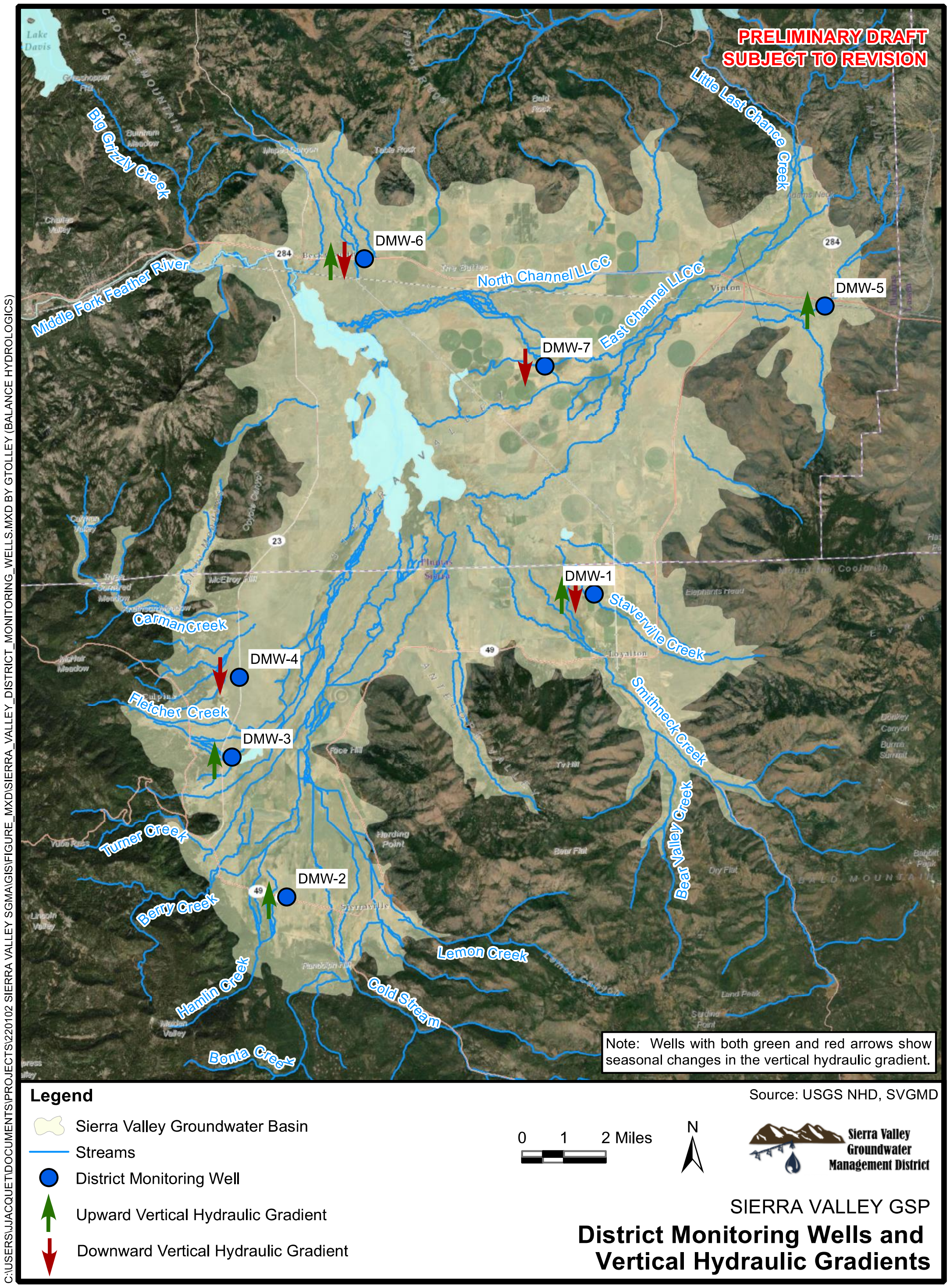
[13] Positive values indicate an upward gradient where the deep aquifer has the potential to flow toward shallow groundwater or discharge to surface water. A negative value indicates a downward gradient and the potential for shallow groundwater or surface water to be recharge the deep aquifer.

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



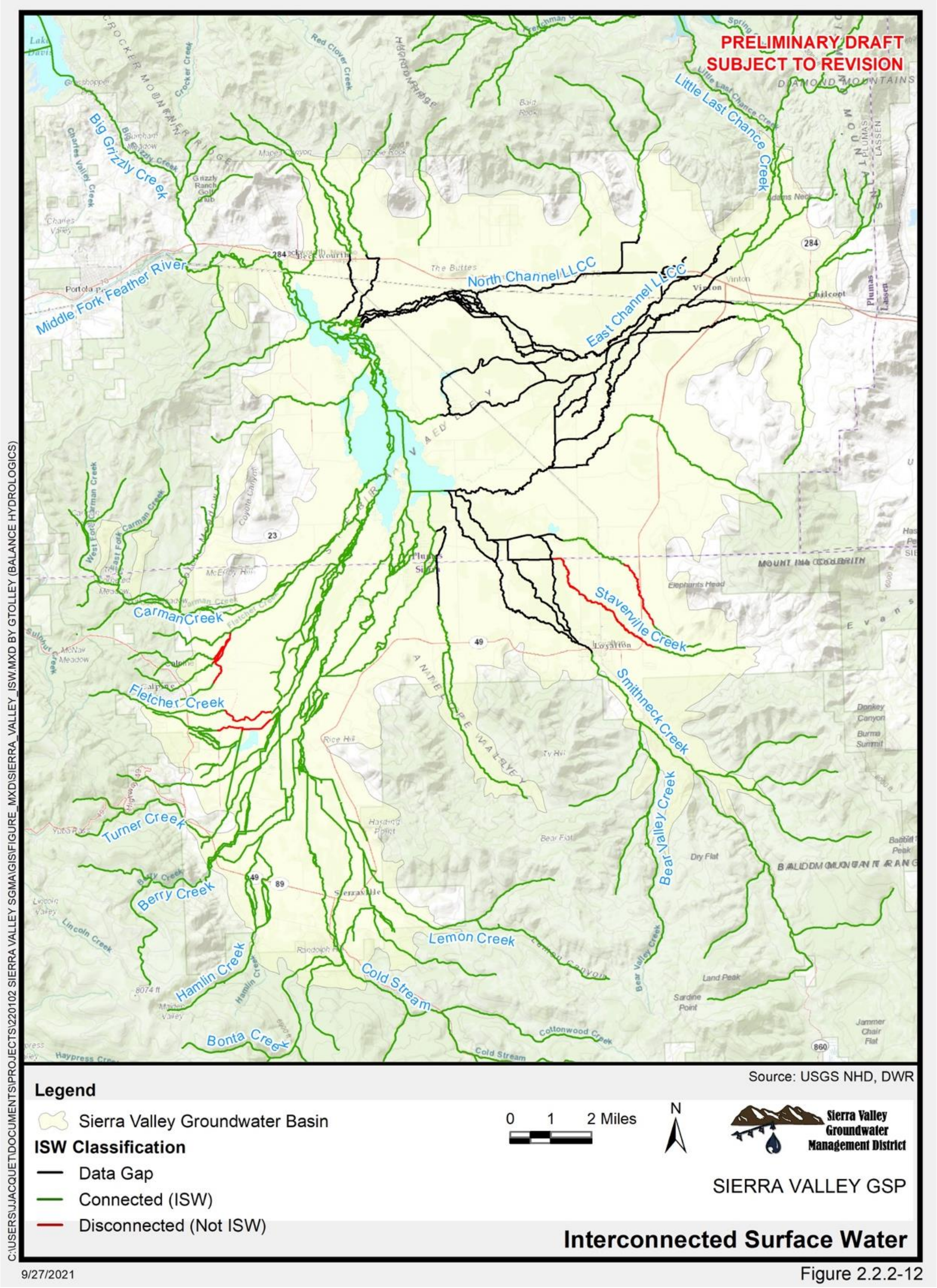
Vertical gradients from DMW-2, DMW-3, and DMW-5 show the potential for upwelling of deep groundwater to shallow groundwater. This indicates that where ISW exists near these wells, the surface water is likely gaining and supported by groundwater. DMW-1, DMW-4, and DMW-7 show a mostly downward vertical gradient. This indicates that where ISW exists in the vicinity of these wells, the streams are likely losing and most at risk from being disconnected from groundwater. DMW-1 and DMW-6 show both upward and downward gradients. Seasonal variation in DMW-1 from an upward vertical gradient in the spring to a downward vertical gradient in the fall results from a decrease in deep groundwater elevations in late summer while shallow groundwater elevations stay relatively steady. Seasonal variation in DMW-6 from a downward gradient in the Spring to upward gradient in the Fall results from a decrease in shallow groundwater elevation below the elevation of the deep groundwater.

