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Annual Report for the Sustainable Groundwater Management Program
2019 Water Year

Livermore Valley Groundwater Basin

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Sustainable Groundwater Management Program
2019 Water Year (October 2018 – September 2019)
Livermore Valley Groundwater Basin

ZONE 7 WATER AGENCY

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Acronyms and Abbreviations

Abbrev	Description	Abbrev	Description
µg/L	Micro grams per liter	DVWTP	Del Valle Water Treatment Plant
ACCDA	Alameda County Community Development Agency	DWR	California Department of Water Resources
ACDEH	Alameda County Department of Environmental Health	EBMUD	East Bay Municipal Utilities District
ACNP	Alamo Canal near Pleasanton	EBRPD	East Bay Regional Parks District
ADLLV	Arroyo de la Laguna at Verona	EIR	Environmental Impact Report
ADVP	Arroyo Del Valle Pleasanton	EPA	Environmental Protection Agency
AF	Acre-feet	ESL	Environmental screening level
AF/yr	Acre-feet per year	ETo	Evapotranspiration
ALP	Arroyo Las Positas	ft	Feet
ALP_ELCH	Arroyo Las Positas at El Charro	GDE	Groundwater-dependent ecosystem
ALPL	Arroyo Las Positas near Livermore	GIS	Geographic information system
ALTC	Altamont Creek	GPQ	Groundwater Pumping Quota
AMHAG	Arroyo Mocho Hageman	GSA	Groundwater Sustainability Agency
AM_KB	Arroyo Mocho at Kaiser Bridge	GSP	Groundwater Sustainability Plan
AMNL	Arroyo Mocho near Livermore	GWMP	Groundwater Management Plan
AMP	Arroyo Mocho Pleasanton	GWE	Groundwater Elevation
AOC	Area of Concern	HI	Hydrologic Inventory
AVADLL	Arroyo Valle at Arroyo de la Laguna	HRL	Health reference level
AVBLC	Arroyo Valle below Lang Canyon	InSAR	Interferometric Synthetic Aperture Radar
AVNL	Arroyo Valle near Livermore	ISCO	In-situ chemical oxidation
BBID	Byron-Bethany Irrigation District	LAMP	Local Agency Management Program
bgs	Below ground surface	LAVWMA	Livermore-Amador Valley Water Management Agency
BMOs	Basin management objectives	lbs	Pounds
BMPs	Best management practices	LDV	Lake Del Valle
BTEX	Benzene, toluene, ethylbenzene, xylene	LLNL	Lawrence Livermore National Laboratory
CASGEM	California Statewide Groundwater Elevation Monitoring	LTCP	Low-Threat Underground Storage Tank Closure Policy
CCNP	Chabot Canal near Pleasanton	LWRP	Livermore Water Reclamation Plant
CCR	California Code of Regulations	MCL	Maximum contaminant level
CEC	Constituents-of-emerging-concern	mg/L	Milligrams per liter
CEQA	California Environmental Quality Act	MGDP	Mocho Groundwater Demineralization Plant
cfs	Cubic feet per second	MOU	Memorandum of Understanding
CIMIS	California Irrigation Management Information System	msl	Mean sea level
CIP	Capital Improvement Program	MTBE	Methyl tertiary-butyl ether
COL	Chain of Lakes	NAVD	North American Vertical Datum
Cr	Chromium	N	Nitrogen
CrVI	Hexavalent chromium	NC	North Canyons
CWS	California Water Service	NL	Notifications Level
CY	Calendar year	NMP	Nutrient Management Plan
DCE	Dichloroethene	NO_3	Nitrate Ion
DERWA	DSRSD-EBMUD Recycled Water Authority	OWTS	Onsite wastewater treatment system
DDW	California State Water Resources Control Board Division of Drinking Water	PCE	Tetrachloroethylene
DSRSD	Dublin San Ramon Services District	PFAS	Per- and polyfluoroalkyl substances
DTSC	Department of Toxic Substances Control	PFOA	Perfluorooctanoic acid

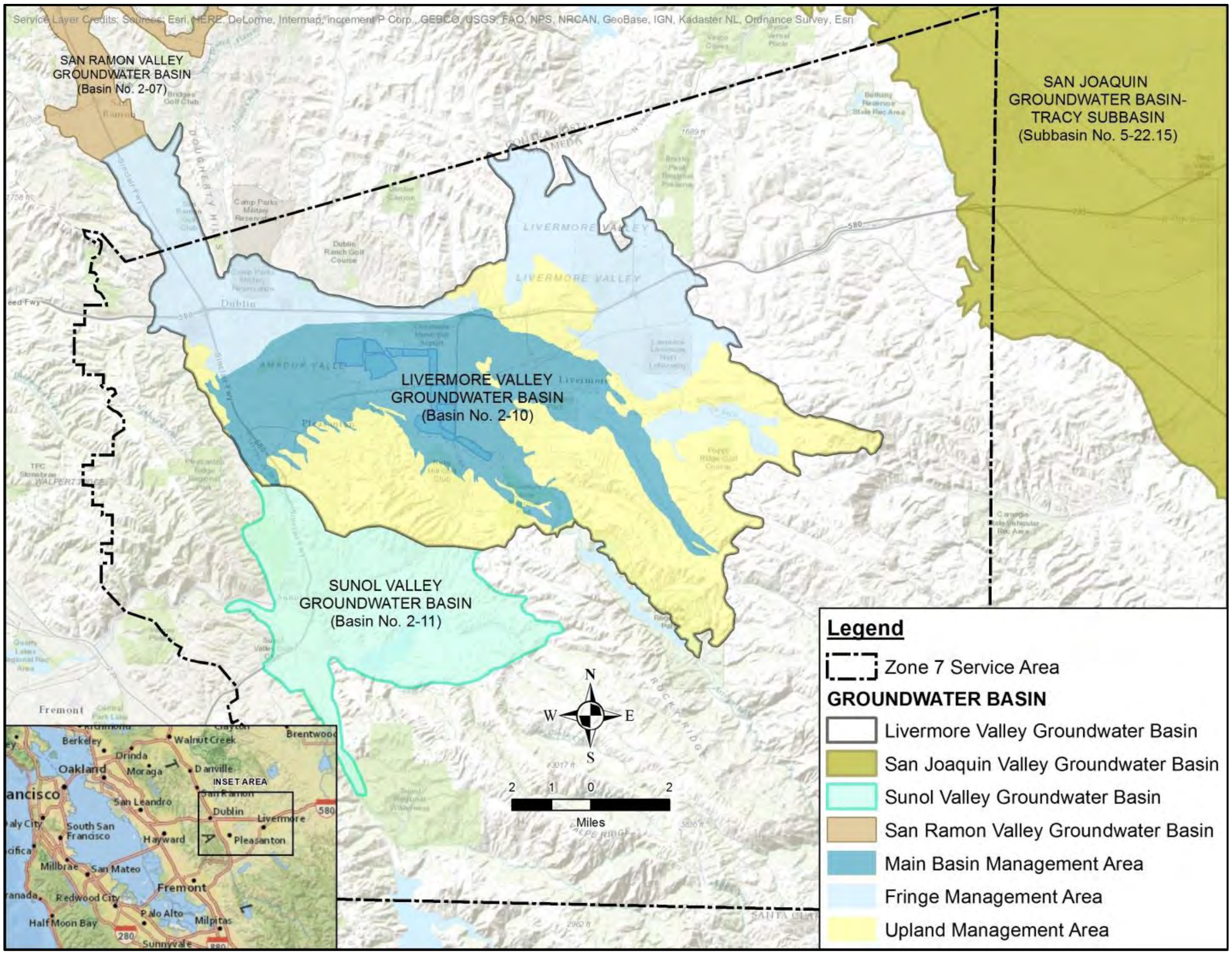
Abbrev	Description	Abbrev	Description
PFOS	Perfluorooctanesulfonic acid	SWRCB	State Water Resources Control Board
POTW	Publicly owned treatment works	TAF	Thousand acre-feet
ppb	Parts per billion	TCE	Trichloroethylene
ppt	Parts per trillion	TDS	Total dissolved solids
PPWTP	Patterson Pass Water Treatment Plant	TKN	Total Kjeldahl nitrogen
PRG	Preliminary Remediation goals	TPHd	Total petroleum hydrocarbons as diesel
RL	Response Level	TPHg	Total petroleum hydrocarbons as gasoline
RO	Reverse osmosis	TSS	Toxic Sites Surveillance
RP	Responsible Party	USEPA	U.S. Environmental Protection Agency
RWQCB	California Regional Water Quality Control Board	USGS	U.S. Geological Survey
SBA	South Bay Aqueduct	UST	Underground storage tank
SGMA	Sustainable Groundwater Management Act	VA	Veteran’s Administration
SLIC	Spills, Leaks, Investigations, and Clean-ups	VOC	Volatile organic compound
SFPUC	San Francisco Public Utilities Commission	WBIC	Weather-Based Irrigation Controller
SMP	Salt Management Plan	WDR	Waste Discharge Requirement
SMP	Surface mining permit	WMP	Well Master Plan
SNMP	Salt Nutrient Management Plan	WWMP	Wastewater Management Plan
SVE	Soil vapor extraction	WY	Water year (October 1 through September 30)
SWP	State Water Project		

Executive Summary

ES.1 Introduction

Zone 7 Water Agency (Zone 7) has managed and imported local surface water and groundwater resources for beneficial uses in the Livermore Valley Groundwater Basin (*Figure ES-A*) for more than 50 years. Consistent with its management responsibilities, duties, and powers, Zone 7 is designated in the 2014 Sustainable Groundwater Management Act (SGMA) as the exclusive Groundwater Sustainability Agency (GSA) within its jurisdictional boundaries. As a part of SGMA, Zone 7 received approval from California Department of Water Resources (DWR) of the Alternative Groundwater Sustainability Plan for the Livermore Valley Groundwater Basin (Alternative GSP) (*Zone 7, 2016d*) in July 2019.

Figure ES-A: Livermore Valley Groundwater Basin



This *Annual Report for the Sustainable Groundwater Management Program 2019 Water Year Livermore Valley Groundwater Basin* (2019 Annual Report) was prepared in compliance with Title 23, California Code of Regulations Section 356, *Annual Report and Periodic Evaluations by the Agency* for the 2019 Water Year (WY) (October 1, 2018 through September 30, 2019). It summarizes this year's groundwater monitoring, evaluation, and management efforts in the Livermore Valley Groundwater Basin. *Table ES-A* provides a summary of the required information and the specific location(s) in the report where required information is provided.

For this Annual Report, the results for each of the water resource monitoring, evaluation, and management programs are summarized in the Executive Summary, while the details are provided in the following sections.

- Section 1: Agency and Basin Information
- Section 2: Precipitation and Evaporation
- Section 3: Surface Water
- Section 4: Mining Area
- Section 5: Surface Water-Groundwater Interaction
- Section 6: Groundwater Elevations
- Section 7: Groundwater Quality
- Section 8: Land Surface Elevation
- Section 9: Land Use
- Section 10: Wastewater and Recycled Water
- Section 11: Groundwater Storage
- Section 12: Groundwater Supply Sustainability
- Section 13: Water Quality Sustainability

In an effort to avoid duplication, material included in the *Alternative Groundwater Sustainability Plan for the Livermore Valley Groundwater Basin* (Alternative GSP) (*Zone 7, 2016d*) has not been repeated here, but specific sections are referenced when more background detail may be desired.

Table ES-A: Location of Required Items in the 2019 Groundwater Management Annual Report

Annual Report Requirement (23 CCR Article 7, Sections from Water Code § 10733.2)	Location(s) in Report	
	Text Section	Figures
356.2 (a) General information, including an executive summary and a location map depicting the basin covered by the report.	Executive Summary Section 1, Agency and Basin Information • Section 1.1, Introduction • Section 1.3, Zone 7 Service Area • Section 1.6, Plan Area • Section 1.7, Basin and Hydrogeologic Setting • Section 1.7.1, Basin Management Areas • Section 1.8, Aquifer Zones • Section 1.9, Groundwater Characteristics	• Figure 1-1, Map of Livermore Valley Groundwater Basin, Zone 7 Service Area, and Basin Management Areas and Subareas
356.2 (b) (1) Groundwater elevation data from monitoring wells identified in the monitoring network shall be analyzed and displayed as follows: (A) Groundwater elevation contour maps for each principal aquifer in the basin illustrating, at a minimum, the seasonal high and seasonal low groundwater conditions. (B) Hydrographs of groundwater elevations and water year type using historical data to the greatest extent available, including from January 1, 2015, to current reporting year.		• Figure ES-1, Key Well Hydrograph (Bernal) • Figure 6-3: Historical Key Well Hydrographs, 1901 to 2019 Water Years • Figure 6-4: Groundwater Gradient Map, Upper Aquifer, Spring 2019 WY • Figure 6-5: Groundwater Gradient Map, Upper Aquifer, Fall 2019 WY • Figure 6-6: Change in Groundwater Elevation, Upper Aquifer, Fall 2018 WY to Fall 2019 WY • Figure 6-8: Groundwater Gradient Map, Lower Aquifer, Spring • Figure 6-9: Groundwater Gradient Map, Lower Aquifer, Fall 2019 WY

Annual Report Requirement (23 CCR Article 7, Sections from Water Code § 10733.2)	Location(s) in Report	
	Text Section	Figures
356.2 (b) (2) Groundwater extraction for the preceding water year. Data shall be collected using the best available measurement methods and shall be presented in a table that summarizes groundwater extractions by water use sector, and identifies the method of measurement (direct or estimate) and accuracy of measurements, and a map that illustrates the general location and volume of groundwater extractions.	Section 11, Groundwater Storage • Table 11-A: HI Method Groundwater Storage Supply and Demand Volumes, 2019 WY (AF) • Table 11-B: Groundwater Storage Summary, 2019 WY (in Thousand AF) • Table 11-2: Description of Hydrologic Inventory Components • Table 11-3: Historical Groundwater Storage, Hydrologic Inventory Method, 1974 to 2019 Water Years	• Figure 11-3: Graph of Historical Groundwater Storage, 1974 to 2019 Water Years
356.2 (b) (3) Surface water supply used or available for use, for groundwater recharge or in-lieu use shall be reported based on quantitative data that describes the annual volume and sources for the preceding water year.	Section 12, Groundwater Supply Sustainability • Table 12-A: Imported Water Sources for the 2019 Calendar Year (AF)	• Figure 12-1: Livermore-Amador Valley Water Supply and Use, 2019 Water Year • Figure 12-2: Valley Water Production from Imported Water and Groundwater, 1974 to 2019 Water Years • Figure 11-5: Main Basin Groundwater Production, 1974 to 2019 Water Years
356.2 (b)(4) Total water use shall be collected using the best available measurement methods and shall be reported in a table that summarizes total water use by water use sector, water source type, and identifies the method of measurement (direct or estimate) and accuracy of measurements. Existing water use data from the most recent Urban Water Management Plans or Agricultural Water Management Plans within the basin may be used, as long as the data are reported by water year.	Section 12, Groundwater Supply Sustainability Section 11, Groundwater Storage • Table 11-2: Description of Hydrologic Inventory Components Section 9, Land Use • Table 9-1: Table of Livermore Valley Land Use Acreage	• Figure 12-1: Livermore-Amador Valley Water Supply and Use, 2019 Water Year

Annual Report Requirement (23 CCR Article 7, Sections from Water Code § 10733.2)	Location(s) in Report	
	Text Section	Figures
356.2 (b)(5)(A) Change in groundwater in storage maps for each principal aquifer in the basin.	Section 11, Groundwater Storage	- Figure 6-10: Change in Groundwater Elevation, Lower Aquifer, Fall 2018 WY to Fall - Figure 11-2: Change in Groundwater Storage, Fall 2018 to Fall 2019
356.2 (b)(5)(B) A graph depicting water year type, groundwater use, the annual change in groundwater in storage, and the cumulative change in groundwater in storage for the basin based on historical data to the greatest extent available, including from January 1, 2015, to the current reporting year.		- Figure 11-3: Graph of Historical Groundwater Storage, 1974 to 2019 Water Years

Annual Report Requirement (23 CCR Article 7, Sections from Water Code § 10733.2)	Location(s) in Report	
	Text Section	Figures
356.2 (c) A description of progress towards implementing the Plan, including achieving interim milestones, and implementation of projects or management actions since the previous annual report.	Section 11, Groundwater Storage • Section 11.2, Groundwater Budget Section 12, Groundwater Supply Sustainability • Section 12.1, Introduction • Section 12.2, Import of Surface Water • Section 12.4, Future Supply Reliability • Section 12.5, Water Conservation • Section 12.6, Chain of Lakes Recharge Projects • Section 12.7, Well Master Plan • Section 12.9, Existing and Future Recycled Water Use Section 13, Water Quality Sustainability • Section 13.2, Well Ordinance Program • Section 13.3, Toxic Site Surveillance Program • Section 13.4.2, Salt Management • Section 13.5, Nutrient Management • Section 13.5.3, OWTS Management	

AF	acre-feet	OWTS	On-Site Wastewater Treatment System
GW	groundwater	WY	water year
HI	Hydrologic Inventory Method		

ES.2 2019 Groundwater Conditions Overview

ES.2.1. Overview

Zone 7 has been managing groundwater resources sustainably for the past 50 years as demonstrated in *Figure ES-B*. Zone 7 was able to keep the groundwater resources replenished and minimize reliance on groundwater production to meet potable water demands during the 2019 WY. Overall, groundwater conditions in the Livermore Basin are stable and have recovered from the 2011-2015 drought.