Nested wells also help establish whether a surface body is connected to a perched aquifer or the principal aquifer. Perched aquifers represent groundwater that is separated from the regional or principal aquifer by an unsaturated zone. They occur when a relatively impermeable layer (e.g. a clay layer with very low hydraulic conductivity) prevents the downward movement of groundwater creating saturated conditions above the low permeability layer. There is limited data to define the extent of perched aquifers, but preliminary data from DMW-7 (installed in 2020) valley fill stratigraphy, and anecdotal evidence from valley residents indicate the existence of perched aquifers near Little Last Chance Creek and Smithneck Creek. Due to the lack of shallow groundwater monitoring in these areas, streams here have not been classified as disconnected or interconnected surface water, but instead have been classified as a data gap. Section 3.4 presents the proposed monitoring network that can be used to fill this data gap and establish the presence or absence of perched aquifers. For any perched aquifers that are identified, the importance to agricultural and/or environmental users will be evaluated and a decision will be made on whether it should be included and managed in future GSP updates.

2.2.2.6.5 Interconnected Surface Water Results

Figure 2.2.2-11Figure 2.2.212 presents a map of streams identified as ISW, non-ISW, and streams that do not have enough information to make a distinction on connectedness that are classified as a data gap. In general, surface water in the central and eastern portions of the Sierra Valley is classified as a data gap due to the lack of shallow groundwater elevation data. 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 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



Update Fig #

2.2.2.7 Identification of groundwater-dependent ecosystems

SGMA requires GSAs to consider groundwater dependent ecosystems (GDEs) and other beneficial uses of groundwater when developing 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, ISW (see Section 2.2.2.6) can be used by both aquatic and riparian GDEs. Identification of GDEs involves determining which vegetation types can tap groundwater through their root systems and identifying ecosystems that rely on ISW (including rivers, springs, and seeps) by mapping the extent of ISW features (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 2.2.2.6. 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. This information was then refined based on local information.

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 GDE vegetation communities. 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. 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. NWI riverine polygons that were not within 50 ft of ISW points were classified as unlikely GDEs.

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 than using a single year alone.

Three meadows along Carman Creek were added to the GDE map based on observations of the vegetation and shallow groundwater described in (Rodriguez et al 2017, Davis et al. 2020).

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 or the California Endangered Species Act;
- 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; 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).

Databases on regional and local occurrences and spatial distributions of special-status species within the Sierra Valley Groundwater Basin were reviewed for available information. Spatial database queries (e.g., CNDDB) included potential GDEs plus a 1-mile buffer. Information on the special-status species that have potential to occur in the groundwater basin was obtained from the following sources:

California Natural Diversity Database (CNDDB) (CDFW 2020c~~b~~);
California Native Plant Society (CNPS) Manual of California Vegetation (2021);
eBird (2021);
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); and
Feather River Land Trust Sierra Valley Birder's Guidebook (Feather River Land Trust n.d.).

Botanists and wildlife biologists 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. 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, fish using a stream interconnected with groundwater)
- 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 2.2.2.7.1). 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, springs and other interconnected surface waters).

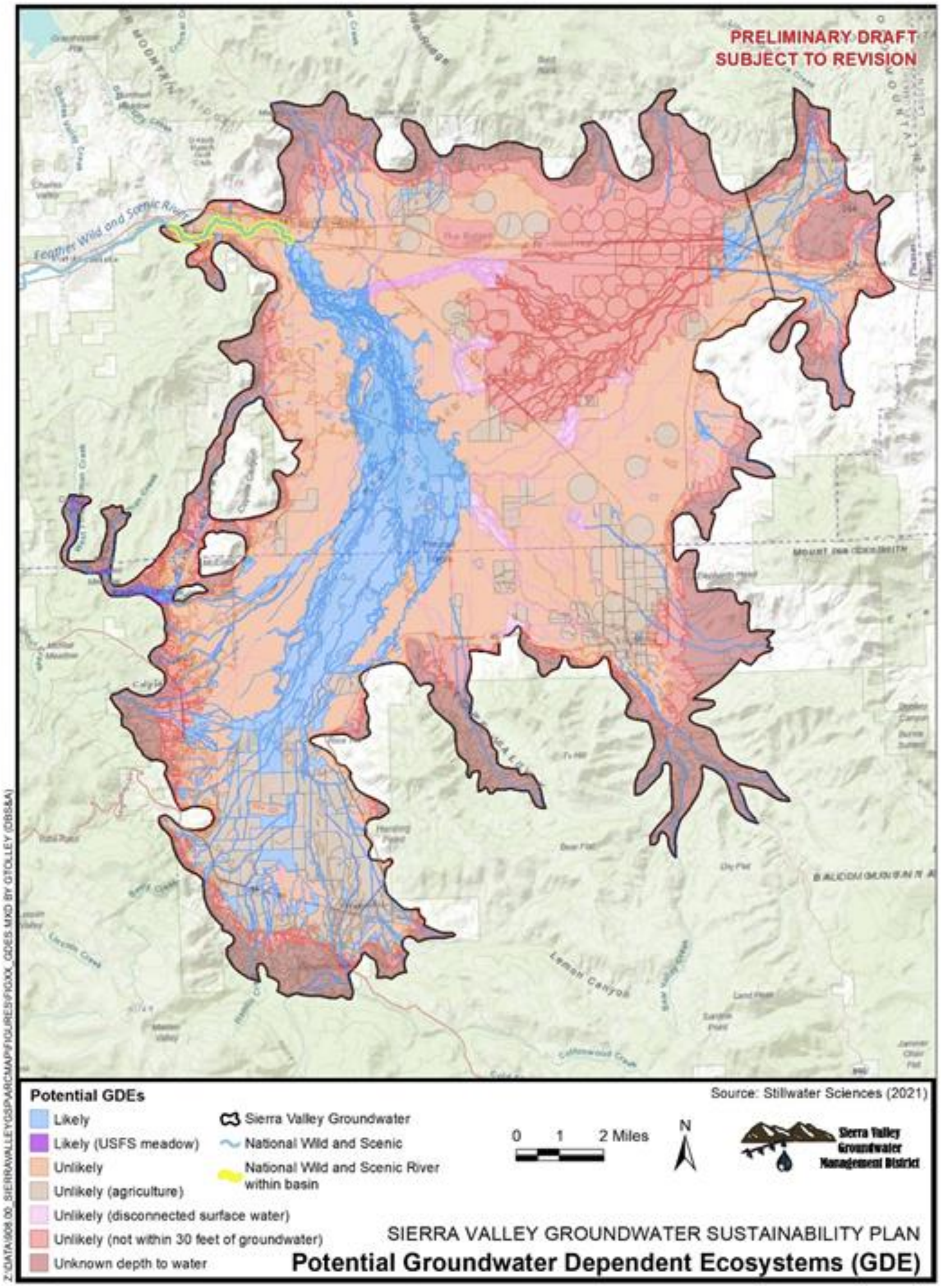
Database query results for local and regional special-status species occurrences were combined with their known habitat requirements to develop a list of groundwater dependent special-status species (Section 3.2) that satisfy the following criteria: (1) documented to occur within the GDE unit, or (2) 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,-581 acres of GDEs, approximately 14% 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. The meadows along Carman Creek contain approximately 226 acres of the GDEs. GDEs are primarily located along the western edge of the basin where groundwater is shallower and associated with the large wetland complex. The GDEs in the wetland complex overlie clay-rich sediments with poorly drained soils. There are few wells near the GDEs, and the groundwater depths and the connection to groundwater are somewhat uncertain. Nevertheless, given that this area is supplied by interconnected surface water (see Figure 2.2.2-12) and our best estimate is that depth to groundwater is less than 30 ft, the large wetland complex is mapped as a GDE.

Due to the semi-confined nature of the aquifer system and the spatial and temporal sparseness of measurements, uncertainty in groundwater elevation is quite high. The standard deviation of 2017-2020 average groundwater elevation within a half-mile buffer of the GDEs ranges from 42 to 80 ft Up to 9,500 acres of potential GDEs that were removed because the depth to groundwater exceeded 30 ft could be reclassified as likely GDEs if groundwater elevations increased by one standard deviation. Additional shallow groundwater monitoring well data are needed to reduce uncertainty in depth to water assessments (see Section 2.2.2.7.7)

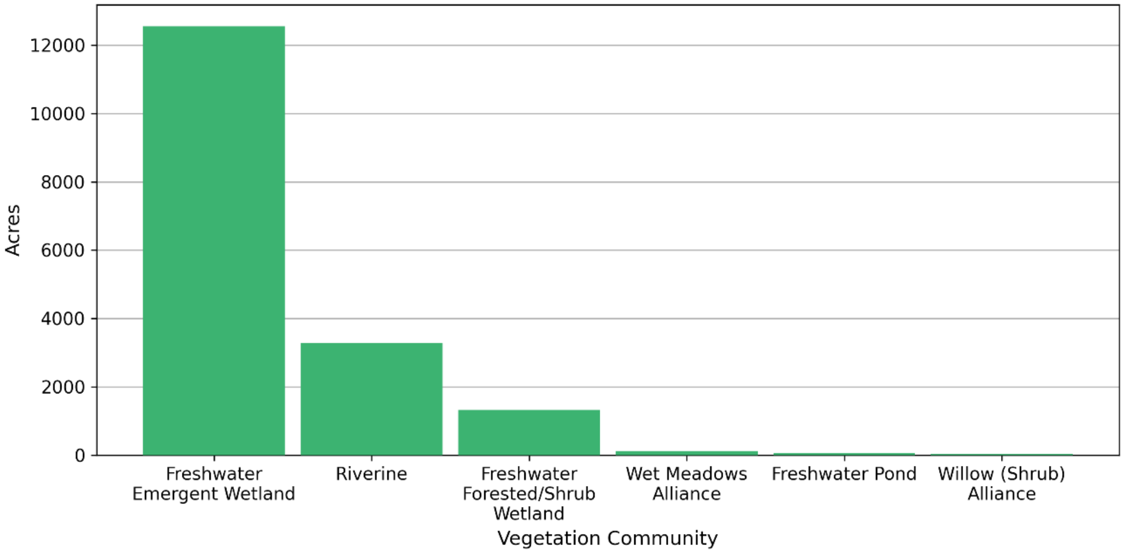
Figure 2.2.2-13 Potential Groundwater Dependent Ecosystems in the Sierra Valley Groundwater Basin



Source: Stillwater Sciences (2021)

Freshwater emergent marshland is the most prevalent vegetation community (12,640 acres, Figure 2.2.2- 16 comprising 72% of all GDE area. Riverine (3,276 acres) and freshwater forested/shrub wetland (1,329 acres) communities are also prevalent, comprising 19% and 8%, respectively, of all GDE area.

Figure 2.2.2-14 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. At the time of this GSP preparation, groundwater elevation contours were available only through Fall 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. Sustained drought may impede groundwater level recovery in the future.

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. Irrigation canals may also contribute surface water to the GDE units.

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 plant 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. The lower 4.5 miles of the Middle Fork Feather River within the basin are part of the Wild and Scenic Reach of the river.

Nine 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).

In addition to the special-status plant species listed in Table 2.2.2-3, the TAC identified Sierra Valley evening primrose (*Camissonia tanacetifolia ssp. Quadriperforata*) as a plant of special interest in Sierra Valley. The Sierra Valley evening primrose is unlikely to be groundwater dependent.

Table 2.2.2-2 Special-status plant species and sensitive natural communities with known occurrence within the Sierra Valley Groundwater Basin

Common name *Scientific name*	Status[1]	Association with GDE	Jepson habitat[2]	Harnach (2016) habitat[3]	Query source
Plants					
Lemmon's milk-vetch *Astragalus lemmonii*	1B.2, S2, G2	Likely	Moist, alkaline meadows, lake shores	Common, subalkaline meadows	CNDDB and Harnach (2016)
Lens-pot milk-vetch *Astragalus lentiformis*	1B.2, S2, G2	Unlikely	Dry sandy soil, sagebrush or pine	Dry sandy slopes and open pine forests	Harnach (2016)
Pulsifer's milk-vetch *Astragalus pulsiferae var. pulsiferae*	1B.2, S2, G4T2	Unlikely	Sandy or rocky soil, often with pines, sagebrush	Locally frequent, dry sandy granitic slopes	CNDBB and Harnach (2016)
Hillman's silverscale *Atriplex argenta var. hillmani*	2B.2, S2, G5T4	Possible	Saline or clay valley bottoms	Limited, subalkaline flats	Harnach 2016
Scalloped moonwort *Botrychium crenulatum*	2B.2, S3, G4	Likely	Saturated hard water seeps and stream margin	N/A	CNDDB
Mingan moonwort *Botrychium minganense*	2B.2, S3, G4G5	Likely	Meadows, open forest along streams or around seeps	N/A	CNDDB
Western goblin *Botrychium montanum*	2B.1, S2, G3	Possible	Shady conifer woodland, especially under *Calocedrus* spp. along streams	N/A	CNDDB

Common name ***Scientific name***	**Status[1]**	**Association with GDE**	**Jepson habitat[2]**	**Harnach (2016) habitat[3]**	**Query source**
Watershield *Brasenia schreberi*	2B.3, S3, G5	Likely	Ponds, slow streams	Uncommon, shallow ponds	CNDDB and Harnach 2016
Fiddleleaf hawksbeard *Crepis runcinata*	2B.2, S3, G5	Possible	Sagebrush scrub, pinyon-juniper woodland, wetland-riparian zones	Meadows and subalkaline flats	CNDDB and Harnach 2016
Globose cymopterus *Cymopterus globosus*	2B.2, S1, G3G4	Unlikely	Sandy open flats	N/A	CNDDB
Oregon fireweed *Epilobium oreganum*	1B.2, S2, G2	Likely	Bogs, small streams	Rare. Moist edges of river	Harnach (2016)
Nevada daisy *Erigeron eatonii var. nevadincola*	2B.3, S2S3, G5T2T3	Unlikely	Open grassland, rocky flats, generally in sagebrush or pinyon/juniper scrub	Uncommon, rocky volcanic soils	CNDDB and Harnach (2016)
Alkali hymenoxys *Hymenoxys lemmonii*	2B.2, S2S3, G4	Possible	Roadsides, open areas, meadows, slopes, drainage areas, stream banks	Fairly frequent. Subalkaline areas	CNDDB and Harnach (2016)
Sierra Valley ivesia *Ivesia aperta var. aperta*	1B.2, S2, G2T2	Possible	Dry, rocky meadows, generally volcanic soils	Common, disturbed areas and roadsides	CNDDB and Harnach (2016)
Bailey's ivesia *Ivesia baileyi var baileyi*	2B.2, S2, G5T4	Unlikely	Volcanic crevices	Rare, volcanic cliffs	Harnach (2016)
Plumas ivesia *Ivesia sericoleuca*	1B.2, S2, G2	Likely	Dry, generally volcanic meadows	Fairly common in scattered localities. Seasonally wet clay soils. Primarily on	CNDDB and Harnach (2016)

Common name ***Scientific name***	**Status^1**	**Association with GDE**	**Jepson habitat^2**	**Harnach (2016) habitat^3**	**Query source**
				the W side of the valley	
Webber's ivesia *Ivesia webberi*	1B.1, S1, G1	Unlikely	Rocky clay in sagebrush flats	Rare, volcanic scalds and cobbley areas	CNDDB and Harnach (2016)
Santa Lucia dwarf rush *Juncus luciensis*	1B.2, S3, G3	Likely	Wet, sandy soils of seeps, meadows, vernal pools, streams, roadsides	Vernally moist sands and along streams	CNDDB and Harnach (2016)
Seep kobresia *Kobresia myosuroides*	2B.2, S2, G5	Possible	Rocky seeps	Rare, drying vernal meadows	CNDDB and Harnach (2016)
Sagebrush loeflingia *Loeflingia squarrosa var. artemisiarum*	2B.2, S2, G5T3	Unlikely	Sand, gravel of hills, mesas, dunes, disturbed areas	Disturbed areas	CNDDB and Harnach (2016)
Tall alpine-aster *Oreostemma elatum*	1B.2, S2, G2	Likely	Peatlands, marshy areas, wet meadows, montane forest	Wet meadows, marshy areas and peatlands	CNDDB
Susanville beardtongue *Penstemon sudans*	4.3, S4, G4	Unlikely	Open, rocky, igneous soils in sagebrush scrub, yellow-pine and montane forests	N/A	CNDDB and Harnach (2016)
Modoc County knotweed *Polygonum polygaloides ssp. esotericum*	1B.3, S3, G4G5T3	Possible	Vernal pools, seasonally wet places, pinyon/juniper woodland	Uncommon, vernally moist areas	CNDDB and Harnach (2016)
Nuttall's ribbonleaved pondweed	2B.2, S2S3, G5	Likely	Shallow water, ponds, lakes, streams	Limited, shallow water	CNDDB and Harnach (2016)