Figure ES-B: Bernal Key Well Hydrograph

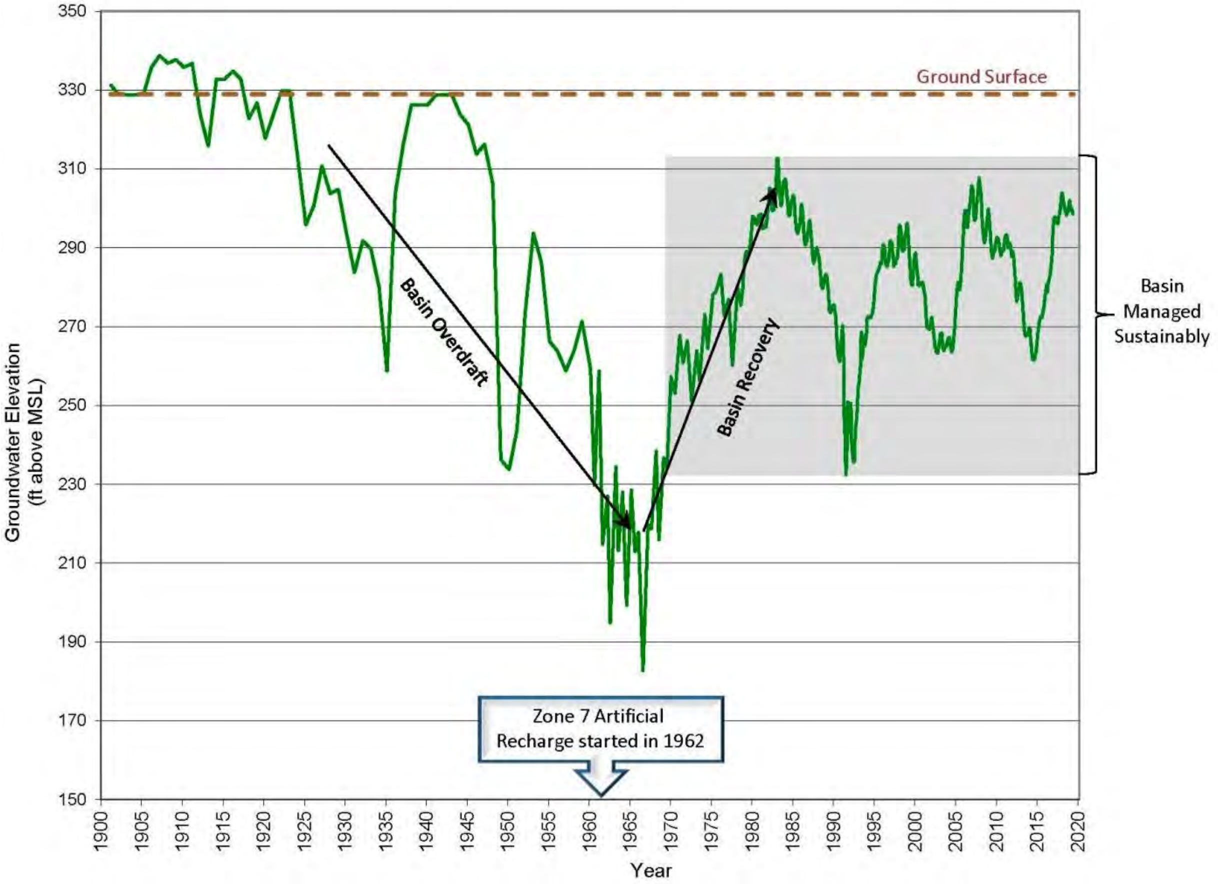


Table ES-B summarizes the five sustainability indicators, their associated undesirable results, and minimum thresholds as presented in the *Alternative GSP* (*Zone 7, 2016d*). The table also includes the 2019 WY status for each indicator and any action taken in the 2019 WY or planned for the upcoming WY. More in depth descriptions of each sustainability indicator can be found in the sections of the Executive Summary that immediately follow, as well as in this 2019 Annual Report for the Sustainable Groundwater Management Program.

Table ES-B: Summary of Sustainability Indicators and 2019 WY Status

Sustainability Indicator	Undesirable Results Alt GSP	Minimum Threshold Alt GSP	Status 2019 WY	Action Taken
Groundwater Levels	Loss of wellfield or loss of domestic supply well	Historic Lows	Main Basin was 10' to 160' above historic lows in all areas except a limited area surrounding Lake E due to mining activities	Increased monitoring of the quarry operations to prevent undesirable results
Groundwater Storage	Chronic loss of storage	Total Storage above 128 TAF (Historic Low)	Total Storage at 252 TAF, (124 TAF above Historic Low)	No action needed
Groundwater Quality	Lower Aquifer degradation resulting in wellfield not being suitable to provide drinking water supply	TDS >500 mg/L	Main Basin avg TDS = 658 mg/L TDS was detected above the minimum threshold in Mocho Wellfield municipal supply wells	Increase municipal supply pumping, operation of MGDP, and artificial groundwater recharge with low TDS water in 2020 WY
		NO3 (as N) > 10mg/L	NO3 (as N) exceeded threshold in northeastern Mocho II Subarea, but overall continues to decrease with time	Continue to monitor
		Boron > 1.4 mg/L	Boron exceeded threshold in two wells in the Mocho Wellfield up to 3.0 mg/L	Continue to monitor
		Total Chromium > 0.050 mg/L[1]	Chromium threshold wasn't exceeded in any municipal or lower aquifer wells[2]	No action needed
Land Subsidence	Inelastic subsidence	Land surface elevation decrease of 0.4'	Elastic fluctuations of 0.07' per cycle with less than 0.02' for the year	No action needed
Surface Water-Groundwater Interaction	Depletion of surface water in the Alkali Sink	Elevation 491' in 2S/2E 34E1 Elevation 501' in 2S/2E 27P2	Elevation 494.08' in 2S/2E 34E1 Elevation 502.62' in 2S/2E 27P2	No action needed

[1] The minimum threshold was changed from CrVI < 0.010 mg/L in the Alternative GSP to Total Cr < 0.050 mg/L after SWRCB rescinded the CrVI MCL in 2017.

[2] One upper aquifer monitoring well in a fringe basin exceeded the threshold.

ES.2.2. Surface Water – Groundwater Interaction

Ongoing monitoring and management by Zone 7 have supported the maintenance of steady groundwater levels in the Springtown Alkali Sink area, indicating no significant surface water depletion since the late 1970s. Results for 2019 WY indicate that groundwater levels continue to be above the thresholds defined in the Alternative GSP. Zone 7's ongoing Surface Water-Groundwater Interaction Monitoring Program and results for the 2019 WY are described in *Section 5, Surface Water-Groundwater Interaction*.

ES.2.3. Groundwater Levels

Zone 7's Groundwater Elevation Monitoring Program includes the measurement of groundwater levels in monitoring and production wells to confirm that management objectives are met, to assess groundwater supplies, and to define any new management objectives needed to achieve sustainability. The program focuses on the Main Basin, where groundwater is pumped for municipal uses. However, water levels are also measured in most of the Fringe Management Areas.

Groundwater levels for the 2019 WY followed a typical historical seasonal pattern: rising in the beginning of the water year with rainfall recharge and reduced pumping, levelling off in late spring, and then dropping during the second half of the water year as groundwater demand increased. Compared to the levels at the end of the 2018 WY, groundwater elevations generally varied little in the western portion of the Main Basin and rose in some areas of the eastern portion of the Basin. In general, groundwater elevations remained considerably above the threshold elevations (historic lows).

Upper Aquifer water levels in the Mocho II Subbasin rose up to about 21 feet from the 2018 WY because of Zone 7's renewed stream recharge along the Arroyo Mocho. Groundwater levels in the Fringe Management Areas (which only have an Upper Aquifer) stayed relatively constant throughout 2019 WY, varying generally by less than approximately 5 ft.

At the end of the water year, groundwater levels in the vicinity of the Bernal Subarea were more than 120 ft above the historic low. In the Amador Subarea, levels were generally 40–100 ft above the historic lows except in the immediate vicinity of two mining excavations that were being dewatered during the water year. Over the majority of the Mocho II Subarea, the end-of-year groundwater levels were 90–150 ft above historical lows.

Water levels in the immediate vicinity of Lake E (mining area) have been below the historic low water level of 215 ft mean sea level (msl) since 2012, with no observed undesirable results. The water levels are drawn down in that area due to dewatering by the quarry operator for mining activities. During the 2019 WY, water levels in the area of Lake E were 35 ft below the historic low. Zone 7 continues to monitor the localized impacts of this use for any potential undesirable results.

Section 6, Groundwater Elevations, further describes Groundwater Elevation Monitoring Program and results for the 2019 WY.

ES.2.4. Groundwater Quality

Groundwater quality is an important factor in achieving and maintaining sustainable groundwater resources. The main purpose of monitoring groundwater quality is to assure that remediation of past groundwater degradation is proceeding, and that no new degradation has occurred or is currently taking place. Zone 7 maintains a robust monitoring network of wells for annual sampling and reporting. Each well in the program is monitored and/or sampled to fulfill one or more specific objectives. The groundwater monitoring program conducts annual sampling and analysis for inorganic constituents of concern for meeting the Livermore Basin groundwater quality objectives. The four main constituents of concern that are monitored and have set minimum thresholds are total dissolved solids (TDS), nitrate, boron, and chromium (Cr). In addition, per- and polyfluoroalkyl substances (PFAS) were added to the list of analytes for all municipal supply wells and select monitoring wells in the 2019 WY. Zone 7 also has programs that review permits, correspondence, and monitoring reports required by other agencies related to contamination and nutrient loads (see *ES 3.1, Water Quality Sustainability*). Overall, there were no significant groundwater quality changes relative to the minimum thresholds encountered during the 2019 WY. A brief summary of the results of each of these constituents for the 2019 WY are provided below.

TDS

Many of the municipal supply wells in the Pleasanton area produced water having TDS concentrations greater than the minimum threshold of 500 milligrams per liter (mg/L) during 2019 WY. For the 2019 WY, the highest TDS concentration in Zone 7 wells was detected in samples collected from the Mocho wellfield (962 mg/L in Mocho 4) and a monitoring well located central to four active wellfields used for municipal and public supply (921 mg/L in 3S/1E 17B 4). These concentrations are down from the 2018 WY when TDS was detected at over 1,000 mg/L in these wells. Zone 7 used its Mocho Groundwater Demineralization Plant (MGDP) to help reduce the TDS in delivered water in the 2019 WY. Other planned corrective actions and strategies are described in *Section 5.3.3.2, Salt Management Strategy of the Alternative GSP*.

Nitrates

In the Lower Aquifer, nitrate was only detected above the minimum threshold in one Area of Concern (AOC), the Buena Vista AOC, during the 2019 WY. Nitrate concentrations exceeded the minimum threshold in two monitoring wells (10.2 mg/L in 3S/2E 5N 1 and 10.0 mg/L in 3S/2E 15E 2) and one municipal supply well (11.0 mg/L in CWS 19). The nitrate plumes appear to be stable and will continue to be monitored.

Boron

Boron has been detected above the minimum threshold of 1.4 mg/L in a handful of lower aquifer monitoring wells in the past and again in the 2019 WY. Boron was detected at slightly above 3.0 mg/L in monitoring well 3S/1E 17D11 in the Hopyard Wellfield (compared to 2.8 mg/L in the 2018 WY). Boron has never been detected above 1 mg/L in the Hopyard municipal supply wells.

Chromium

The minimum threshold for total Cr in groundwater is < 0.050 mg/L which matches the State's MCL. No total Cr detections exceeded this threshold in any municipal supply wells or lower aquifer monitoring wells in 2019 WY. Total Cr above 0.050 mg/L was detected in one upper aquifer monitoring well (0.063 mg/L in monitoring well 3S/2E 12C 4) located in the Fringe Subarea-Northeast. This is consistent with previous years.

PFAS

PFAS are a large group of human-made substances that do not occur naturally in the environment and are classified by the Environmental Protection Agency (EPA) as "contaminants of emerging concern". While there are no current federal or California State limits (e.g., Maximum Contaminant Levels [MCLs]) for any PFAS compounds, in December 2019, the EPA published draft screening levels of 40 parts per trillion (ppt) and Preliminary Remediation goals (PRGs) of 70 ppt for PFOS and/or PFOA (combined or individually) for groundwater that is a current or potential source of drinking water. In addition to the California State Water Resources Control Board Division of Drinking Water (DDW)-required quarterly monitoring of the municipal wells, Zone 7 sampled and tested several other monitoring program wells for PFAS to determine if PFAS contamination is widespread. Only one of Zone 7's municipal wells, Mocho Well No. 1 (i.e., 3S/1E 9M 2), had PFOS concentrations (78 to 90 ppt) that exceeded DDW's recommended Response Level of 70 ppt. Several monitoring wells also had exceedances and additional testing is underway.

More detailed results of Zone 7's Groundwater Quality Monitoring Program can be found in *Section 7, Groundwater Quality*. A description of Zone 7's management actions regarding groundwater basin quality can be found in *Section 13, Water Quality Sustainability*.

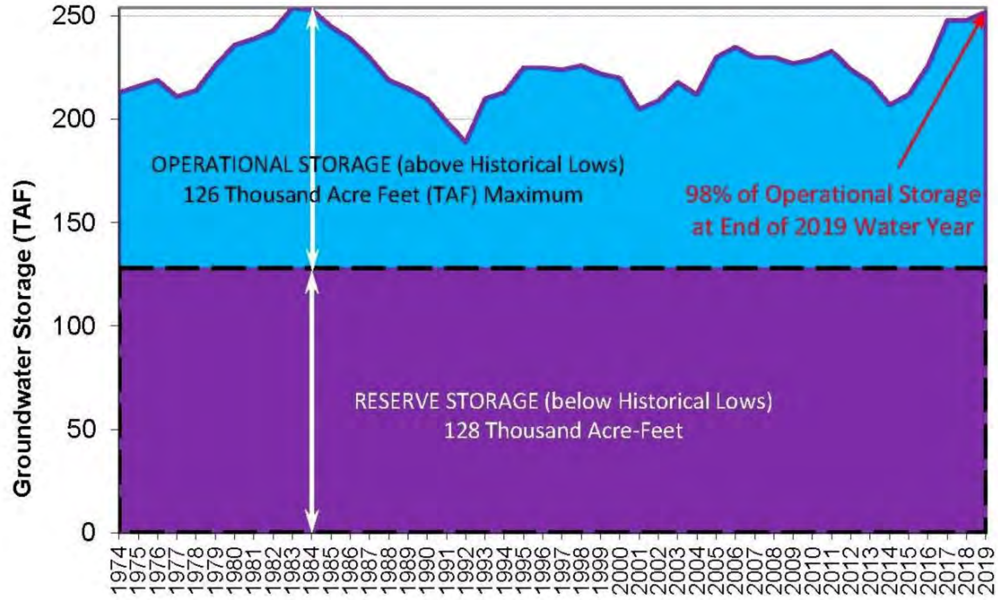
ES.2.5. Subsidence

Up through the 2018 WY, Zone 7 contracted with a licensed land surveyor to measure the land surface elevations of approximately 40 benchmarks that extended from bedrock outside of the Main Basin to the vicinity of Zone 7's production wellfields. In 2016, Zone 7 contracted with TRE Canada, Inc. (TRE) to evaluate Interferometric Synthetic Aperture Radar (InSAR) as an alternative to land surveying for subsidence monitoring. Starting in 2019, Zone 7 is now using InSAR instead of the land surveys for analyzing land subsidence. For the 2019 WY, Zone 7 contracted with TRE Altamira to acquire satellite data collected between the 2016 WY and the 2019 WY to perform an InSAR study for the Livermore Valley. For this study, TRE increased the coverage area to include most of the Livermore Valley Groundwater Basin area, including the entire Main Basin and most of the Fridge and Upland Areas. The study indicated that there continues to be no inelastic (permanent) deformation between the 2016 and 2019 water years; just seasonal and cyclical surface elevation fluctuations that correlate with groundwater elevation fluctuations. These "elastic" fluctuations generally have been + or - 0.07 ft per cycle; and less than 0.03 ft of net change during the 2019 WY. The results are presented in *Section 8, Land Surface Elevation*.