Common name ***Scientific name***	**Status[1]**	**Association with GDE**	**Jepson habitat[2]**	**Harnach (2016) habitat[3]**	**Query source**
Potamogeton epihydrus					
Sticky pyrrocoma *Pyrrocoma lucida*	1B.2, S3, G3	Possible	Alkaline clay flats, sagebrush scrub, open forest	Localized stands. Meadow areas in pines and sagebrush	CNDDB and Harnach (2016)
Green-flowered prince's plume *Stanleya viridiflora*	2B.3, S2, G4	Unlikely	Cliffs, shale, clay knolls, steep bluffs, white ash deposits	Clay flats	CNDDB and Harnach (2016)
Many-flowered thelypodium *Thelypodium milleflorum*	2B.2, S3?, G5	Unlikely	Sandy soils, scrub	Sandy areas	Harnach (2016)
Golden violet *Viola purpurea ssp. aurea*	2B.2, S2, G5T2T3	Unlikely	Pinyon/juniper woodland, sagebrush, sandy slopes	Rare, sagebrush and sandy soils	Harnach (2016)
Sensitive Natural Communities					
Montane Freshwater Marsh	S3.2, G3	Likely	Sites lacking significant current, permanently flooded by fresh water. Widely scattered throughout Montane California.	N/A	CNDDB

[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.

? uncertain numeric ranking (e.g., S3? indicates the element is most likely an S3 but there is a significant chance the element could be an S2 or S4)

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: Jespson (2020)

[3] Source: Harnach (2016)

2.2.2.7.4.1 Terrestrial and aquatic wildlife

Thirty-one special-status terrestrial and aquatic wildlife species were identified during scoping as having the potential to likely or possible occur within the Sierra Valley Groundwater Basin. Of these, twenty-one were potentially groundwater dependent species: one amphibian species, fifteen bird species, and six mammal species. Information on these groundwater dependent species, including regulatory status and habitat associations, is provided Table 2.2.2- 4. The Sierra Valley groundwater basin is within the range of a recently observed gray wolf (*Canis lupus*) pack (CDFW 2021a). The gray wolf is an endangered species in California but has been delisted by the USFWS. The gray wolf likely depends on some groundwater-dependent species for food, but the groundwater dependence of prey in Sierra Valley has not been explored.

Additional bird and invertebrate species for which there is conservation concern and have the potential to occur in the Sierra Valley Groundwater Basin include: white-faced ibis (Plegadis chihi; CDFW watchlist [WL]), ferruginous hawk (*Buteo regalis*; CDFW WL, USFWS Birds of Conservation Concern [BCC]), prairie falcon (*Falco mexicanus*; CDFW WL, USFWS BCC), Cooper’s hawk (*Accipiter cooperii*; CDFW WL), sharp-shinned hawk (*Accipiter striatus*; CDFW WL), long-billed curlew (*Numenius americanus*; CDFW WL; USFWS BCC), canvasback (*Aythya valisineria*; California [CA] imperiled [S2]), western pearlshell (*Margaritifera falcata*; CA critically imperiled [S1], S2), western ridged mussel (*Gonidea angulata*; CA S1, S2), brownish dubiraphian riffle beetle (*Dubiraphia brunnescens*; CA S1), and Pinnacles optioservus riffle beetle (*Optioservus canus*; CA S1) (Feather River Land Trust n.d., TNC 2021).

Sierra Valley Groundwater Basin, including GDEs, provides high quality habitat that is utilized by birds for breeding, foraging, migrating, and over-wintering. Two-hundred and thirty-seven bird species have been identified in the Sierra Valley, including waterfowl, raptors, and shorebirds (Feather River Land Trust n.d.). 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.

Fish occur in interconnected reaches of Sierra Valley streams and thus are dependent upon groundwater. There has not been a recent study of fish in SVGB streams and thus the current distribution of fish in Sierra Valley is not well known. Available information, which is largely based on fish occurrence data from a 1973 DWR report (DWR 1973) summarized by Vestra (2005), indicates that up to 15 species of fish, both native and non-native, occur in the SVGB. These include several fish species native to other California watersheds and introduced to Sierra Valley waters accidentally through out-of-basin water diversions and non-native trout introduced intentionally (stocked) to provide angling opportunities. None of the fish species believed to currently occur in the SVGB are listed by the state or federal government as threatened or endangered.

Many coldwater upland streams within the SVGB support native rainbow trout (Oncorhynchus mykiss) as well as non-native brown trout (Salmo trutta) and brook trout (Salvelinus fontinalis) and potentially riffle sculpin (Cottus gulosus) (Rogers et al. 2018, Vestra 2005, Moyle et al. 1996). The trout populations have historically been supported by stocking. Lahontan cutthroat trout (O. clarki henshawi), a native species listed as threatened under the federal Endangered Species Act that historically may have occurred in Sierra Valley streams, are no longer present in the watershed (Rogers et al. 2018). Lahontan cutthroat trout were introduced experimentally to Palen Reservoir on Antelope Creek in the mid-1990s by CDFW (Vestra 2005), but the experimental population apparently did not persist.

Native Sacramento sucker (Catostomus occidentalis) and Sacramento pikeminnow (Ptychocheilus grandis) have been documented in the Middle Fork Feather River within the SVGB (CDFW 2021b, USDA Forest Service 2021). Lahontan redside (Richardsonius egregius), mountain sucker (Catostomus platyrhynchus), and mountain whitefish (Prosopium williamsoni), all of which are native to nearby basins but were introduced to the Sierra Valley via an irrigation canal from the Little Truckee River, are found primarily in valley floor streams and sloughs in the SVGB (Vestra 2005, Moyle et al. 1996). Speckled dace (Rhinichtys osculus), which is considered native to the Feather River basin, is also found primarily in valley floor streams and sloughs (Vestra 2005, DWR 1998).

Introduced fish species in Sierra Valley include sportfish such as largemouth bass (Micropterous salmoides), green sunfish (Lepomis cyanellus), bluegill (L. macrochirus), and brown bullhead (Ameiurus nebulosus) as well as golden shiner (Notemigonus crysoleucas), common carp (Cyprinus carpio), and the aforementioned brown and book trout (Vestra 2005).

2448 **-Table 2.2.2- 4 Groundwater-dependence of special-status wildlife species with potential to occur or suitable habit in the**
2449 **Sierra Valley Groundwater Basin**

Common name ***Scientific name***	**Status**[1] **Federal/State**	**Potential to occur in the SVGB**[2]	**Query source**[3]	**GDE . association**[4]	**Habitat Associations**
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					
Foothill yellow-legged frog *Rana boylii*	BLMS, FSS/ST	Unlikely	CNDDB	Direct	Shallow tributaries and mainstems of perennial streams and rivers, typically associated with cobble or boulder substrate; occasionally found in isolated pools, vegetated backwaters, and deep, shaded, spring-fed pools. The frog is reliant on surface water that may be fed by groundwater. Found up to 6,000 feet.
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 range from 4,500 to over 12,000 feet elevation.
Bird					
American White Pelican	–/SSC	Likely	CAFSD, eBird	Indirect	Salt ponds, large lakes, and estuaries; loafs on open water during the day; roosts along water's

Common name *Scientific name*	Status[1] Federal/State	Potential to occur in the SVGB[2]	Query source[3]	GDE . association[4]	Habitat Associations
Pelecanus erythrorhynchos					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, FRLT	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).
Bank swallow *Riparia riparia*	BLMS/ST	Likely	CAFSD, eBird, FRLT	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, FRLT	Indirect	Nests semi-colonially in protected areas of marshes with floating nests. Feeds on insects.
Burrowing Owl *Athene cunicularia*	FSS/SSC	Likely	eBird, FRLT	No known reliance on groundwater	Level, open, dry, heavily grazed or low- stature grassland or desert vegetation with available burrows. Preys on invertebrates and vertebrates.
California spotted owl *Strix occidentalis occidentalis*	BLMS, FSS/SSC	Unlikely	CNDDB, IPAC	No known reliance on groundwater	Typically in older forested habitats; nests in complex stands dominated by conifers, especially coastal redwood, with hardwood understories; some open areas are important for foraging. Preys on small mammals.
Golden eagle *Aquila chrysaetos*	BGEPA, BLMS/SFP	Likely	eBird, FRLT	No known reliance on groundwater	Open woodlands and oak savannahs, grasslands, chaparral, sagebrush flats; nests on steep cliffs or medium to tall trees. Primary prey are small to

Common name *Scientific name*	Status[1] Federal/State	Potential to occur in the SVGB[2]	Query source[3]	GDE . association[4]	Habitat Associations
					medium mammals and birds; also scavenge and catch fish.
Greater sandhill crane *Antigone canadensis tabida*	BLMS, FSS/ST, SFP	Likely	CNDDB, CAFSD, eBird, FRLT	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).
Greater white-fronted goose *Anser albifrons*	–/SSC	Likely	eBird, FRLT	Indirect	Forage in wet sedge meadows, tidal mudflats, ponds, lakes, and wetlands during migration. Diet includes sedges, grasses, berries, and plant tubers during the summer and seeds, grain, and grasses in the winter.
Long-eared owl *Asio otus*	BLMS/SSC	Likely	eBird, FRLT	Indirect	Riparian habitat; nests in dense vegetation close to open grassland, meadows, riparian, or wetland areas for foraging. Prey on small mammals.
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.
Northern harrier *Circus hudsonius*	–/SSC	Likely	eBird, FRLT	Indirect	Nests, forages, and roosts in wetlands or along rivers or lakes, but also in grasslands, meadows, or grain fields. Eats small mammals, amphibians, reptiles, and birds.
Olive-sided flycatcher *Contopus cooperi*	–/SSC	Likely	eBird, FRLT	No known reliance on groundwater	Primarily advanced-successional conifer forests with open canopies. Prey on insects including wasps, bees, dragonflies, grasshoppers, beetles, moths, and flies

Common name ***Scientific name***	**Status[1]** **Federal/State**	**Potential to occur in the SVGB[2]**	**Query source[3]**	**GDE . association[4]**	**Habitat Associations**
Peregrine falcon *Falco peregrinus anatum*	FD/SD, SFP	Likely	eBird, FRLT	No known reliance on groundwater	Wetlands, woodlands, cities, agricultural lands, and coastal area with cliffs (and rarely broken-top, predominant trees) for nesting; often forages near water. Diet includes birds and bats.
Redhead *Aythya americana*	–/SSC	Likely	CAFSD, eBird, FRLT	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.
Short-eared owl *Asio flammeus*	–/SSC	Likely	eBird, FRLT	Indirect	Salt or freshwater marshlands, ungrazed grasslands, old pastures, and irrigated alfalfa or grain fields. Eat small mammals.
Swainson's hawk *Buteo swainsoni*	BLMS/ST	Likely	CNDDB, eBird, FRLT	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.
Tricolored blackbird *Agelaius tricolor*	BLMS, FSS/ST	Unlikely	CAFSD	Indirect	Feeds in grasslands and agriculture fields; nesting habitat components include open accessible water with dense, tall emergent vegetation, a protected nesting substrate (including flooded or thorny vegetation), and a suitable nearby foraging space with adequate insect prey.
Willow Flycatcher *Empidonax traillii*	FSS/SE	Likely	CNDDB, CAFSD, eBird, FRLT	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

Common name ***Scientific name***	**Status[1]** **Federal/State**	**Potential to occur in the SVGB[2]**	**Query source[3]**	**GDE . association[4]**	**Habitat Associations**
					(Rohde et al 2019). Feeds on insects, fruits, and berries.
Vaux's swift *Chaetura vauxi*	–/SSC	Likely	FRLT	No known reliance on groundwater	Redwood and Douglas-fir habitats with large snags, especially forest with larger basal hollows and chimney trees. Eat insects and spiders.
Western Least Bittern *Ixobrychus exilis hesperis*	FSS/SSC	Likely	CAFSD, eBird	Indirect	Freshwater and brackish marshes with dense aquatic or semiaquatic vegetation interspersed with clumps of woody vegetation and open water. Predominantly prey on small fish.
Yellow-headed blackbird *Xanthocephalus xanthocephalus*	–/SSC	Likely	CAFSD, eBird, FRLT	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.
Yellow rail *Coturnicops noveboracensis*	FSS/SSC	Unlikely	CAFSD	Indirect	Marshes. Often next in sedges. Feeds on invertebrates in wetlands (e.g., aquatic insects and mollusks).
Yellow warbler *Setophaga petechia*	–/SSC	Likely	eBird, FRLT	Indirect	Open canopy, deciduous riparian woodland close to water, along streams or wet meadows.). Reliant on groundwater-dependent riparian vegetation for breeding habitat (e.g., willows, alders, and cottonwoods). Typically eat insects.
Mammals					
American badger *Taxidea taxus*	–/SSC	Likely	CNDDB	No known reliance on groundwater	Shrubland, open grasslands, fields, and alpine meadows with friable soils.

Common name *Scientific name*	Status[1] Federal/State	Potential to occur in the SVGB[2]	Query source[3]	GDE . association[4]	Habitat Associations
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.
Gray wolf *Canis Lupus*	FD/SE	Likely	CDFW (2021a)	Indirect	Utilizes a variety of habitats with sufficient prey. Some of the prey may be groundwater dependent.
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

Common name *Scientific name*	Status[1] Federal/State	Potential to occur in the SVGB[2]	Query source[3]	GDE . association[4]	Habitat Associations
					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.
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

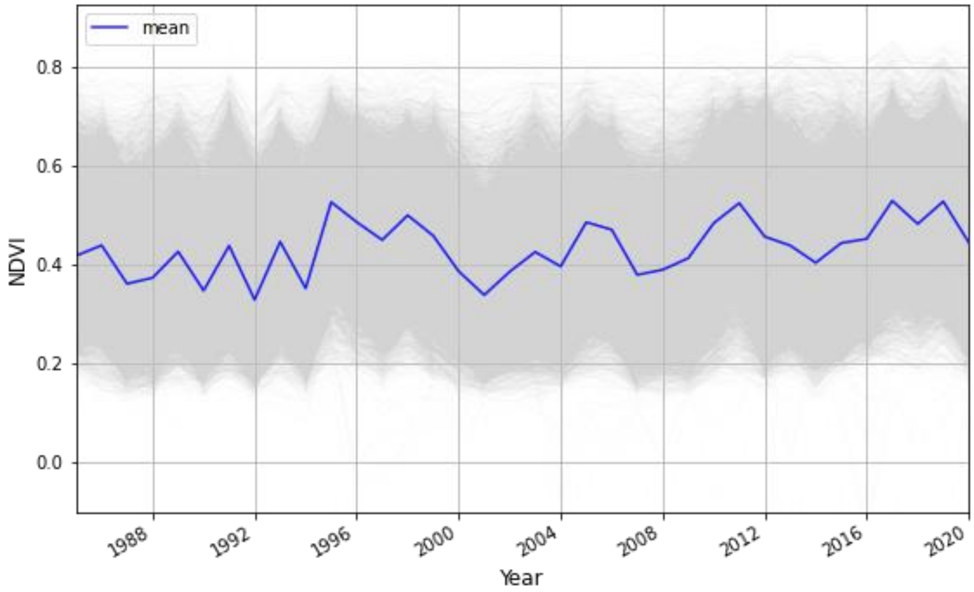
2.2.2.7.5 Changes in Vegetation Health

Assessing the impacts of groundwater changes on GDEs in Sierra Valley is complicated by a lack of data on changes to the extent of wetlands through time and any associated effects on special-status species dependent on groundwater. Instead, t~~T~~his section focuses on quantifying changes in vegetation through time using remote sensing data. While increases or decreases in vegetation health do not provide a definitive indication that all components of the ecosystem are thriving or under stress, the do provide a first-order check on the linkage between groundwater and the vegetation communities that compose the ecosystem.

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 and is essentially a measure of the greenness of remotely sensed images (Rouse et al. 1974 and Jiang et al. 2006 as cited in Klausmeyer et al. 2019).