ES.2.6. Groundwater Storage

Zone 7 uses two methods for calculating groundwater storage in the Main Basin: The Groundwater Elevation (GWE) Method and the Hydrologic Inventory (HI) Method. Storage volumes from the two methods are averaged to estimate the total storage of the Main Basin at the end of the water year (see *Section 2.4.1 of the Alternative GSP*). *Section 11*, *Groundwater Storage* presents the storage volume for the 2019 WY and shows an overall increase of 4.2 thousand acre-feet (TAF) between the end of the 2018 WY and the end of the 2019 WY. Operational groundwater storage at the end of 2019 WY was 123.8 TAF, which is about 98% of the estimated historical high operational storage (*Figure ES-C*). The minimum threshold for groundwater storage is shown as the line between Reserve Storage and Operational Storage in *Figure ES-C.* There were no undesirable results for groundwater storage in the 2019 WY.

Figure ES-C: Operational Storage in Main Basin Management Area



ES.3 Project and Management Action Overview

Zone 7 is currently implementing a variety of programs to assess, manage, monitor, and protect groundwater supplies. *Section 12, Groundwater Supply Sustainability* and *Section 13, Water Quality Sustainability* provide details on the key programs Zone 7 managed and implemented during 2019 WY.

ES.3.1. Groundwater Supply Sustainability

To achieve sustainable groundwater levels, Zone 7 carefully manages all available water supplies, including imported surface water, local surface water, groundwater, and recycled water. During 2019 WY, Zone 7 imported 30,400 acre-feet (AF) of water to meet potable uses and continued to pursue efforts to strengthen supply reliability of imported water and reduce demand through continued promotion of local conservation efforts. Zone 7 also continued to manage groundwater through monitoring natural recharge and demand, limiting excess groundwater pumping by retailers through the use of quotas as well as artificial recharge and adjustments to Zone 7 groundwater pumping. In addition, Zone 7 carefully monitors a series of former quarry lakes, known as the Chain of Lakes (COL), for water storage and groundwater replenishment. Zone 7 was part of a joint effort by the Tri-Valley water agencies, studying the technical feasibility of potable reuse, or purified recycled water, to enhance long-term water supply reliability. In May 2018, the Tri-Valley water agencies completed the Joint Tri-Valley Potable Reuse Technical Feasibility Study. The results showed that potable reuse was technically feasible. The next steps that were identified include a regional water demand study, regional water supply updates, and technical studies regarding the COL and groundwater injection well siting. These, and Zone 7's other groundwater supply management actions, are discussed in *Section 12, Groundwater Supply Sustainability.*

ES.3.2. Water Quality Sustainability

Preserving or improving groundwater quality is a key component of sustainable groundwater management. Zone 7 administers four key programs to ensure the protection of groundwater quality: the Water Well Ordinance Program, the Toxic Site Surveillance Program, the Salt Management Plan (SMP), and the Nutrient Management Plan (NMP). During the 2019 WY, 139 drilling permits were issued with groundwater quality protection conditions, and 83% of the permitted work was physically inspected by Zone 7 permit compliance staff. Four new soil and groundwater contamination cases were identified and are being actively monitored and addressed along with 40 other active contamination cases within Zone 7's service area. Eight of these cases are being considered for closure.

Zone 7 also continued to implement its SMP and NMP to monitor, assess, reduce, and manage salt and nutrient loading. As part of its strategy to manage salt loading, Zone 7 exported 1,873 tons of salt from the Valley via the MGDP. For nutrient management, Zone 7 has a role in managing On-Site Wastewater Treatment System (OWTS) densities within the Livermore Valley Groundwater Basin and watershed, mainly through the approval process for non-residential (e.g. commercial and industrial) OWTS use authorizations. Additional updates or changes made to these programs during the 2019 WY are discussed in *Section 13, Water Quality Sustainability*.

1 Agency and Basin Information

1.1 Introduction

Zone 7 has been generating annual groundwater reports and submitting them to the California Department of Water Resources (DWR) since the 2005 Water Year (WY). This *Annual Report for the Sustainable Groundwater Management Program 2019 Water Year Livermore Valley Groundwater Basin* (2019 Annual Report) is prepared in compliance with Title 23, California Code of Regulations Section 356, Annual Report and Periodic Evaluations by the Agency. The results for each of the water resource monitoring, evaluation, and management programs are summarized in the Executive Summary, while the details are provided in the main report sections. In an effort to keep this report concise, historical and reference materials included in the *Alternative Groundwater Sustainability Plan for the Livermore Valley Groundwater Basin* (Alternative GSP) (*Zone 7, 2016d*) have not been repeated here.

All of the data included in this report are conveyed based on the 2019 WY (i.e., October 1, 2018 through September 30, 2019); however, due to other reporting obligations, some information in this report (e.g., retailer groundwater pumping quota in *Section 11, Groundwater Storage)* is compiled and reported on a calendar year (CY) basis (i.e., January 1 through December 31, 2019).

1.2 Basin Management

Zone 7 Water Agency (Zone 7) provides water services in addition to flood protection, and has managed imported and local surface and groundwater resources for beneficial uses in the Livermore Valley Groundwater Basin (DWR Basin 2-10) for more than 50 years. In 2005, Zone 7 adopted a Groundwater Management Plan (GWMP), which documented ongoing policies and programs for managing groundwater to support existing and beneficial uses in the valley (*Zone 7, 2005a*). This was amended in June 2015 with the adoption of the Nutrient Management Plan (NMP) (*Zone 7, 2015b*). Consistent with its management responsibilities, duties, and powers, Zone 7 is designated in the 2014 Sustainable Groundwater Management Act (SGMA) as the exclusive Groundwater Sustainability Agency (GSA) within its boundaries (*Figure 1-1*).

In December 2016, Zone 7 submitted the Alternative GSP to DWR in compliance with SGMA. The Alternative GSP was approved by DWR in July 2019. The first Five-Year Update to the Alternative Groundwater Sustainability Plan for Livermore Valley Groundwater Basin is due in January 2022.

In November 2019, Zone 7 submitted a grant proposal entitled *Five Year Update: 2022 Alternative Groundwater Sustainability Plan for Livermore Valley Groundwater Basin* for Round 3 of the Sustainable Groundwater Management Planning Grant program funded by Proposition 68 and Proposition 1. The overarching goal of this grant project is to prepare a Five-Year Update for the 2016 Alternative GSP that addresses the DWR recommendations on the original Alternative GSP and addresses data needs and analyses identified by Zone 7 staff. The proposed work includes expanding Zone 7's cross-section network, extending the existing Areal Recharge Spreadsheet Model to Fringe and Upland Management Areas, further studying per- and polyfluoroalkyl substances (PFAS) as a constituent of concern, developing interferometric synthetic aperture radar (InSAR) techniques to monitor subsidence over a larger portion of the groundwater basin, investigating additional existing groundwater dependent ecosystems, and evaluating management actions taken to reduce high nitrate concentrations in key areas. The grant request is for $500,000. Specific details on the Grant Program can be found at: https://water.ca.gov/Work-With-Us/Grants-And-Loans/Sustainable-Groundwater

1.3 Zone 7 Service Area

The Zone 7 water service area (*Figure 1-1*) is located about 40 miles southeast of San Francisco, and encompasses an area of approximately 425 square miles of the eastern portion of Alameda County, including the Livermore-Amador Valley, Sunol Valley, and portions of the Diablo Range. Zone 7 also serves a portion of Contra Costa County (Dougherty Valley in San Ramon) through an out-of-service-area agreement with Dublin San Ramon Service District (DSRSD).

As the water wholesaler, Zone 7 supplies treated State Water Project (SWP) water to four local retail water supply agencies (*Figure 1-2*).

- California Water Service —Livermore District (CWS)
- Dublin San Ramon Services District (DSRSD)
- City of Livermore (Livermore)
- City of Pleasanton (Pleasanton)

1.4 Zone 7 Programs

Zone 7 is the lead agency for many water resource management programs and coordinates with groundwater resource programs of others in the Basin. Zone 7 programs include the following:

- Monitoring groundwater using long-term well measurements coupled with a detailed groundwater basin numerical model;
- Monitoring surface water interacting with groundwater using stream flow measurements and surface water elevations in quarry-made lakes;
- Monitoring water quality through annual surface water and groundwater sampling for salt and nutrient parameters;
- Monitoring land surface elevation changes;
- Importing and banking surface water to meet current and future demands;
- Implementing a conjunctive use program that maximizes use of the storage capacity of the groundwater basin, including long-term implementation of the Chain of Lakes (COLs) Program;

- Managing groundwater pumping for sustainability;
- Maintaining groundwater storage volumes with natural and imported supplies for long-term sustainability;
- Promoting sound recycled water use; and
- Planning for future supply demands.

Through these and other programs, Zone 7 has sustainably managed the groundwater basin to avoid undesirable results. The historical groundwater data show that the Basin has been operated sustainably for over 45 years, including through three major droughts. Most of the datasets discussed in this annual report date back to 1974, allowing a comprehensive, long-term assessment of Zone 7's basin management.

The history of Zone 7 Water Agency, including its statutory responsibilities and its ongoing coordination with other local agencies in the Basin, is described in *Section 1.2*, *Zone 7 Water Agency* of the Alternative GSP (*Zone 7, 2016d*).

1.5 Groundwater Management Ordinances

In 2017, Zone 7 adopted its Sustainable Groundwater Management Ordinance (Ordinance) to enhance existing sustainable management programs for the local groundwater basin. The Ordinance recognizes groundwater as an essential resource for municipal, industrial, and domestic uses, as well as agricultural production, and sets provisions for groundwater protection within Eastern Alameda County. Nothing in the ordinance determines or alters water rights, groundwater rights, or existing county ordinances. The Ordinance is discussed in more detail in *Section 12.8* of this report.

Zone 7 administers the drilling/well permit program within its service area pursuant to a Memorandum of Understanding (MOU) with Alameda County and ordinances adopted by the Cities of Dublin, Pleasanton, and Livermore. As a result, any planned new well construction, soil-boring construction, or well destruction must be permitted by Zone 7 before the work is started. Additionally, all unused or abandoned wells must be properly destroyed; or, if there are plans to use the well in the future, a signed statement of intent to use must be filed at Zone 7. The permits issued during the 2019 Water Year are discussed in *Section 13.2* of this report.

In 1982, the Zone 7 Board of Directors adopted the *Wastewater Management Plan (WWMP) for the Unsewered, Unincorporated Area of Alameda Creek Watershed above Niles* (*Zone 7, 1982*) and its recommended policies (Resolution No. 1037). A separate policy was established in 1985 that prohibits the use of septic tanks for new developments zoned for commercial or industrial uses (Resolution 1165). Whereas Alameda County Department of Environmental Health (ACDEH) administers the County Onsite Wastewater Treatment Systems (OWTS) Ordinance, Zone 7 approval is explicitly required for nonresidential uses within the Upper Alameda Creek Watershed (Resolution 1165). The nonresidential OWTS applications submitted to Zone 7 during the 2019 WY are discussed in *Section 13.5.3* of this report.

1.6 Plan Area

The Plan Area (*Figure 1-1*) is the entire Livermore Valley Groundwater Basin (DWR Basin No. 2-10), encompassing approximately 69,600 acres (109 square miles) in Alameda and Contra Costa counties. The Plan Area is referred to as the Basin in this document. While the Alameda County portion of the Basin lies wholly within Zone 7's Service Area, the northwestern portion of the Basin extends beyond the Zone 7 Service Area into Contra Costa County. In 2016, Zone 7 entered into a MOU with East Bay Municipal Utilities District (EBMUD), City of San Ramon, and DSRSD under which Zone 7 will serve as the GSA for the Contra Costa portion of the Basin.

Adjacent groundwater basins are the San Ramon Valley (Basin No. 2-07), a very-low priority basin that extends to the northwest in Contra Costa County, and the Sunol Valley (Basin No. 2-11), which is also a very-low priority basin to the southwest of the Livermore Valley Groundwater Basin. A small portion of the Tracy Subbasin (Basin No. 5-22.15), a medium priority basin, is located within the Zone 7 service area. This portion of the Tracy Subbasin is managed by Byron-Bethany Irrigation District (BBID) under a MOU between BBID and Zone 7 dated April 26, 2017.

Zone 7 used the updated (2016) DWR Bulletin 118 boundary for the Livermore Valley Groundwater Basin in its Alternative GSP and this 2019 Annual Report. This boundary differs slightly from the basin boundary used in the original GWMP and earlier annual reports. Details regarding the plan area, including surface and well water supplies, land use, general plans, and well permitting are provided in *Section 1.3, Plan Area*, of the Alternative GSP.

1.7 Basin and Hydrogeologic Setting

1.7.1 Basin Management Areas

The Livermore Valley Groundwater Basin is an inland alluvial basin underlying the east-west trending Livermore-Amador Valley (Valley) in northeastern Alameda County. The Valley floor covers about 42,000 acres, extends approximately 14 miles in an east-west direction, and varies from 3 to 6 miles in width. It is surrounded primarily by north-south trending faults and the hills of the Diablo Range. The Livermore Valley Groundwater Basin is located in the Valley floor and extends south and north into the uplands of Pleasanton and Livermore. Groundwater generally flows from the southeast and east to the west, toward the municipal wellfields in the West Amador and Bernal Subareas. For more detailed information about the history of the Livermore Valley Groundwater Basin, and additional details regarding the physical setting, climate, streams, groundwater-dependent ecosystems (GDEs), soils, and geology, see *Section 2, Basin Setting,* of the Alternative GSP.

For purposes of groundwater management, the Basin has been divided into three management areas based on varying geologic, hydrogeologic, and groundwater conditions. These are the Main Basin, Fringe Subareas, and Upland Areas shown in *Figure 1-1* and listed in *Table 1-A*.

Table 1-A: Basin Management Areas

Basin	Area	General Description
Main Basin	19,809 acres	Central portion of Valley floor
Fringe Subareas	21,956 acres	Edges of Valley floor
Upland Areas	27,778 acres	Gently-sloping Valley wall
Total	69,557 acres	

1.7.2 Main Basin

The Main Basin[1] covers almost 20,000 acres and contains the thickest alluvial deposits, the highest-yielding aquifers, and the best-quality groundwater within the Basin.

The Main Basin is hydraulically connected to the fringe areas through the shallow alluvium; however, subsurface inflow from the Fringe Subareas into the deeper portions of the Main Basin is considered to be minor due to subsurface geologic barriers believed to be either faulting or an alluvium/bedrock contact. The deeper aquifers of the Main Basin are primarily recharged by rainfall and surface waters where they outcrop in the Uplands Areas and through vertical migration of groundwater within the Main Basin itself. The Main Basin aquifers generally have the highest transmissivity and the best quality groundwater. All of the Valley's municipal supply wells are completed in the "Lower" Main Basin Aquifer Zone (described in *Section 1.8.3*), and some include the deeper Livermore Formation.

1.7.3 Fringe Management Areas and Subareas

The Fringe Management Areas are defined by water-bearing areas outside of the Main Basin that consist of thinner deposits of recent alluvium underlain by relatively shallow bedrock. These areas are also characterized by lower-permeability aquifers overlain by clay-rich soils. Because the alluvium is generally thinner, the primary hydraulic connection between the Fringe Management Areas and the Main Basin Management Area is through the Upper Aquifer. In general, lower alluvium aquifer units in the Main Basin do not extend into the Fringe Management Area. Domestic wells located in the Fringe Management Area are typically completed in the deeper aquifers of the Livermore Formation.