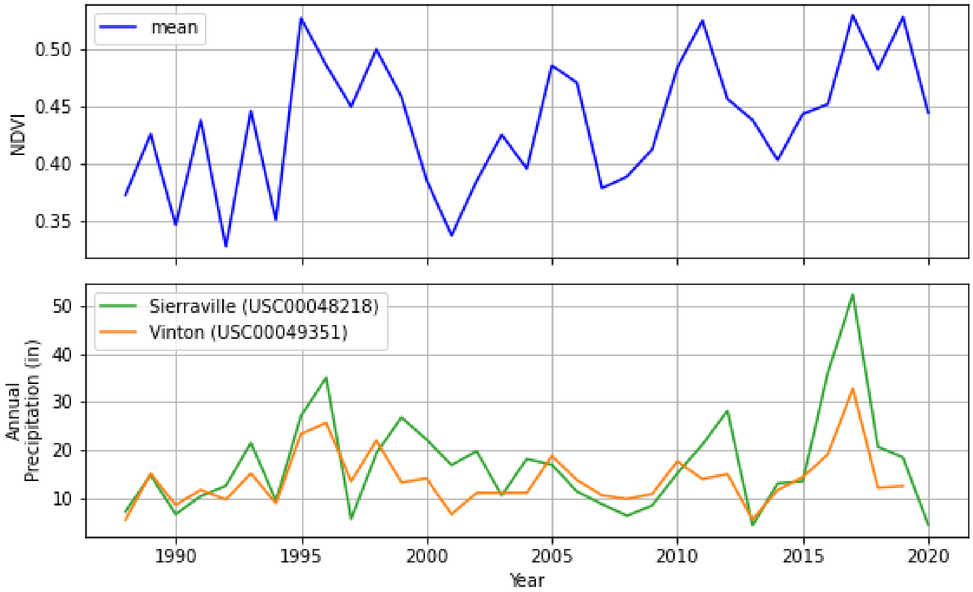
From 1985-2020 the mean Summer NDVI in the basin ranges from 0.33 to 0.53 (Figure 2.2.2- 17). No long-term trends are apparent in Summer NDVI for the basin. Local NDVI changes near long-term monitoring points are explored in Chapter 3.

Figure 2.2.2-15 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 basin-wide NDVI are generally tied to precipitation at the Sierraville (USC00048218) and Vinton (USC00049351) stations (Figure 2.2.2- 18).

Figure 2.2.2-16 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 nine likely groundwater dependent special-status plants, one sensitive natural community, and 30 special--status wildlife species. In addition, the lower 4.5 miles of the Middle Fork Feather River in the groundwater basin are designated as a Wild and Scenic River.

2.2.2.7.7 Data Gaps

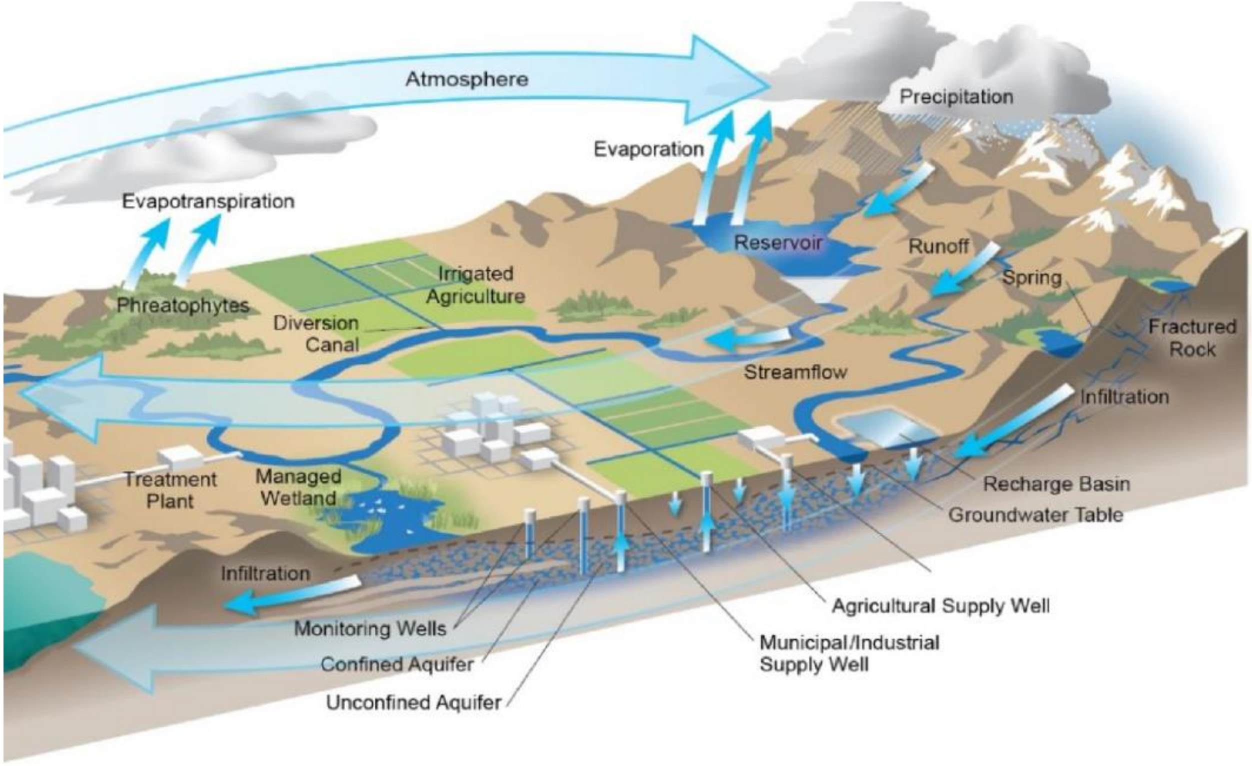
There are gaps in available data that make assessing the extent and sensitivity of GDEs to groundwater management. In particular, available vegetation maps lack sufficient detail to determine the rooting depth of vegetation to compare with groundwater depth. Instead, we need to use general rooting depths 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)*

NOTE: *The water budget section is incomplete as the modeling team required additional time for model calibration in order to ensure the model represents the hydrologic system of the Sierra Valley as best as possible given the project timeline. Below is an outline of what will be included in the GSP. A complete version of the water budget section will be released as an addendum to the public review draft by November 1st, 2021.*

This Plan includes a water budget (reported in tabular and graphical form) for the Basin to provide an accounting and assessment of the total annual volumes of groundwater and surface water that enter and leave the Basin, including historical, current, and projected water budget conditions, and the change in the volume of water stored (Reg. § 354.18[a]).

A water budget is a useful tool for tracking the components that contribute to or withdraw from the volume of water in storage, similar to how a bank account balance is monitored for cash deposits and withdraws. A schematic of the Basin water budget components is shown on Figure 2.2.3-1.



Notes:
- Figure is modified from DWR, 2016d.

Figure 2.2.3-1 Water Budget Schematic

A water budget is necessary to tabulate and sum total volumes of inflows (positive values) and outflows (negative values) of water to determine whether a basin experienced an overall (net) increase, decrease, or relatively little change in the volume of water in storage.

$$Inflows - Outflows = Change\ in\ Storage$$

The typical unit of measure for a water budget is acre-feet per year (AFY). One AFY (i.e., 325,851 gallons per year) is more than enough water to meet the typical annual demand of the average California household. An acre-foot (AF) represents the amount of water that would be required to cover a football field with a 1 foot tall body of water.

An important component of sustainability involves tracking the cumulative change in storage, making sure that the amount of negative changes in storage (i.e., during prolonged droughts) is not significantly greater than the total of positive changes in storage (i.e., during following wet years). So long as the cumulative change in storage balances out (i.e., the total of annual changes tends towards zero), the Basin can be considered to not be experiencing significant overdraft conditions (i.e., average inflows equal average outflows) - a critical component of demonstrating sustainable groundwater conditions.

2.2.3.1 Description of Inflows, Outflows, and Change in Storage

The Basin water budgets are conceptualized into three components subsystems:

- surface water
- land surface (unsaturated zone)
- aquifer (groundwater/saturated zone)

2.2.3.1.1 Surface Water Budget

The surface water subsystem comprises stream flows that interact with the land surface and groundwater subsystems. The majority of surface water inflows are quantified using a Precipitation Runoff Modeling System (PRMS) model (Markstrom et al., 2015) developed for the Basin (2021a; Appendix 2-8), along with observed flows where available.

Inflows

Inflows into the surface water subsystem within the groundwater basin consist of:

- streamflow entering at the Basin boundaries
- groundwater discharge to streams (i.e., gaining stream conditions)

Gaining steam conditions are most prevalent during wet years and spatially *[to be further developed*]... Surface water flows are estimated with the PRMS model (Appendix 2-8) due to the lack of observed flows (i.e., gauging stations) in the majority of streams, with the exception of Little Last Chance Creek and Big Grizzly Creek, which are gauged for reservoir releases (i.e., have observed flows). Cold Stream PRMS flow estimates are supplemented with reported irrigation diversions from the Little Truckee River.

Outflows

Outflows from the surface water subystem occur as:

- streamflow that leaves the groundwater basin from the Middle Fork Feather River
- irrigation diversions
- streambed percolation (i.e., groundwater recharge or losing stream conditions)

Losing stream conditions are most prevalent immediately following extended droughts (when the most subsurface storage capacity is available due to lower groundwater levels) and spatially...

Change in Storage

The surface water subsystem is conceptualized to not exhibit significant changes in storage, because there are no significant surface water reservoirs (e.g., lakes) within the Basin and storage within the stream channels is small compared to inflows and outflows.

2.2.3.1.2 Land Surface Budget

The land surface budget represents flows associated with vegetation and soil (i.e., the unsaturated zone) in the Basin. The land surface subsystem acts as an interface between the surface water and groundwater subsystems. Flows within the groundwater basin boundary are quantified using the Soil-Water Budget Model (Appendix 2-8)

Inflows

Inflows to the land surface subsystem consist of:

- precipitation
- irrigation sourced from surface water (diversions)
- irrigation sourced from groundwater pumping (wells)

Precipitation inputs are quantified using local meteorological station data and spatially distributed using PRISM datasets. Irrigation flows are estimated using the Soil-Water Budget Model (Appendix 2-8). These inflows contribute to the moisture content of the land surface (i.e., soil) system.

Outflows

Outflows from the land surface system occur as:

- evapotranspiration (ET) by vegetation and crops
- deep percolation past the root zone (groundwater recharge)

ET rates are quantified using relationships between reference ET values from CIMIS and the spatial distribution of vegetation and crop types (described in Section 2.2.1.3 and Appendix 2-8). ET rates are greater during the warmer (e.g., summer) seasons due to higher temperatures and water demand by vegetation. Groundwater recharge occurs when simulated soil water content exceeds field capacity, resulting in gravity drainage into the groundwater subsystem.

Change in Storage

Land surface subsystem storage reflect changes in soil moisture content. Inter-annual (i.e., year-to-year) changes in storage are generally expected to be small. This is because the total storage volume is relatively small compared to the annual flows and therefore generally fills back up each winter. However, intra-annual (i.e., seasonal) changes in soil moisture storage may occur as a results of crop type and irrigation management practices in the valley.

2.2.3.1.3 Groundwater Budget

The groundwater budget represents flows that occur within the saturated subsurface (i.e., groundwater aquifers) and between the land surface and surface water subsytems. The groundwater budget is quantified using a finite-difference (MODFLOW) numerical model that is calibrated to historical data available from water year 2000 through 2020 (Appendix 2-8).

Inflows

Inflows to the groundwater subsystem consist of:

- recharge distributed across the groundwater basin area
- mountain-front recharge
- streambed percolation (i.e., losing stream conditions).

Groundwater recharge is represented by the SWBM and is equivalent to the outflow from the land surface subsystem. The mountain-front recharge component represents inflows from the surrounding mountain watershed runoff and fractured bedrock underflow processes (Wilson and Guan, 2004). Stream exchange is an inflow to the groundwater system when more water is lost by the stream subsystem to the aquifer than is gained.

Outflows

Outflows from the groundwater system occur as:

- pumping for irrigation or municipal use
- evapotranspiration (ET) of shallow groundwater

- discharge to surface water (i.e., when net stream exchange is negative).

The majority of groundwater pumping in the Basin is for agricultural uses, with a minor component of pumping used for municipal (i.e., public) and domestic (i.e., private) drinking water supply uses. ET in the groundwater budget represents evaporation processes associated with shallow groundwater levels (i.e., when/where water levels are within about 1 foot of land surface) that are not captured by the SWBM. Stream exchange is an outflow from the groundwater system when more water is lost by the aquifer to stream subsystem than is gained by streambed percolation.

Change in Storage

The terms “groundwater storage” and “groundwater in storage” are defined in this Plan as the volume of water contained within an aquifer(s) at a given time. The term “groundwater storage capacity” is defined as the maximum volume of water the aquifer(s) are capable of storing at any time.

Changes in the volume of groundwater in storage correspond with changes in groundwater levels in the Basin. Generally, increases in groundwater storage result in increases in observed groundwater levels and vice versa. Consistent, long-term declines in groundwater storage are indicative of groundwater overdraft within a basin. The relationship between average groundwater level changes and changes in storage in the Sierra Valley are based on storage (hydraulic) properties of the aquifer system represented in SVHSM.

2.2.3.2 Quantification of Historical Water Budget Conditions (Reg § 354.18[c][2])

Historical water budget conditions are quantified for a 15-year period (water years 2001 through 2015) using SVHSM (Appendix 2-8) and presented by hydrologic subsystem. Water year types for the Basin are designated by grouping the five Sacramento Valley water year hydrologic classification indices (critical, dry, below normal, above normal, and wet) provided by DWR for into three water year type classifications (dry, normal, and wet). Critical and dry DWR water year types are considered “dry” years, below normal and above normal DWR water year types are considered “normal” years, and wet DWR water year type is similarly considered a “wet” year in the Basin.

2.2.3.2.1 Availability of Surface Water Supply Deliveries (Reg § 354.18[c][2][A])

The Basin receives imported surface water diverted from the Little Truckee River. Reported deliveries from 1959 through 2020 range from about 120 to 10,600 AFY, and average approximately 6,600 AFY. Releases into Little Last Chance Creek from Frenchman Reservoir from 2000 through 2020 have a median value of about 10,800 AFY and range from about 6,300 to 56,500 AFY. Approximately 75% of the water is available for diversion and surface-water irrigation. Additional surface-water is released into Big Grizzly Creek from Lake Davis but enters the groundwater basin near the outlet and is not expected to significantly contribute to the groundwater system.

2.2.3.3 Quantitative Assessment of the Historical Water Budget (Reg § 354.18[c][2][B])

The historical annual surface water budget for the Basin is shown with water year types on Figure 2.2.3-2 and summarized in Table 2.2.3-1. The water budget reveals a wide range of surface water conditions that depend on the water year type. During dry, normal, and wet years, surface water flows within the Basin average about 50,000 AFY, 100,000 AFY, and 300,000 AFY, respectively.

Table 2.2.3-1. Historical Surface Water Budget Summary

insert table upon model completion

The historical annual land surface budget for the Basin is shown with water year types on Figure 2.2.3-3 and summarized in Table 2.2.3-2. The water budget reveals a wide range of conditions that depend on the water year type. During dry, normal, and wet years, land surface flows within the Basin average about 125,000 AFY, 200,000 AFY, and 375,000 AFY, respectively.[additional detail to be provided upon model completion]

Table 2.2.3-2. Historical Land surface Budget Summary

insert table upon model completion

The historical annual groundwater budget for the Basin is shown with water year types on Figure 2.2.3-4 and summarized in Table 2.2.3-3. The water budget reveals a wide range of conditions that depend on the water year type. During dry, normal, and wet years, groundwater flows within the Basin average about 100,000 AFY, 150,000 AFY, and 275,000 AFY, respectively.

Table 2.2.3-3. Historical Groundwater Budget Summary

insert table upon model completion

The relative contributions of recharge attributed to the basin floor area versus the mountain-front area vary depending on the water year type. This is because basin floor recharge rates are conceptualized to vary more significantly as result of climate conditions, while mountain-front recharge is modelled as a constant inflow to the basin of about 80,000 AFY. During dry years, basin floor recharge varies between about 10,000 and 50,000 AFY. During normal years, basin floor recharge varies between about 50,000 and 100,000 AFY. During wet years, basin floor recharge is much greater, varying between over 100,000 and as high as about 325,000 AFY.

ET is the largest outflow component from the groundwater system. [NOTE: ET may be adjusted depending on model calibration results] Rates range from approximately 50,000 AFY during dry years to nearly 200,000 AFY during wet years. Approximately 100,000 due to the increased extent of shallow groundwater conditions (i.e., higher groundwater levels) in the Basin for uptake by vegetation roots. Groundwater discharge to streams (surface water exchange), the second largest source of outflow from the Basin aquifer[s], on average, consistently results in net outflow (i.e., gaining stream) conditions. Similar to ET, more groundwater discharge to streams tends to occur during wet years (about 25,000 to 50,000 AFY) than normal years (about 20,000 AFY on average) and dry years (about 10,000 AFY or less, on average). Groundwater pumping, on the other hand, generally decreases as water year types become wetter (from about 12,500 AFY during dry years to about 9,000 AFY during normal and about 7,000 AFY during wet years) due to increased availability of precipitation. The variability in groundwater pumping is largely a result of changes in agricultural demand (which makes up about 94% of pumped groundwater demand in the Basin). No significant (net) underflow is considered to occur out of the Basin.