Areas of significant subsurface inflows through the Upper Aquifer from the Fringe Management Areas into the Main Basin Management Area occur in the following locations.

- Along the northern and eastern boundaries between these two areas, currently estimated at about 900 AF per year (AF/yr), and

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[1] Prior to 1985, this area was called the central basin; for the past 30 years the term *Main Basin* has been used.

- Along the northwestern boundary (at the Bernal Subarea) of the Main Basin estimated to be about 100 AF/yr.

1.7.4 Upland Management Areas

The Upland Management Areas are primarily defined by areas where the recent alluvium is absent but the Livermore Formation and other older water-bearing bedrock units are exposed. These consolidated units are more resistant to erosion and form low, rolling hills around the more-gently sloping alluvial valley. Most of the precipitation that falls on the Upland Management Areas leaves as runoff and contributes to streams in both the Fringe and Main Basin Management Areas. A small amount of deep percolation of precipitation in the Upland Management Areas may also contribute to the Main Basin's subsurface inflow. The northern portion of the Upland Management Areas is called the Tassajara Uplands, and the southern and eastern portions are called the Livermore Uplands (*Figure 1-1*). Neither of these upland areas have been further divided into subareas because of the absence of significant groundwater pumping and the lack of need for localized groundwater management actions. The long history of groundwater levels in the few domestic and livestock supply wells present in the Upland Management Areas demonstrate that current uses/withdrawals are currently sustainable.

1.8 Aquifer Zones

1.8.1 Introduction

Although multiple aquifers have been identified in the Main Basin alluvium, wells have been classified generally as being completed in either the Upper or Lower Aquifer Zone. In the Main Basin, the two aquifer zones are generally separated by a relatively continuous silty clay aquitard, which is up to 50 feet (ft) thick and occurs between 80 and 175 ft below ground surface (bgs). Additional details as well as a stratigraphic cross section of the Main Basin Upper and Lower Aquifers are provided in *Section 2.2.3, Basin Hydrostratigraphy* of the Alternative GSP. Such differentiation is not applicable to the Fringe and Upland Management Areas.

1.8.2 Upper Aquifer Zone

The Upper Aquifer consists of alluvial materials, primarily including sandy gravel and clayey or silty gravels. These gravels are usually encountered underneath a confining surficial clay or silty clay layer, typically 5 to 70 ft bgs in the west and exposed at the surface in the east. They are present in the Main Basin and Fringe Management Areas. The base of the Upper Aquifer Zone varies from 80 to 175 ft bgs in the Main Basin and 10 to 70 ft bgs in the Fringe Management Area (*DWR, 1974*). Groundwater in this zone is generally unconfined; however, when water levels are high, portions of the Upper Aquifer Zone in the western portion of the Main Basin can become confined.

1.8.3 Lower Aquifer Zone

All aquifers encountered below the confining aquitard in the central portions of the Main Basin are known collectively as the Lower Aquifer Zone. The Lower Aquifer materials consist of coarse-grained, water-bearing units interbedded with relatively low-permeability, fine-grained units. The Lower Aquifer Zone derives most of its water from the Upper Aquifer Zone through the leaky aquitard(s) when piezometric heads in the upper zone are greater than those in the lower zone. Some replenishment may also come from the water-bearing members of the Livermore Formation that are in contact with the Lower Aquifer Zone.

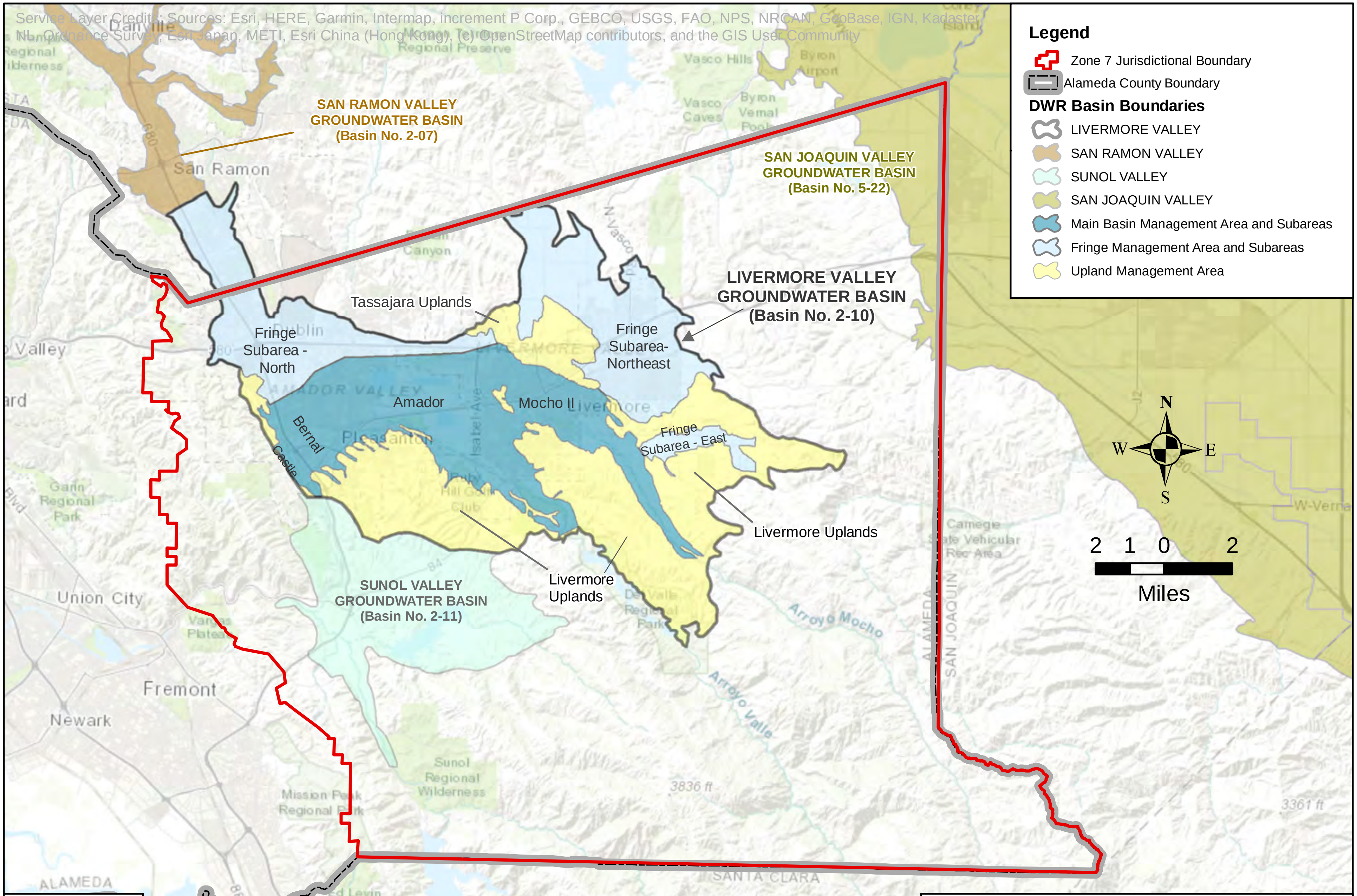
1.9 Groundwater Characteristics

The northern extent of the Livermore Valley Groundwater Basin is dominated by a sodium- rich water, while much of the western part of the Basin near Pleasanton has a magnesium-sodium characteristic (i.e., both magnesium and sodium are dominant cations). The area along the eastern portion of the Basin, beneath the City of Livermore, has magnesium as the predominant cation. Most groundwater in the Main Basin, where all of the Valley's municipal supply wells are completed, is hard or very hard (i.e., calcium carbonate [$CaCO_3$] greater than 120 milligrams per liter [mg/L]). Groundwater tends to be the hardest in the western portion of the Main Basin. Groundwater of the Lower Aquifer Zone generally has lower total dissolved solids (TDS) than that of the Upper Aquifer Zone; however, both aquifer zones are designated for potable use in the Regional Water Quality Control Board Water Quality Control (RWQCB) San Francisco Bay Basin (Region 2) Water Quality Control Plan (Basin Plan) (*RWQCB, 2011*). For more information on the characteristics of the groundwater basin see *Section 1.3.6, Beneficial Uses* of the Alternative GSP.

1.10 Monitoring Networks and Modeling

Zone 7 has developed and implemented an extensive basin-wide monitoring network that has expanded and improved over time. The overall objective of the monitoring network is to provide sufficient information to allow tracking of groundwater conditions to meet the sustainability goal of the Basin, including the prevention of undesirable results. The monitoring network includes six distinct monitoring programs: 1. Precipitation and Evaporation Monitoring, 2. Surface Water Monitoring, 3. Groundwater Elevation Monitoring, 4. Groundwater Quality Monitoring, 5. Land Surface Elevation Monitoring, and 6. Wastewater and Recycled Water Monitoring. Zone 7 uses a proprietary data management system to store and analyze data gathered in these programs. Details regarding the monitoring programs are provided in *Section 4, Monitoring Networks,* of the Alternative GSP.

Zone 7 also maintains a numerical groundwater model of the basin for analyzing various groundwater basin management actions. This MODFLOW model uses Groundwater Vistas and various MODFLOW packages (e.g., NWT, MT3D) to perform the modeling calculations. The active part of the groundwater model encompasses only the Main and North Fringe Management Areas of the Basin. Additional information regarding the groundwater model is provided in *Section 2.6, Groundwater Model*, of the Alternative GSP. Updates made to the monitoring network and modeling during the 2019 WY are provided in subsequent sections of this 2019 Annual Report.

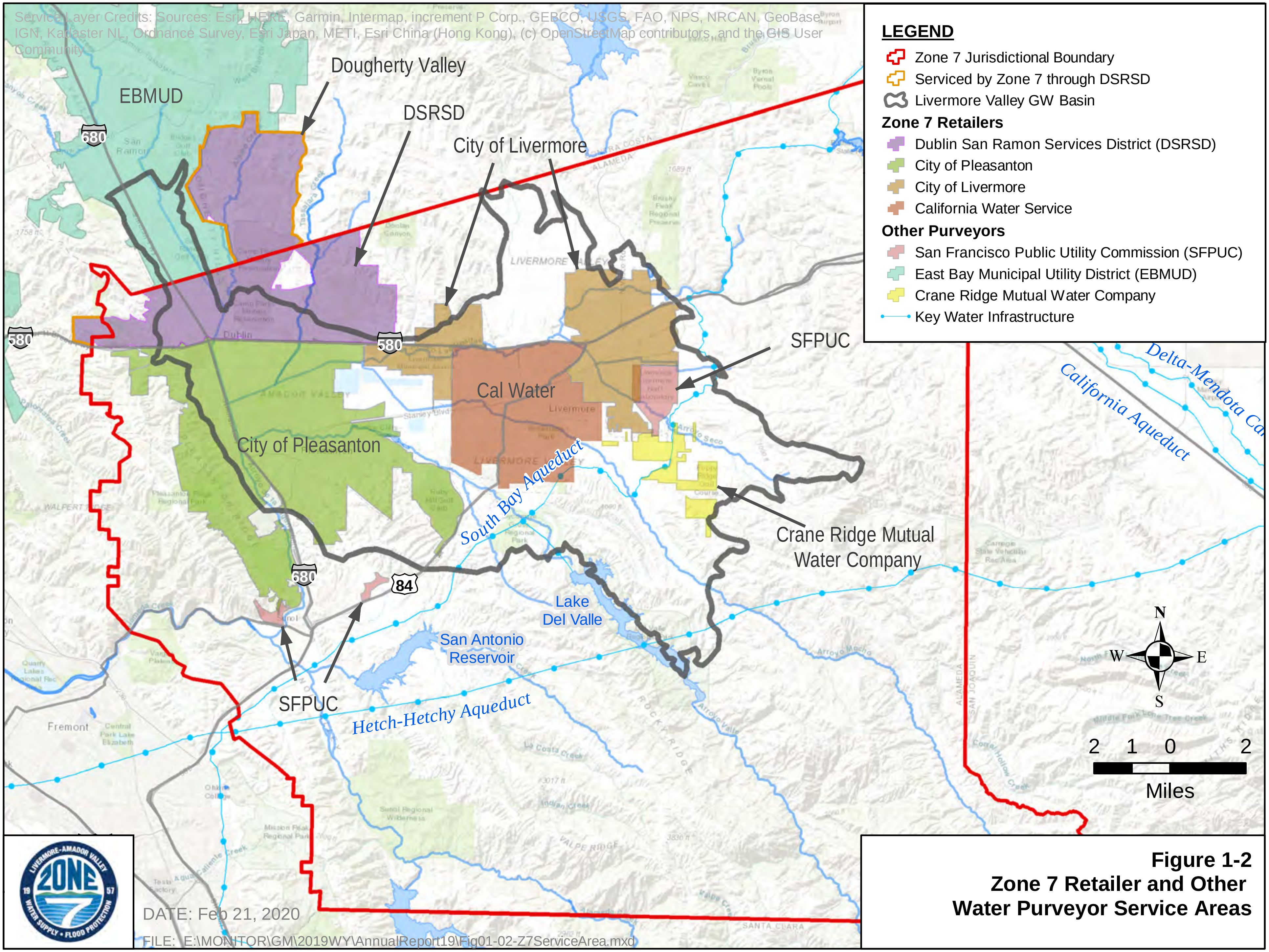


Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

DATE: Jan 24, 2020

FILE: E:\MONITOR\GM\2019WY\AnnualReport19\Fig01-01-GW Basins and Z7 Service Area.mxd

Figure 1-1
Groundwater Basins
Within Zone 7 Service Area



DATE: Feb 21, 2020

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Figure 1-2
Zone 7 Retailer and Other Water Purveyor Service Areas

2 Precipitation and Evaporation

2.1 Program Description

2.1.1 Monitoring Network

Zone 7 uses a network of climatological stations (see *Figure 2-1* and *Table 2-1*) to provide high-quality data for water inventory calculation and management decisions, including both daily record stations and 15-minute recorder stations. Zone 7's climatological monitoring program also contains both reference evapotranspiration (ETo) and pan evaporation stations to determine water losses to the atmosphere. Station 191 California Irrigation Management Information System (CIMIS) is a reference ETo station which estimates the ETo value of the water used by a well-watered, full-cover grass surface. The pan evaporation stations at Lake Del Valle (LDV) and Livermore Water Reclamation Plant (LWRP) measure evaporation directly. This data is then converted to ETo to use with the CIMIS readings to calculate evaporation from the mining area ponds. The CIMIS Station's ETo is also used as part of Zone 7's Water Conservation program to help regulate weather-based irrigation controllers (WBICs, also known as "SMART" Controllers).

For more detailed information on Zone 7's overall Climatological Monitoring Program see *Section 4.2, Climate Monitoring* of the Alternative GSP.

2.1.2 Program Changes for the Water Year

Five rain gauges were added into the program in the 2019 water year:

- Arroyo Valle below Lang Canyon (AVBLC)
- Line G-1 at Dublin Boulevard (CM_G1_DB)
- Line J-1 below Dublin Boulevard (CM_LJ1_BDB)
- Sunol Glen Elementary School (CM_SGE)
- Tassajara Creek below I-580 (CM_TC_BI580)

However, not all of the new gauges were operational at the start of the new water year; therefore, some of the gauges are missing three or four months of rain totals. The gauges at Line J-1 and Tassajara Creek data did not come on-line until January 2019, whereas the gauge at Line G-1 did not start collecting data until February of 2019. The gauges at AVBLC and Sunol Glen Elementary School had been collecting data before 2019 but were not part of the Precipitation and Evaporation Program until the 2019 WY.

2.2 Results for the 2019 Water Year

In the 2019 WY, total rainfall on the watershed was 116% of average (*Table 2-2*). Rainfall totals from individual stations ranged from 13.60 inches (105% of average) at Patterson Pass Water Treatment Plant

(Station 24) to 39.94 inches (164% of average) at Lick Observatory (Station 44) in Santa Clara County. At Station 15e in Livermore, the station with the longest historical record (1871- 2019) (*Table 2-3* and *Figure 2-2*), rainfall totaled 17.06 inches (117% of average) in the 2019 WY.

ETo for the 2019 WY was 46.59 inches (108% of normal) at the LDV Station; 51.00 inches (100% of normal) at the CIMIS Station 191; and 51.91 inches (112% of normal) at the LWRP Station (*Table 2-4*).