At the Basin scale, stream leakage is generally a net inflow to the groundwater system, especially during wet years preceded by dry years (e.g., 2005 and 2006). Lowered groundwater levels resulting from the dry year conditions provide more capacity for surface water to infiltrate and percolate into groundwater in storage. Stream percolation correlates well with the water year type, from as low as 30,000 AFY during dry years to as high as about 55,000 AFY during wet years, on average. This is due to the increased availability of surface water associated with precipitation.

Overall, these water budget components add up to and result in annual increases or decreases of groundwater storage (Figure 2.2.3-4) that average near zero change over the long-term. Typical annual changes in groundwater storage range between increases and decreases of about 10,000 AFY, yet increases as great as 20,000 AFY can occur during the wettest (e.g., 1993 and 2005) years, and decreases as low as about 15,000 AFY can occur during drought (e.g., 1990) years.

2.2.3.3.1 Ability of the Agency to Operate the Basin Within Sustainable Yield (Reg § 354.18[c][2][C])

In the context of observed long-term groundwater levels and the historical water budget, the Basin has historically operated sustainably. Temporary groundwater budget deficits occur during drought periods (i.e., dry and critical water years), but recover during subsequent wet periods when groundwater budget surpluses occur. While the Basin overall operates within it’s safe yield, the Eastern Basin area does exhibit greater overdraft than the Western Basin area, the former of which may be an area to improve groundwater conditions depending on GSA and stakeholder input. The Basin sustainable yield has been estimated at about 6,000 AFY (Bachand and Carlton, 2020). Historical groundwater pumping records indicate about 8,000 AFY water demand on average. The higher average groundwater pumping than sustainable yield indicates the Basin is overdrafted by 2,000 AFY over the long-term (based on water years 2003 through 2020).

2.2.3.4 Quantification of Current Water Budget Conditions (Reg § 354.18[c][1])

Current water budget conditions are represented in this Plan by the five most recent water years, 2016 through 2020. This period represents a transition in observed climate conditions from the peak of the drought (i.e., 2016) and towards less dry conditions (i.e., 2017 through 2019), corresponding to a partial recovery of groundwater levels in the Basin.

The current surface water budget is shown on Figure 2.2.3-2 (in addition to the historical water budget) and summarized in Table 2.2.3-4.

Table 2.2.3-4. Current Surface Water Budget Summary

insert table upon model completion

The current land surface budget is shown on Figure 2.2.3-3 (in addition to the historical water budget) and summarized in Table 2.2.3-5.

Table 2.2.3-5. Current Land surface Budget Summary

insert table upon model completion

The current groundwater budget is shown on Figure 2.2.3-4 (in addition to the historical water budget) and summarized in Table 2.2.3-6.

Table 2.2.3-6. Current Groundwater Budget Summary

insert table upon model completion

Currently, there has not been significant enough above normal or wet year(s) to completely offset the historical deficit in groundwater in storage and "fill" the Basin. Although the historical average 1,500 AFY deficit rate is less than the current average 10,000 AFY surplus, these changes in groundwater in storage do not completely offset one another, because the historical average represents a significantly longer duration than the current average change in storage (i.e., 15 years versus five years). This is why tracking changes in groundwater in storage as the cumulative (total) of annual changes in storage is useful for comparing different time periods. The current estimated rate of recovery of groundwater in storage is similar to rates of recovery that occurred in the past, prior to full recovery of groundwater levels.

This current water budget information was developed with consideration of available evapotranspiration and sea level rise information (Reg. § 354.18[d][2]) included in United (2018, 2021a) groundwater model documentation, water year type information provided by DWR (2021a,b), and precipitation and temperature data from PRISM. The land use information used in the historical water budget is consistent with that shown on Figure 2.2.1-5.

2.2.3.5 Quantification of Projected Water Budget Conditions (Reg § 354.18[c][3])

It is important to note that the projected water budget is based on assumptions of events that may occur in the future and is not intended to represent a prediction of future conditions. Instead, the projected water budget is constructed to simulate a "what-if" scenario and evaluate the Agency's ability to operate the Basin sustainably (discussed in Section 3). The projected water budget represents a scenario analogous to the 1943 to 2019 (76-year long) historical record, modified with changes in projected climate change and water demand and supply.

2.2.3.5.1 Projected Hydrology (Reg § 354.18[c][3][A])

The baseline hydrology used as the basis for the projected water budget is based on applying precipitation and ET and streamflow change factors from the Variable Infiltration Capacity (VIC) 2070 central tendency (CT) climate scenario, provided by DWR (2018b,c), to historical hydrology of years 1943 through 2019 (DBS&A, 2021b; Appendix 2-8). The 2070 CT climate change factors were determined to exhibit more variability (i.e., more severe droughts and intense wet years) than the 2030 CT climate change factors, indicating that the 2070 CT climate change assumptions are more conservative from a water supply and demand planning perspective.

2.2.3.5.2 Projected Water Demand (Reg § 354.18[c][3][B])

Projected water demands consist of....

2.2.3.5.3 Projected Surface Water Supply (Reg § 354.18[c][3][C])

DBS&A (2021b) used hydrological models to simulate reservoir operations and streamflow routing using historical datasets and DWR adjustment factors. These projected surface water supplies are incorporated into the PRMS and MODFLOW models to calculate the projected groundwater budget.

The projected annual surface water budget is shown on Figure 2.2.3-5, and summarized in Table 2.2.3-7. The projected surface water budget is tabulated in Appendix 2-8.

Table 2.2.3-7. Projected Surface Water Budget Summary

insert table upon model completion

The projected annual land surface budget is shown on Figure 2.2.3-6, and summarized in Table 2.2.3-8. The projected land surface budget is tabulated in Appendix 2-8.

Table 2.2.3-8. Projected Land surface Budget Summary

insert table upon model completion

The projected annual groundwater budget is shown on Figure 2.2.3-7, and summarized in Table 2.2.3-9. The projected groundwater budget is tabulated in Appendix 2-8.

Table 2.2.3-9. Projected Groundwater Budget Summary

insert table upon model completion

2.2.3.6 Quantification of Overdraft (if applicable) (Reg. § 354.18[b][5])

The Basin is considered by DWR to not exhibit critical long-term overdraft. DWR's analysis of long-term groundwater hydrographs used a base period of water years 1989 to 2009 for this determination, which includes wet and dry periods and has the same mean precipitation as the long-term mean. per California's Groundwater - Update 2020 (Bulletin 118). This finding is supported by the observed recovery of groundwater levels following each drought, as shown on Figure 2.2-18 from Section 2.2.2.1, and the insignificant cumulative change in storage estimated with the historic and projected water budgets.

Temporary overdraft occurs during periods of multiple years of below average or dry precipitation trends; however, following an above average or (especially) wet year, the Basin "resets" (refills) quickly. While beneficial uses (i.e., pumping) of groundwater contribute to steeper groundwater level (storage) declines during drier periods, the climate variability that is responsible for less precipitation is another significant factor that reduces groundwater levels during these periods, even in the absence of groundwater pumping.

2.2.3.7 Estimate of Sustainable Yield (Reg. § 354.18[b][7])

The Basin sustainable yield has been estimated at about 6,000 AFY. Historical groundwater pumping records indicate about 8,000 AFY water demand on average. The higher average groundwater pumping than sustainable yield indicates the Basin is overdrafted by 2,000 AFY over the long-term (based on water years 2003 through 2020).

$$Sustainable\ Yield = Pumping + Change\ in\ Storage$$

The estimated sustainable yield for the Basin is calculated to be about 6,000 AFY, based on [to be added]... The sustainable yield is rounded down by 100 AFY from the average pumping rate to account for water budget uncertainty. This sustainable yield represents the average pumping rate for the 50-year SGMA planning horizon that corresponds with an estimate of no net change in storage. Year-to-year rates of pumping are expected to vary less than or greater than the long-term sustainable yield value. For example, the projected groundwater budget (Appendix 2-8) incorporated annual pumping rates as high as 20,100 AFY and as low as 10,600 AFY. Based on this projected water budget, the Basin can pump (on average) 2,600 AFY more than historic (which was about 12,400 AFY) and not experience chronic declines in groundwater elevations or changes in storage. Consideration of this sustainable yield estimate in the context of other undesirable results is discussed in Section 3.

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

The Subbasin is not currently divided into separate management areas.

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