Additional information is provided in the following tables.

- *Table 2-1*, *Table of Climatological Stations, 2019 WY*
- *Table 2-2, Monthly Precipitation Data, 2019 WY*
- *Table 2-3, Historical Monthly Precipitation (inches), Monitoring Station 15E, Livermore, 1871 to 2019 WY*
- *Table 2-4, Monthly Evapotranspiration Data, 2019 WY*
- *Table 2-5, Historical Monthly Pan Evaporation (inches), Monitoring Station Lake Del Valle, Livermore*

TABLE 2-1
TABLE OF CLIMATOLOGICAL STATIONS
2019 WATER YEAR

PRECIPITATION NETWORK

SITE	COMPUTER SITE ID	STATION NAME	LOCATION	OBSERVER	ELEV-ATION	STATION ESTABLISHED	15 MIN RECORD	MEAN ANNUAL (IN)
15E	CM_STA 15E	NOAA Livermore	Wellingham Drive, Livermore	MR. RON HAFNER	480	1871	-	14.52
17	CM_STA 17	Del Valle Plant	601 East Vallecitos Rd, Livermore	ZONE 7	640	1974	1978 to Present	16.14
24	CM_STA 24	Patterson Plant	Patterson Pass Rd, Livermore	ZONE 7	680	1963	1969 to Present	12.93
34	CM_STA 34	Mocho Wellfield	Santa Rita Rd, Pleasanton	ZONE 7	340	1968	1970 to 2010	18.08
44	CM_STA 44	Mt Hamilton	Lick Observatory, Mt. Hamilton	LICK OBSERVATORY	4209	1881	-	24.41
101	CM_STA 101	Tassajara	Camino Tassajara Rd, Danville	MRS. JOAN HANSEN	800	1912	-	18.65
170	CM_STA 170	Parkside	Parkside Drive, Pleasanton	ZONE 7	330	1986	1986 to 2005	20.60
191	CM_STA 191	CIMIS Station	Alameda County Fairgrounds Golf Course	DWR	335	2004	2004 to Present	17.44
ALTC	CM_STA ALTC	Altamont Creek	at ALTC_BD surface water station	ZONE 7	500	2015	2015 to Present	-
AMNL	CM_STA AMNL	Arroyo Mocho Near Liv	at AMNL surface water station	ZONE 7	750	2015	2015 to Present	-
AMP	CM_STA AMP	Arroyo Mocho Pleas	At AMP Surface Water Station	ZONE 7	335	2016	2016 to Present	-
AVBLC	CM_STA AVBLC	CM Site at AVBLC	at AVBLC surface water station	ALAMEDA COUNTY	757	2016	2016 to Present	-
LG1_DB	CM_STA LG1_DB	CM Site at Line G-1 at Dublin Blvd	Dublin Blvd and Scarlett Dr, Dublin	ZONE 7	336	1900	2019 to Present	-
LJ1_BDB	CM_STA LJ1_BDB	CM Site at Line J1 Below Dublin Blvd	Dublin Doulevard, Dublin	ZONE 7	332	2019	2019 to Present	-
NC	CM_STA NC	North Canyons Office	Zone 7's North Canyons building	ZONE 7	450	2015	2015 to Present	-
SGE	CM_STA SGE	CM Site at Sunol Glen Elementary	11601 Main St, Sunol	ZONE 7	253	2016	2016 to present	-
TC_BI580	CM_STA TC_BI580	CM Site at Tassajara Creek Below I580	Old Santa Rita Rd, Pleasanton	ZONE 7	342	2019	2019 to Present	-

EVAPORATION NETWORK

SITE	COMPUTER SITE ID	STATION NAME	LOCATION	OBSERVER	ELEV-ATION	STATION ESTABLISHED	15 MIN RECORD	MEAN ANNUAL (IN)
LDV-EV	CM_STA LDV-EV	Lake Del Valle	Arroyo Rd, Livermore	DWR	760	1969	-	43.07
LWRP-EV	CM_STA LWRP-EV	Livermore Water Reclamation Plant	Jack London Drive, Livermore	LWRP	410	1974	-	46.15
191-ETO	CM_STA 191-ETO	CIMIS Station	Alameda County Fairgrounds, Pleasanton	DWR	335	2004	-	51.22

* Stations LDV and LWRP record evaporation using pan evaporation equipment. ETo is derived using : ETo= Pan Evaporation x 0.6402

TABLE 2-2
MONTHLY PRECIPITATION DATA
2019 WATER YEAR

MONTHLY PRECIPITATION IN INCHES

	MONITORING STATION																	2019 Network	% Historic Network
	CM_STA 15E	CM_STA 17	CM_STA 24	CM_STA 34	CM_STA 44	CM_STA 101	CM_STA 170	CM_STA 191	CM_STA ALTC	CM_STA AMNL	CM_STA AMP	CM_STA AVBLC	CM_STA G1_DB	CM_STA LJ1_BDB	CM_STA NC	CM_STA SGE	CM_STA TC_BI580	Average	Average
	15E	**17**	**24**	**34**	**44**	**101**	**170**	**191**	**ALTC**	**AMNL**	**AMP**	**AVBLC^**	**LG1_DB**	**LJ1_BDB**	**NC**	**SGE**	**TC_BI580**		
OCT	0.18	0.02	0.20	0.23	0.11	0.10	0.03	0.24	0.64	0.10	0.12	0.13	NA	NA	0.22	0.06	NA	0.17	17.5%
NOV	1.64	1.01	1.47	2.16	6.25	2.06	2.82	2.16	1.44	1.21	1.78	2.30	NA	NA	1.46	3.07	NA	2.20	110.0%
DEC	1.54	1.24	1.62	2.06	3.10	2.46	2.27	1.98	1.51	1.31	1.49	2.44	NA	NA	1.28	2.06	NA	1.88	74.1%
JAN	2.66	2.58	1.61	4.14	5.78	2.46	4.93	3.96	2.20	2.53	3.68	4.99	NA	2.60	2.46	3.46	3.65	3.36	103.9%
FEB	6.31	7.00	5.48	7.65	11.57	7.73	9.32	7.95	5.64	6.24	6.85	10.18	6.70	8.09	5.04	6.79	6.53	7.36	189.5%
MAR	2.58	1.93	1.63	2.82	6.91	3.79	2.82	2.75	1.98	1.80	2.47	3.60	2.31	2.82	2.11	3.74	2.34	2.85	99.6%
APR	0.30	0.21	0.12	0.28	1.40	0.47	0.31	0.26	0.26	0.23	0.23	0.26	0.17	0.23	0.26	0.54	0.17	0.34	29.7%
MAY	1.63	1.33	1.40	1.52	4.73	2.20	2.07	1.73	1.43	1.39	1.37	1.83	1.64	1.95	1.36	2.31	1.44	1.84	219.7%
JUN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0%
JUL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0%
AUG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0%
SEP	0.22	0.32	0.07	0.11	0.09	0.38	0.11	0.11	0.12	0.18	0.07	0.72	0.07	0.11	0.11	0.30	0.07	0.19	138.8%
TOTAL	**17.06**	**15.64**	**13.60**	**20.97**	**39.94**	**21.65**	**24.68**	**21.14**	**15.22**	**14.99**	**18.06**	**26.45**	**10.89**	**15.80**	**14.30**	**22.33**	**14.20**	**20.18**	
% AVG	**117%**	**97%**	**105%**	**116%**	**164%**	**116%**	**120%**	**121%** *	**	**	**	**	**	**	**	**	**	**114%**	

*Average Rainfall for Station 191 calculated from data collected at the station from 2004 to present.

**Insufficient data for average calculation

^Data under review

DISTRIBUTION OF DAILY PRECIPITATION

Number of days with rainfall greater than reference

Rainfall	MONITORING STATION																	2019 Network
(inches)	**15**	**17**	**24**	**34**	**44**	**101**	**170**	**191**	**ALTC**	**AMNL**	**AMP**	**AVBLC**	**LG1_DB**	**LJ1_BDB**	**NC**	**SGE**	**TC_BI580**	**Average**
>Trace	77	74	67	69	72	79	78	74	80	77	75	91	44	51	65	92	58	72
>0.1	43	37	37	46	47	62	44	49	44	41	42	51	26	34	38	47	34	42
>0.5	10	10	7	12	13	28	17	13	7	7	10	14	7	10	7	15	6	11
>1	1	2	1	3	1	13	5	4	1	2	3	6	2	4	1	4	3	3
>2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 2-3
HISTORICAL MONTHLY PRECIPITATION
MONITORING STATION 15E, LIVERMORE (INCHES)
1871 to 2019 WATER YEARS

Water Year	OCTWY	NOVWY	DECWY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL OCT-SEP	TOTAL JULY-JUNE	% AVERAGE OCT-SEP
1871	NA	NA	NA	1.42	1.93	0.36	1.25	0.02	0.00	0.00	0.00	0.00	NA	NA	NA
1872	0.00	1.13	11.69	2.15	2.69	0.65	0.43	0.00	0.32	0.00	0.00	0.00	19.06	19.06	131%
1873	0.00	1.22	3.87	1.04	3.73	0.68	0.15	0.00	0.00	0.00	0.00	0.00	10.69	10.69	74%
1874	0.42	0.70	4.48	2.96	1.03	1.34	0.95	0.32	0.06	0.00	0.00	0.30	12.56	12.26	87%
1875	1.67	2.03	0.20	5.40	1.20	0.35	0.00	0.00	0.52	0.00	0.00	0.00	11.37	11.67	78%
1876	0.00	7.23	1.62	2.68	3.01	4.39	0.73	0.33	0.00	0.00	0.00	0.00	19.99	19.99	138%
1877	1.26	0.10	0.00	2.47	0.56	1.10	0.13	0.39	0.00	0.00	0.00	0.00	6.01	6.01	41%
1878	1.27	1.29	0.73	4.61	6.73	2.01	0.96	0.06	0.00	0.00	0.00	0.00	17.66	17.66	122%
1879	0.24	0.31	0.17	2.83	1.78	2.49	0.75	1.34	0.20	0.00	0.00	0.00	10.11	10.11	70%
1880	0.83	1.06	1.94	1.48	1.80	1.45	6.51	0.91	0.00	0.00	0.00	0.00	15.98	15.98	110%
1881	0.00	0.65	7.75	2.40	2.62	1.06	1.93	0.00	0.04	0.00	0.00	0.00	16.45	16.45	113%
1882	0.08	0.78	1.97	1.07	1.72	4.85	1.03	0.20	0.00	0.00	0.00	0.34	12.04	11.70	83%
1883	1.52	1.48	0.38	2.38	0.63	3.45	1.50	2.18	0.00	0.00	0.00	0.35	13.87	13.86	96%
1884	1.52	0.57	0.44	4.03	5.29	5.92	2.70	0.20	1.73	0.00	0.10	0.30	22.80	22.75	157%
1885	1.14	0.02	6.22	1.72	0.36	0.78	1.29	0.08	0.00	0.00	0.00	0.05	11.66	12.01	80%
1886	0.00	6.20	1.94	4.20	0.24	1.18	2.36	0.00	0.00	0.40	0.00	0.00	16.52	16.17	114%
1887	0.30	0.70	0.81	0.90	6.23	0.23	1.60	0.00	0.00	0.00	0.00	0.80	11.57	11.17	80%
1888	0.00	0.61	3.51	3.20	0.94	2.51	0.60	0.66	0.30	0.00	0.00	0.76	13.09	13.13	90%
1889	0.00	3.80	2.21	0.46	0.67	5.15	0.51	2.25	0.00	0.00	0.00	0.00	15.05	15.81	104%
1890	3.94	2.95	8.63	5.24	3.71	2.85	0.86	0.48	0.00	0.00	0.00	1.20	29.86	28.66	206%
1891	0.00	0.00	3.31	0.54	4.18	2.50	1.88	0.40	0.15	0.00	0.00	1.32	14.28	14.16	98%
1892	0.05	0.38	4.42	0.84	1.08	3.96	0.90	1.30	0.00	0.00	0.00	0.45	13.38	14.25	92%
1893	1.65	4.97	7.27	3.02	3.12	3.68	1.40	0.73	0.00	0.00	0.00	0.00	25.84	26.29	178%
1894	0.00	1.59	2.14	4.97	5.36	0.81	0.58	1.19	0.52	0.00	0.00	1.45	18.61	17.16	128%
1895	1.15	0.50	8.56	6.83	1.56	1.81	1.26	1.25	0.00	0.00	0.00	0.22	23.14	24.37	160%
1896	0.83	1.69	1.28	7.16	0.17	1.50	3.11	0.39	0.00	0.00	0.73	0.55	17.41	16.35	120%
1897	1.48	3.02	1.71	1.89	3.54	4.04	0.24	0.00	0.08	0.00	0.00	0.06	16.06	17.28	111%
1898	1.43	0.52	1.31	1.47	1.78	0.78	0.45	0.96	0.35	0.00	0.00	0.95	10.00	9.11	69%
1899	0.74	0.25	1.61	2.60	0.08	4.81	0.35	0.15	0.22	0.00	0.00	0.00	10.81	11.76	75%
1900	2.52	2.49	2.07	2.44	0.34	1.11	0.86	1.10	0.00	0.00	0.00	0.18	13.11	12.93	90%
1901	1.93	4.48	1.06	2.69	5.15	0.95	1.80	1.58	0.00	0.00	0.00	0.68	20.32	19.82	140%
1902	0.70	1.99	0.74	0.99	3.62	2.69	0.75	0.32	0.00	0.00	0.13	0.00	11.93	12.48	82%
1903	0.47	2.07	0.87	3.19	0.94	5.65	0.81	0.12	0.00	0.00	0.00	0.00	14.12	14.25	97%
1904	0.00	2.16	0.59	0.89	4.18	3.71	1.56	0.24	0.00	0.00	0.32	1.62	15.27	13.33	105%
1905	1.00	0.78	1.42	2.43	2.30	3.12	0.93	1.89	0.00	0.00	0.00	0.00	13.87	15.81	96%
1906	0.00	1.01	1.18	5.56	2.67	5.18	0.95	1.61	0.56	0.00	0.00	0.20	18.92	18.72	130%
1907	0.03	1.34	6.45	3.22	1.86	8.85	0.47	0.16	0.56	0.00	0.00	0.00	22.94	23.14	158%
1908	0.81	0.04	3.90	2.27	1.35	0.73	0.28	0.53	0.00	0.00	0.00	0.03	9.94	9.91	69%
1909	0.27	0.60	1.55	10.18	3.96	1.94	0.00	0.00	0.05	0.00	0.00	0.62	19.17	18.58	132%
1910	0.75	1.68	5.77	2.50	1.14	1.90	0.10	0.00	0.04	0.00	0.00	0.10	13.98	14.50	96%
1911	0.29	0.10	1.32	12.60	1.42	4.45	0.69	0.24	0.07	0.00	0.00	0.00	21.18	21.28	146%
1912	0.43	0.29	1.71	2.66	0.20	1.99	0.73	0.94	0.65	0.00	0.00	0.48	10.08	9.60	70%
1913	0.71	0.44	0.81	2.63	0.38	1.65	0.54	0.58	0.01	0.27	0.02	0.00	8.04	8.23	55%
1914	0.00	2.47	3.17	7.10	2.11	0.66	0.76	0.45	0.19	0.00	0.00	0.00	16.91	17.20	117%
1915	0.45	0.33	3.96	4.16	5.79	1.50	0.66	2.66	0.00	0.00	0.00	0.00	19.51	19.51	135%
1916	0.00	0.76	4.41	11.35	2.17	1.47	0.21	0.05	0.00	0.00	0.00	0.44	20.86	20.42	144%
1917	0.50	0.68	3.28	1.06	3.37	1.08	0.15	0.02	0.00	0.00	0.00	0.04	10.18	10.58	70%
1918	0.00	0.43	0.66	0.59	3.08	3.32	0.61	0.00	0.00	0.00	0.00	5.72	14.41	8.73	99%
1919	0.39	2.38	1.51	1.03	4.58	2.33	0.05	0.00	0.00	0.00	0.00	0.48	12.75	17.99	88%
1920	0.15	0.33	2.21	0.22	0.71	3.52	1.07	0.00	0.13	0.00	0.00	0.00	8.34	8.82	58%
1921	2.03	1.43	3.81	3.38	0.59	0.83	0.16	1.05	0.00	0.00	0.00	0.05	13.33	13.28	92%
1922	0.15	1.17	3.38	1.51	5.46	1.83	0.23	0.27	0.00	0.00	0.00	0.00	14.00	14.05	97%
1923	0.54	2.86	5.43	1.80	0.65	0.15	2.15	0.00	0.02	0.00	0.00	0.82	14.42	13.60	99%
1924	0.25	0.76	0.87	1.40	0.93	0.65	0.28	0.07	0.00	0.00	0.00	0.00	5.21	6.03	36%
1925	1.30	1.53	2.63	1.02	3.74	1.14	1.75	1.41	0.04	0.00	0.00	0.00	14.56	14.56	100%
1926	0.00	0.97	1.14	2.44	3.58	0.16	3.11	0.11	0.00	0.00	0.00	0.00	11.51	11.51	79%
1927	0.93	2.83	0.78	1.74	3.49	1.54	1.73	0.10	0.18	0.00	0.00	0.03	13.35	13.32	92%
1928	1.71	1.43	2.00	1.46	0.89	3.43	1.43	0.45	0.00	0.00	0.00	0.00	12.80	12.83	88%
1929	0.00	2.57	2.76	1.26	0.87	1.07	0.70	0.03	0.83	0.00	0.00	0.00	10.09	10.09	70%
1930	0.01	0.00	1.81	3.64	1.91	1.88	1.14	0.43	0.00	0.00	0.00	0.20	11.02	10.82	76%
1931	0.58	1.15	0.26	3.45	1.67	0.57	0.36	0.93	0.11	0.00	0.00	0.00	9.08	9.28	63%
1932	0.27	1.89	5.63	1.29	3.15	0.19	0.41	0.37	0.00	0.00	0.00	0.00	13.20	13.20	91%
1933	0.00	0.51	2.03	4.51	0.44	2.09	0.13	0.70	0.03	0.00	0.00	0.01	10.45	10.44	72%
1934	0.75	0.00	3.69	1.29	2.86	0.00	0.13	0.60	0.53	0.00	0.00	0.27	10.12	9.86	70%
1935	0.62	2.71	2.32	3.53	0.52	3.16	3.28	0.00	0.00	0.00	0.04	0.00	16.18	16.41	112%
1936	0.79	0.21	1.53	3.28	6.76	0.71	0.63	0.46	0.10	0.00	0.00	0.00	14.47	14.51	100%
1937	0.40	0.02	3.26	3.38	4.13	5.07	0.68	0.17	0.20	0.00	0.00	0.00	17.31	17.31	119%
1938	0.55	2.46	4.57	2.40	6.14	4.09	0.90	0.02	0.00	0.00	0.00	0.00	21.13	21.13	146%
1939	1.00	1.08	0.52	2.40	1.57	2.18	0.53	0.18	0.00	0.00	0.00	0.16	9.62	9.46	66%
1940	1.23	0.15	0.78	8.13	5.14	2.60	0.35	0.14	0.00	0.00	0.00	0.25	18.77	18.68	129%
1941	0.50	0.43	4.63	3.24	4.19	2.07	2.76	0.23	0.00	0.00	0.03	0.00	18.08	18.30	125%
1942	0.72	0.89	5.34	3.89	1.68	1.42	3.10	1.00	0.00	0.00	0.00	0.09	18.13	18.07	125%
1943	1.08	3.05	1.73	4.48	1.68	2.39	1.14	0.00	0.06	0.00	0.00	0.00	15.61	15.70	108%
1944	0.30	0.53	1.23	2.36	4.89	1.01	0.94	0.73	0.00	0.00	0.00	0.00	11.99	11.99	83%
1945	0.77	3.41	2.03	0.87	3.68	3.19	0.20	0.17	0.00	0.00	0.02	0.00	14.34	14.32	99%
1946	1.07	2.07	2.98	0.76	1.23	1.69	0.02	0.61	0.00	0.24	0.00	0.02	10.69	10.45	74%
1947	0.02	2.93	2.07	0.69	1.45	2.34	0.53	0.17	0.36	0.00	0.00	0.00	10.56	10.82	73%
1948	1.84	0.85	0.51	0.20	1.11	2.79	2.50	1.03	0.16	0.03	0.00	0.00	11.02	10.99	76%
1949	0.46	0.34	2.71	1.39	2.47	3.38	0.02	0.34	0.00	0.03	0.16	0.05	11.35	11.14	78%

Water Year = October to September

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TABLE 2-3
HISTORICAL MONTHLY PRECIPITATION
MONITORING STATION 15E, LIVERMORE (INCHES)
1871 to 2019 WATER YEARS

Water Year	OCTWY	NOVWY	DECWY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL OCT-SEP	TOTAL JULY-JUNE	% AVERAGE OCT-SEP
1950	0.08	1.20	1.21	4.65	1.54	1.44	0.85	0.59	0.01	0.00	0.00	0.08	11.65	11.81	80%
1951	1.84	5.95	4.95	2.23	1.81	1.82	0.55	0.35	0.06	0.00	0.00	0.00	19.56	19.64	135%
1952	1.04	3.01	6.07	7.60	1.40	2.36	2.20	0.16	0.04	0.00	0.00	0.10	23.98	23.88	165%
1953	0.01	2.11	6.33	2.07	0.05	1.12	1.42	0.61	0.59	0.00	0.15	0.00	14.46	14.41	100%
1954	0.21	1.33	0.64	2.19	2.27	3.00	0.73	0.16	0.27	0.00	0.00	0.04	10.84	10.95	75%
1955	0.00	1.68	3.33	2.45	1.69	0.38	1.28	0.65	0.00	0.00	0.01	0.01	11.48	11.50	79%
1956	0.01	1.31	10.15	5.49	1.15	0.14	1.92	0.63	0.00	0.00	0.00	0.63	21.43	20.82	148%
1957	0.79	0.03	0.48	2.65	2.23	1.30	1.14	2.65	0.04	0.00	0.00	0.05	11.36	11.94	78%
1958	1.06	0.37	1.62	3.16	5.37	4.44	3.74	0.66	0.41	0.00	0.00	0.02	20.85	20.88	144%
1959	0.09	0.14	0.86	2.45	3.59	0.29	0.35	0.00	0.00	0.00	0.07	1.89	9.73	7.79	67%
1960	0.00	0.00	0.75	2.98	4.12	0.60	0.48	0.42	0.00	0.02	0.00	0.01	9.38	11.31	65%
1961	0.05	2.92	1.25	2.08	1.04	1.92	1.03	0.69	0.19	0.00	0.13	0.16	11.46	11.20	79%
1962	0.15	2.24	0.82	0.73	5.61	1.82	0.22	0.00	0.00	0.00	0.00	0.00	11.59	11.88	80%
1963	3.64	0.28	1.55	1.40	4.50	2.60	3.47	0.70	0.00	0.00	0.00	0.33	18.47	18.14	127%
1964	0.93	3.18	0.19	2.37	0.08	1.57	0.21	0.48	0.32	0.00	0.12	0.04	9.49	9.66	65%
1965	0.85	2.44	4.91	2.11	0.59	1.73	1.53	0.00	0.00	0.00	0.21	0.00	14.37	14.32	99%
1966	0.03	4.22	3.23	1.05	1.17	0.17	0.33	0.10	0.12	0.17	0.00	0.11	10.70	10.63	74%
1967	0.00	3.43	2.35	6.14	0.29	4.15	4.65	0.19	0.48	0.00	0.00	0.02	21.70	21.96	150%
1968	0.24	0.88	1.62	3.93	0.90	2.40	0.43	0.15	0.00	0.00	0.00	0.00	10.55	10.57	73%
1969	0.43	2.48	3.04	6.28	4.76	0.55	1.24	0.08	0.00	0.00	0.00	0.00	18.86	18.86	130%
1970	1.10	0.49	2.34	5.38	1.18	1.42	0.40	0.07	0.32	0.00	0.00	0.00	12.70	12.70	88%
1971	0.41	5.24	5.27	1.19	0.33	1.75	1.37	0.54	0.00	0.00	0.00	0.13	16.23	16.10	112%
1972	0.04	0.46	3.27	0.90	0.79	0.14	0.64	0.00	0.04	0.00	0.00	0.58	6.86	6.41	47%
1973	2.98	4.91	2.22	5.50	3.38	2.63	0.29	0.03	0.00	0.00	0.00	0.08	22.02	22.52	152%
1974	2.08	3.71	3.80	1.50	0.71	2.69	1.62	0.00	0.00	0.00	0.00	0.00	16.11	16.19	111%
1975	0.50	0.66	1.98	0.84	3.65	5.24	1.42	0.00	0.06	0.10	0.35	0.00	14.80	14.35	102%
1976	1.27	0.08	0.21	0.30	1.46	0.48	0.39	0.00	0.18	0.00	0.91	0.95	6.23	4.82	43%
1977	0.50	0.50	0.73	1.15	0.83	0.82	0.16	1.01	0.00	0.10	0.00	0.22	6.02	7.56	42%
1978	0.13	1.34	3.07	5.44	2.95	3.07	2.49	0.01	0.00	0.00	0.00	0.04	18.54	18.82	128%
1979	0.00	2.16	0.58	4.52	3.19	1.86	0.88	0.34	0.00	0.06	0.00	0.00	13.59	13.57	94%
1980	1.51	1.13	2.66	4.16	4.24	1.36	1.32	0.48	0.00	0.70	0.00	0.00	17.56	16.92	121%
1981	0.04	0.28	1.18	3.97	1.11	2.94	0.61	0.11	0.00	0.00	0.00	0.06	10.30	10.94	71%
1982	2.07	3.44	2.57	5.29	2.16	5.58	1.50	0.00	0.28	0.00	0.01	1.48	24.38	22.95	168%
1983	2.24	3.72	2.80	6.28	5.56	6.14	3.51	0.21	0.00	0.00	0.50	1.02	31.98	31.95	221%
1984	0.27	5.44	3.44	0.33	1.87	1.00	0.53	0.01	0.03	0.00	0.00	0.04	12.96	14.44	89%
1985	1.25	4.71	1.51	0.48	1.25	2.62	0.32	0.07	0.22	0.00	0.03	0.13	12.59	12.47	87%
1986	0.89	2.69	1.97	2.04	7.11	4.09	0.40	0.14	0.00	0.01	0.00	0.45	19.79	19.49	136%
1987	0.04	0.08	0.92	1.83	3.47	2.30	0.16	0.09	0.00	0.00	0.00	0.00	8.89	9.35	61%
1988	0.87	1.40	2.30	1.78	0.38	0.26	1.15	0.45	0.10	0.00	0.00	0.00	8.69	8.69	60%
1989	0.11	1.92	2.03	0.81	0.95	2.94	0.88	0.08	0.10	0.00	0.00	1.33	11.15	9.82	77%
1990	1.13	1.02	0.10	1.54	2.46	0.87	0.37	1.78	0.00	0.02	0.00	0.06	9.35	10.60	64%
1991	0.08	0.39	1.45	0.31	2.20	5.87	0.34	0.35	0.08	0.00	0.21	0.04	11.32	11.15	78%
1992	1.65	0.31	1.19	1.39	4.61	1.97	0.43	0.00	0.09	0.00	0.00	0.00	11.64	11.89	80%
1993	0.90	0.15	4.99	6.41	4.53	2.91	0.63	0.51	0.30	0.00	0.00	0.00	21.33	21.33	147%
1994	0.57	2.00	1.81	0.94	3.33	0.15	1.20	1.78	0.04	0.00	0.00	0.00	11.82	11.82	82%
1995	0.58	3.08	1.36	6.64	0.33	6.66	1.02	0.92	0.70	0.00	0.00	0.00	21.29	21.29	147%
1996	0.00	0.01	5.37	5.17	4.10	2.34	1.91	1.05	0.00	0.00	0.00	0.00	19.95	19.95	138%
1997	1.08	2.55	4.43	5.81	0.15	0.06	0.15	0.29	0.17	0.00	0.42	0.00	15.11	14.69	104%
1998	0.28	4.23	1.95	5.47	7.30	2.37	1.37	2.00	0.13	0.00	0.00	0.18	25.28	25.52	174%
1999	0.54	2.48	0.73	3.23	3.33	1.67	0.99	0.08	0.01	0.00	0.03	0.04	13.13	13.24	91%
2000	0.15	1.26	0.25	4.61	4.87	1.25	0.59	0.69	0.18	0.00	0.01	0.24	14.10	13.92	97%
2001	1.97	0.49	0.45	1.92	2.89	1.22	1.80	0.00	0.12	0.00	0.00	0.09	10.95	11.11	76%
2002	0.37	1.92	5.09	0.72	0.62	1.65	0.16	0.68	0.00	0.00	0.00	0.00	11.21	11.30	77%
2003	0.00	2.65	7.01	0.66	1.31	1.07	3.09	0.95	0.00	0.00	0.29	0.00	17.03	16.74	117%
2004	0.02	2.02	3.57	2.19	4.01	0.39	0.18	0.11	0.00	0.00	0.00	0.58	13.07	12.78	90%
2005	2.77	0.89	3.01	2.81	3.55	3.41	1.53	1.03	0.05	0.00	0.00	0.25	19.30	19.63	133%
2006	0.17	0.65	5.40	2.22	1.32	4.79	2.60	0.34	0.00	0.00	0.00	0.00	17.49	17.74	121%
2007	0.20	1.68	2.25	0.52	3.92	0.33	0.44	0.11	0.00	0.00	0.00	0.21	9.66	9.45	67%
2008	1.12	0.71	2.05	4.79	1.89	0.10	0.02	0.00	0.00	0.00	0.00	0.00	10.68	10.89	74%
2009	0.33	1.40	1.56	1.34	3.31	2.29	0.23	0.51	0.11	0.00	0.00	0.31	11.39	11.08	79%
2010	2.79	0.21	2.02	3.53	2.36	1.57	2.10	0.24	0.00	0.00	0.00	0.00	14.82	15.13	102%
2011	1.00	2.02	3.87	0.78	2.69	4.10	0.22	0.46	1.07	0.00	0.00	0.00	16.21	16.21	112%
2012	1.06	0.93	0.04	1.52	0.52	2.57	2.01	0.02	0.12	0.00	0.00	0.01	8.80	8.79	61%
2013	0.27	3.40	4.22	1.07	0.47	0.33	0.44	0.14	0.04	0.00	0.00	0.33	10.71	10.38	74%
2014	0.00	1.30	0.38	0.08	2.58	1.25	0.98	0.00	0.01	0.00	0.00	0.22	6.80	6.91	47%
2015	0.17	1.19	8.23	0.00	1.62	0.25	0.78	0.50	0.33	0.00	0.01	0.05	13.13	13.29	91%
2016	0.02	2.49	2.55	3.95	0.69	3.30	2.14	0.21	0.00	0.00	0.00	0.00	15.35	15.41	106%
2017	3.34	1.37	2.62	8.10	6.07	2.09	1.93	0.03	0.02	0.00	0.00	0.00	25.57	25.57	176%
2018	0.18	2.20	0.06	3.30	0.57	4.44	1.68	0.01	0.00	0.00	0.00	0.00	12.44	12.44	86%
2019	0.18	1.64	1.54	2.66	6.31	2.58	0.30	1.63	0.00	0.00	0.00	0.22	17.06	16.84	118%
MAXIMUM	3.94	7.23	11.69	12.60	7.30	8.85	6.51	2.66	1.73	0.70	0.91	5.72	31.98	31.95	221%
MINIMUM	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.21	4.82	36%
MEAN	0.71	1.64	2.64	2.91	2.49	2.18	1.08	0.47	0.11	0.01	0.03	0.23	14.52	14.55	100%

Water Year = October to September

TABLE 2-4
MONTHLY EVAPOTRANSPIRATION (ETo) DATA
2019 WATER YEAR

MONTHLY REFERENCE EVAPOTRANSPIRATION (Eto) (inches)

	LDV	LWRP	191	2019 Network Average	% Historic Network Average
OCT	3.76	3.42	3.83	3.67	107.1%
NOV	2.61	1.99	1.90	2.17	125.8%
DEC	1.09	1.17	1.23	1.16	94.6%
JAN	1.24	1.17	1.25	1.22	102.5%
FEB	1.01	6.52	1.59	3.04	185.3%
MAR	2.06	3.46	3.10	2.87	101.5%
APR	3.83	3.63	4.94	4.13	102.0%
MAY	4.01	4.19	5.42	4.54	82.9%
JUN	7.04	6.92	7.71	7.22	111.2%
JUL	7.39	7.17	7.79	7.45	103.3%
AUG	7.20	7.18	7.07	7.15	111.2%
SEP	5.35	5.09	5.17	5.20	101.9%
TOTAL	**46.59**	**51.91**	**51.00**	**49.83**	
% AVG	**108%**	**112%**	**100%**	**106%**	

1) ETo values for LDV and LWRP were approximated using : ETo= Pan Evaporation x 0.642

TABLE 2-5
HISTORICAL MONTHLY PAN EVAPORATION
MONITORING STATION LAKE DEL VALLE, LIVERMORE (INCHES)
1969 to 2019 WATER YEARS

Water Year	OCTWY	NOVWY	DECWY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL OCT-SEP	TOTAL JULY-JUNE	% AVERAGE OCT-SEP
1969	3.20	2.50	1.54	0.66	1.08	4.89	5.92	9.99	7.84	11.38	11.77	8.32	69.09	NA	103%
1970	4.04	2.94	1.12	1.23	2.29	4.96	5.83	8.88	8.88	11.52	9.92	9.16	70.77	71.64	105%
1971	5.07	2.14	1.05	1.33	2.12	3.67	5.17	6.54	8.91	10.92	10.30	9.12	66.34	66.60	99%
1972	5.91	3.01	1.49	1.53	2.01	4.74	6.52	8.84	10.03	11.63	10.40	7.12	73.23	74.42	109%
1973	3.67	1.30	0.93	1.14	1.20	2.98	6.36	8.69	10.59	10.89	10.21	7.33	65.29	66.01	97%
1974	4.70	1.86	0.85	1.40	1.73	2.40	4.16	7.31	9.14	9.68	9.73	7.94	60.90	61.98	91%
1975	5.52	2.15	1.44	1.73	1.99	3.01	3.64	8.27	8.63	9.45	9.39	7.45	62.67	63.73	93%
1976	3.72	2.28	1.58	2.45	1.96	3.94	5.56	8.47	9.85	9.80	7.05	6.80	63.46	66.10	94%
1977	4.82	2.75	2.59	1.08	2.12	3.84	7.15	5.48	9.28	11.24	8.89	6.74	65.98	62.76	98%
1978	5.12	2.70	1.37	0.99	1.43	2.57	3.73	8.69	8.91	10.52	10.24	7.90	64.17	62.38	95%
1979	5.80	2.24	1.51	1.25	1.29	2.29	4.80	8.36	11.02	10.40	9.23	9.47	67.66	67.22	101%
1980	4.14	1.85	1.95	1.66	1.40	3.82	4.78	6.22	8.18	9.41	9.17	7.16	59.74	63.10	89%
1981	5.86	3.30	1.79	1.08	2.18	2.83	5.80	8.11	11.82	11.34	10.23	7.72	72.06	68.51	107%
1982	4.43	2.10	1.14	1.23	2.10	2.25	4.59	7.55	7.31	10.34	10.58	6.83	60.45	61.99	90%
1983	4.53	1.50	1.54	1.72	1.54	2.17	4.05	6.71	8.34	10.44	9.35	7.82	59.71	59.85	89%
1984	4.37	1.86	1.08	1.52	1.79	4.29	5.32	9.04	9.88	11.99	9.80	9.24	70.18	66.76	104%
1985	4.02	1.63	1.11	1.18	2.70	3.09	5.95	7.75	10.40	11.49	9.23	6.38	64.93	68.86	97%
1986	5.05	2.27	1.11	1.11	1.75	3.55	4.96	7.44	8.67	10.20	8.88	6.10	61.09	63.01	91%
1987	4.84	3.47	1.22	1.45	2.08	3.19	6.43	7.90	8.73	8.46	8.97	7.29	64.03	64.49	95%
1988	4.71	1.71	1.50	1.21	2.94	5.17	5.30	7.22	8.92	11.46	8.90	7.90	66.94	63.40	100%
1989	4.81	1.85	1.64	1.39	1.57	2.75	5.75	7.70	9.30	11.30	9.14	6.41	63.61	65.02	95%
1990	4.86	2.95	1.75	1.57	1.83	3.64	5.74	7.86	9.18	10.19	9.21	7.09	65.87	66.23	98%
1991	6.56	3.48	1.95	1.86	2.44	2.63	5.00	6.42	8.50	10.25	8.00	7.61	64.70	65.33	96%
1992	6.45	3.03	1.71	0.96	1.65	2.84	5.91	8.87	8.23	10.01	10.76	7.82	68.24	65.51	101%
1993	5.12	2.79	1.19	1.21	1.42	2.83	4.93	6.61	9.64	10.23	10.02	8.18	64.17	64.33	95%
1994	4.65	3.27	1.22	1.49	1.36	4.12	5.23	6.38	10.01	10.03	10.31	7.44	65.51	66.16	97%
1995	4.94	1.66	0.76	0.73	1.61	2.33	4.75	5.22	8.18	10.06	10.39	7.65	58.28	57.96	87%
1996	6.23	2.80	0.88	1.33	1.66	3.85	6.38	8.12	9.68	12.03	11.13	7.48	71.57	69.03	106%
1997	5.44	2.05	1.04	1.02	2.67	4.82	6.45	8.95	9.40	10.32	8.78	8.52	69.46	72.48	103%
1998	5.25	1.82	1.60	1.19	0.96	2.80	4.36	4.13	7.10	9.91	10.57	7.51	57.20	56.83	85%
1999	4.51	1.63	1.41	1.32	1.58	2.93	5.25	7.04	8.70	10.51	8.58	7.53	60.99	62.36	91%
2000	6.86	2.73	2.51	1.57	1.55	3.91	5.48	7.16	9.66	9.23	9.82	7.86	68.35	68.06	102%
2001	3.84	1.84	1.68	1.45	2.20	4.14	4.86	10.05	10.92	9.78	9.75	7.98	68.49	67.89	102%
2002	6.56	2.56	1.47	1.97	2.56	4.63	5.65	7.82	9.87	11.08	9.87	9.13	73.17	70.60	109%
2003	5.64	3.23	1.73	1.26	2.31	4.04	4.05	7.62	9.78	12.14	9.23	8.84	69.87	69.74	104%
2004	6.71	1.72	1.12	1.08	2.22	4.99	7.38	8.66	9.46	10.16	9.88	8.76	72.14	73.55	107%
2005	4.86	2.21	1.54	1.14	1.54	3.20	4.93	6.60	8.37	11.13	10.65	7.41	63.58	63.19	95%
2006	5.19	2.50	1.50	1.52	2.47	3.04	3.81	8.54	9.82	12.43	9.37	8.42	68.61	67.58	102%
2007	5.27	2.09	2.22	1.98	1.71	4.34	5.86	8.58	9.59	9.814	10.45	7	68.90	71.86	102%
2008	4.45	3.25	1.68	1.37	2.14	4.60	6.65	8.66	10.37	10.54	10.54	8.42	72.67	70.43	108%
2009	6.27	2.40	1.35	2.04	1.95	3.90	6.24	8.52	9.09	11.053	10.12	8.63	71.566	71.26	106%
2010	4.84	3.00	1.28	1.20	1.61	3.91	4.65	6.40	9.52	10.2	9.08	8.26	63.95	66.21	95%
2011	4.98	2.43	1.13	1.53	2.46	2.64	5.64	7.13	8.22	10.25	9.62	8.46	64.49	63.70	96%
2012	4.73	2.30	2.93	2.49	2.84	3.46	5.52	8.84	10.19	11.27	10.58	8.08	73.23	71.63	109%
2013	5.28	2.55	1.89	1.48	2.51	4.74	7.61	9.09	10.20	11.78	9.35	7.45	73.93	75.28	110%
2014	6.04	3.41	2.59	3.43	2.43	4.66	6.23	10.51	10.77	11.05	9.56	7.6	78.28	78.65	116%
2015	6.26	2.73	1.16	1.79	2.65	4.96	6.62	7.31	10.01	10.73	10	9.37	73.59	71.70	109%
2016	5.81	2.19	1.20	0.75	2.80	3.30	5.70	7.92	11.87	12.29	9.71	9.06	72.6	71.64	108%
2017	4.74	2.32	1.56	1.16	1.49	3.78	5.18	8.93	9.78	12.02	10.04	8.34	69.34	70.00	103%
2018	6.53	2.15	2.60	1.51	3.33	3.46	5.30	7.95	10.43	12.22	9.84	8.11	73.43	73.66	109%
2019	5.88	4.07	1.70	1.93	1.57	3.22	5.99	6.27	10.99	11.55	11.25	8.36	72.78	71.79	108%
COUNT	51	51	51	51	51	51	51	51	51	51	51	51	51	50	51
MAXIMUM	6.86	4.07	2.93	3.43	3.33	5.17	7.61	10.51	11.87	12.43	11.77	9.47	78.28	78.65	116%
MINIMUM	3.20	1.30	0.76	0.66	0.96	2.17	3.64	4.13	7.10	8.46	7.05	6.10	57.20	56.83	85%
MEAN	5.16	2.44	1.53	1.44	1.98	3.61	5.47	7.79	9.45	10.75	9.76	7.89	67.28	67.25	100%

ETo can be approximated using: ETo= Pan Evaporation x 0.6402

Water Year = October to September

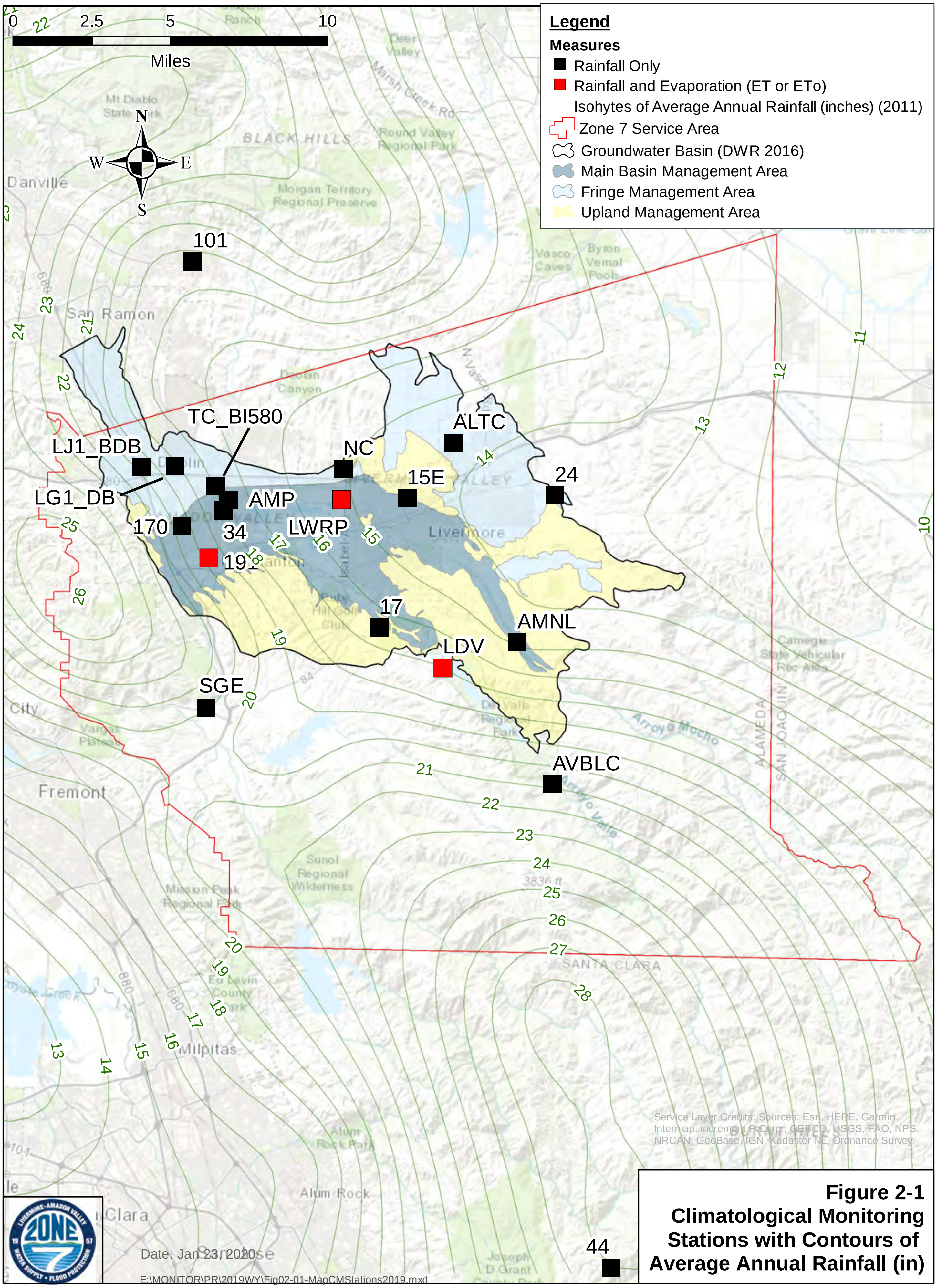
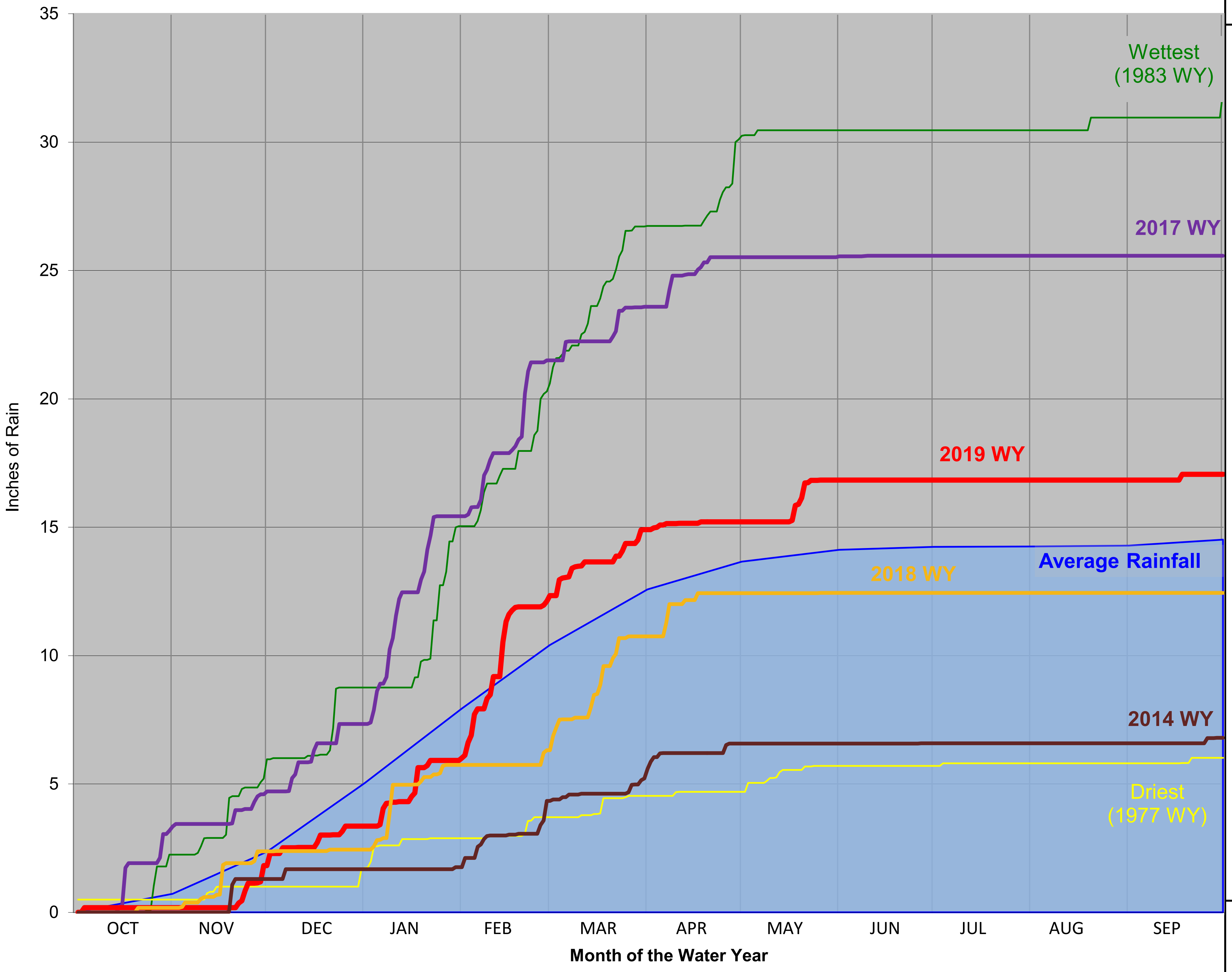


Figure 2-1
Climatological Monitoring Stations with Contours of Average Annual Rainfall (in)

Date: Jan 23, 2020

F:\MONITOR\PR\2019WY\Fig02-01-MapCMStations2019.mxd

FIGURE 2-2
ZONE 7 WATER AGENCY
GRAPH OF LIVERMORE RAINFALL (STATION 15E NOAA)



Total Annual Rainfall	% Avg	Probability of Exceedence
31.98"	220%	1%
25.57"	176%	3%
17.06	118%	28%
14.52"	100%	41%
12.44	86%	60%
6.80	47%	97%
6.02"	41%	98%

Monthly (inches)	0.18	1.64	1.54	2.66	6.31	2.58	0.30	1.63	0.00	0.00	0.00	0.22
% Monthly Avg	25%	100%	58%	91%	255%	119%	28%	354%	0%	0%	0%	94%
YTD (inches)	0.18	1.82	3.36	6.02	12.33	14.91	15.21	16.84	16.84	16.84	16.84	17.06
% Average YTD	25%	79%	94%	85%	126%	123%	119%	120%	119%	118%	118%	118%
% Annual Avg	1%	13%	23%	41%	85%	103%	105%	116%	116%	116%	116%	118%

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3 Surface Water

3.1 Program Description

3.1.1 Monitoring Network

Zone 7's Surface Water Monitoring Program focuses on the four main gaining and losing streams that affect the groundwater basin (Arroyo Valle, Arroyo Mocho, Arroyo Las Positas, and Arroyo de la Laguna) and the diversions, releases, and natural runoff that affect the flows into and out of each of them. *Figure 3-1* shows all the stations monitored for the 2019 WY. *Table 3-1* includes pertinent details of all the stations.

The main program utilizes a network of stream gauge stations and flow meters to compute the quantity of water flowing past each station and the amount of water recharging the Basin between them. At least once per year, water samples are collected from the 10 main stations and submitted to Zone 7's laboratory for analysis of TDS, nutrients, metals, and other minerals from which salt and nutrient loading (and removal) are computed, see *Section 13, Water Quality Sustainability*.

Several other auxiliary surface water monitoring stations have been established as high flow and/or stream temperature monitoring stations to augment the data collected at the 10 main stations for various ongoing flood management and habitat studies (*Table 3-1* and *Figure 3-1*). For detailed information on Zone 7's Surface Water Monitoring Program, see *Section 4.3*, *Surface Water Monitoring,* of the Alternative GSP.

3.1.2 Program Changes for the Water Year

No changes were made to the main Surface Water Monitoring Program that affect the groundwater sustainability. However, a few changes were made to the auxiliary programs, as follows:

- Three new high-flow-only stream gauges were installed. The new stations are Line G-1 at Dublin Boulevard (LG1_DB), Line J-1 below Dublin Boulevard (LJ1_BDB), and Tassajara Creek below Interstate 580 (TC_BI580). These sites initially recorded only stream level and water temperature. Streamflow will be added when high flow measurements are obtained.

- Water level and temperature monitoring along the Arroyo Mocho at Stanley Reach were discontinued in June of 2018 due to sediment burying the sensors. Monitoring for these parameters was not re-established for the 2019 WY due to lack of recharge flows along the reach.

3.2 Results for the 2019 Water Year

3.2.1 Introduction

Nineteen surface water recorder stations and five flow meters were operated and maintained for the Surface Water Monitoring Program in the 2019 WY. Data was tabulated monthly for 11 of the stations (10 main stations plus Station Alamo Canal near Pleasanton [ACNP], see *Table 3-2*). Water samples were collected from all 10 main stations and analyzed to identify the quality of water recharging and discharging from the groundwater basin (*Table 3-3*).

The following sections outline the Surface Water Monitoring Program activities for the 2019 WY (listed by stream) and highlight the findings and conclusions from these activities.

3.2.2 Arroyo Valle

The following are items of special note for the Arroyo Valle in the 2019 WY.

- The watershed runoff total into Lake Del Valle (LDV), as recorded by Arroyo Valle below Lang Canyon (AVBLC) was 36,944 acre-feet (AF); 148% of average.
- Flood releases into Arroyo Valle from LDV (Station LDV_FLD_TTL) totaled 15,202 AF.
- Artificial releases into Arroyo Valle from the South Bay Aqueduct (SBA) totaled 8,263 AF from two turnouts (SBA_TO2_AV and SBA_TO1_AV).
- Peak flows recorded on the Arroyo Valle were 2,000 cubic feet per second (cfs) at Arroyo Valle near Livermore (AVNL) and 2,080 cfs at Arroyo Del Valle at Pleasanton (ADVP); the water year annual means were 27.2 and 24.9 cfs, respectively.
- The aggregate mining companies did not make any discharges into the Arroyo Valle in the 2019 WY.
- East Bay Regional Parks District (EBRPD) diverted 444 AF from the Arroyo Valle into Shadow Cliffs Lake (Station AV_DIV_SC) for recreation and groundwater recharge.
- "Live stream" conditions were maintained in the Arroyo Valle with natural and artificial flows on all but one day during water year.

3.2.3 Arroyo Mocho

The following are items of special note for the Arroyo Mocho in the 2019 WY.

- The total upper watershed runoff that flowed into the Valley, past Station Arroyo Mocho near Livermore (AMNL) was 4,069 AF (114% of average).

- The peak flows recorded on the Arroyo Mocho were 507 cfs at AMNL and 539 cfs at Arroyo Mocho at Livermore (AMHAG); the 2019 WY annual means were 5.6 and 5.0 cfs, respectively.
- Releases into Arroyo Mocho from the South Bay Aqueduct (SBA) for artificial groundwater recharge purposes totaled 775 AF (Station SBA_AM).

3.2.4 Arroyo Las Positas

The following are items of special note for the Arroyo Las Positas (ALP) in the 2019 WY.

- The peak flows recorded on the Arroyo Las Positas were 1,050 cfs at Station Arroyo Las Positas at Livermore (ALPL) and 1,150 cfs at Station Arroyo Las Positas above El Charro Road (ALP_ELCH); the 2019 WY annual means were 8.6 and 9.6 cfs, respectively.
- The peak flow runoff event on February 19, 2019 resulted in flooding on portions of the Las Positas Golf Course.
- No water releases were made from the SBA into Altamont Creek (Station SBA_ALTC), a tributary to the ALP.

3.2.5 Arroyo de la Laguna

The following are items of special note for the Arroyo de la Laguna in the 2019 WY.

- A total of 61,610 AF of water flowed out of the Valley past Station Arroyo de la Laguna at Verona (ADLLV); 116% of average.
- The peak flow recorded at ADLLV was 4,880 cfs; the 2019 WY annual mean was 85.1 cfs.

TABLE 3-1
TABLE OF SURFACE WATER MONITORING STATIONS
AND MONITORING INFORMATION
2019 WATER YEAR

Station ID	Station Name	Station Type	Flow Range	Flow Freq	Gauge Height	Flow (Q)	Water Temp	Other Parameters	WQ Freq	Primary Operator
ALAMO CANAL - LINE F										
ACNP	Alamo Canal near Pleasanton	Stream Gauge	Entire	15 Min	x	x	x	SSD	-	USGS
AC_WCD	Alamo Creek at Willow Creek Dr	Stream Gauge	High	15 Min	x	x	x	-	-	Zone 7
ALTAMONT CREEK - LINE R										
ALTC_BD	Altamont Creek at Bluebell Drive	Stream Gauge	High	15 Min	x	x	x	-	-	Zone 7
SBA_ALTC	SBA Turnout to Altamont Creek	Flow Meter	Low	15 Min	-	x	-	-	-	DWR
ARROYO DE LA LAGUNA - LINE B										
ADLLV	Arroyo De La Laguna at Verona	Stream Gauge	Entire	15 Min	x	x	x	pH, SC	Annual	USGS
ARROYO LAS POSITAS - LINE H										
ALP_ELCH	Arroyo Las Positas above El Charro Road	Stream Gauge	Entire	15 Min	x	x	x	-	Annual	Zone 7
ALPL	Arroyo Las Positas at Livermore	Stream Gauge	Entire	15 Min	x	x	x	Turb, SSD	Annual	Zone 7
LLNL_ALP	LLNL Treated Groundwater Discharge to ALP	Estimated	Low	Daily	-	x	-	-	-	LLNL
ARROYO MOCHO - LINE G										
AMHAG	Arroyo Mocho at Livermore	Stream Gauge	Entire	15 Min	x	x	x	Turb, SSD	Annual	Zone 7
AM_KB	Arroyo Mocho at Kaiser Bridge	Stream Gauge	Entire	15 Min	x	x	x	-	Annual	Zone 7
AMNL	Arroyo Mocho near Livermore	Stream Gauge	Entire	15 Min	x	x	x	-	Annual	Zone 7
AMP	Arroyo Mocho near Pleasanton	Stream Gauge	Entire	15 Min	x	x	x	Turb, SSD	Annual	Zone 7
MA_COPE_I	Cope Lake to Lake I	Lake Gauge	Low	Hourly	x	x	-	-	-	Zone 7
MA_VUL_COPE	Vulcan Discharge to Cope Lake	Flow Meter	Low	Daily	-	x	-	-	-	Vulcan
SBA_AM	SBA Turnout to Arroyo Mocho	Flow Meter	Low	15 Min	-	x	-	-	-	DWR
ARROYO VALLE - LINE E										
ADVP	Arroyo Valle at Pleasanton	Stream Gauge	Entire	15 Min	x	x	x	-	Quarterly*	Zone 7
AVADLL	Arroyo Valle above Arroyo De La Laguna	Water Temp	-	-	-	-	x	-	-	Zone 7
AVBLC	Arroyo Valle below Lang Canyon	Stream Gauge	Entire	15 Min	x	x	x	-	Annual	USGS
AVCAT	Arroyo Valle along Camp Arroyo Trail	Water Temp	-	-	-	-	x	-	-	Zone 7
AVDCC	Arroyo Valle at Dry Creek Confluence	Water Temp	-	-	-	-	x	-	-	Zone 7
AV_DIV_SC	Arroyo Valle Diversion to Shadow Cliffs	Flow Meter	Low	Daily	-	x	-	-	-	EBRPD
AV_ISABEL	Arroyo Valle at Isabel Ave	Water Temp	-	-	-	-	x	-	-	Zone 7
AVNL	Arroyo Valle near Livermore	Stream Gauge	Entire	15 Min	x	x	x	-	Quarterly*	USGS
AVSCPK18	Arroyo Valle at Shadow Cliffs Pond K18	Water Temp	-	-	-	-	x	-	-	Zone 7
AVSGP	Arroyo Valle at Sycamore Grove Park	Water Temp	-	-	-	-	x	-	-	Zone 7
LDV_FLD_GATE	Lake Del Valle Flood Gate	Calculated	High	15 Min	-	x	-	-	-	DWR
SBA_TO1_AV	SBA Turnout 1 to Arroyo Valle	Estimated	Low	15 Min	-	x	-	-	-	Zone 7
SBA_TO2_AV	SBA Turnout 2 to Arroyo Valle	Flow Meter	Low	15 Min	-	x	x	-	-	DWR
CHABOT CANAL - LINE G-1										
CCNP	Chabot Canal below Stoneridge Drive nr Pleasanton	Stream Gauge	High	15 Min	x	x	x	-	-	Zone 7
LG1_DB	Line G1 at Dublin Blvd	Stream Gauge	High	15 Min	x	-	x	-	-	Zone 7
SOUTH SAN RAMON CREEK - LINE J										
LJ1_BDB	Line J1 Below Dublin Blvd	Stream Gauge	High	15 Min	x	-	x	-	-	Zone 7
SSRC_AVBLVD	South San Ramon Creek above Amador Valley Blvd	Stream Gauge	High	15 Min	x	x	x	-	-	Zone 7
TASSAJARA CREEK - LINE K										
TC_BI580	Tassajara Creek below I580	Stream Gauge	High	15 Min	x	x	x	-	-	Zone 7

* Satisfies water rights requirements. Turb = Turbidity. SSD = Suspended Sediment Discharge. SC = Specific Conductance.

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TABLE 3-2
MONTHLY FLOWS (ACRE-FEET)
STREAMFLOW GAUGING STATIONS
2019 WATER YEAR

MONTH	ARROYO VALLE Below LANG CANYON* AVBLC	ARROYO VALLE Near LIVERMORE* AVNL	ARROYO VALLE At PLEASANTON ADVP	ARROYO MOCHO Near LIVERMORE AMNL	ARROYO MOCHO At LIVERMORE AMHAG	ARROYO MOCHO At KAISER BRIDGE AM_KB	ARROYO MOCHO Near PLEASANTON AMP	ARROYO LAS POSITAS At LIVERMORE ALPL	ARROYO LAS POSITAS At EL CHARRO ALP_ELCH	ALAMO CANAL Near PLEASANTON* ACNP	ARROYO DE LA LAGUNA At VERONA* ADLLV
OCT	0	478	105	0	0	0	134	179	113	192	498
NOV	0	387	136	0	0	0	476	344	334	1,151	2,622
DEC	83	353	155	1	4	0	562	422	423	1,137	2,886
JAN	5,342	166	300	279	216	168	1,257	566	681	2,588	6,371
FEB	21,928	9,823	10,680	2,706	3,011	2,712	6,907	2,712	3,476	6,833	30,508
MAR	7,384	5,520	6,055	794	365	237	1,321	688	840	2,737	11,907
APR	1,417	311	184	141	0	0	268	271	228	835	1,623
MAY	624	453	111	115	18	2	530	401	423	1,174	2,806
JUN	162	582	37	25	0	0	145	169	132	258	644
JUL	4	674	84	5	0	0	139	149	108	200	604
AUG	0	570	82	2	0	0	140	159	120	176	530
SEP	0	366	122	1	0	0	129	146	107	208	608
TOTAL	**36,944**	**19682**	**18,050**	**4,069**	**3,614**	**3,119**	**12,007**	**6,206**	**6,984**	**17,488**	**61,607**

* USGS Stations

Note: Monthly streamflows are not calculated or presented in this table at these recorder locations: AC_WCD, ALTC_BD, CCNP, LG1_DB, LJ1_BDB, SSRC_AVBLVD, and TC_BI580 are high-flow-only monitoring; SBA_TO2_AV, SBA_AM, and SBA_ALTC are streamflow input sites.

TABLE 3-3
TABLE OF SURFACE WATER QUALITY RESULTS
2019 WATER YEAR

			FLOW	TEMP.	SC		Mineral Constituents (mg/L)									Select Metals (ug/L)				TDS	Hard
SITE ID	Date	Time	(cfs)	°C	mS/cm	pH	Ca	Mg	Na	K	HCO3	SO4	Cl	NO3N	SiO2	B	As	Fe	Cr	mg/L	mg/L
ADLLV	9/5/2019	14:00	10.6	25	992	8.1	55	37	127	3	312	97	127	0.18	10.3	970	3.5	< 100	2	614	290
ADVP	10/16/2018	13:31	1.5	15.3	477	7.5	33	17	33	2.2	173	27	40	< 0.1	5.4	200	1.3	< 100	< 1	243	152
ADVP	12/5/2018	14:03	1.8	10.4	426	7.6	35	17	31	2.6	169	26	35	< 0.1	8.2	160	< 1	< 100	< 1	238	158
ADVP	3/26/2019	13:12	47.3	13.7	370	8	34	17	25	1.9	157	31	22	< 0.1	6.7	200	1.1	< 100	< 1	217	155
ADVP	6/13/2019	11:55	0.3	24	491	7.5	30	19	34	1.9	161	28	46	< 0.1	2.1	190	1.6	< 100	< 1	241	153
ADVP	9/5/2019	13:04	3.6	22.5	390	7.8	25	16	35	2	165	22	33	< 0.1	6.4	230	1.7	< 100	< 1	221	128
ALP_ELCH	9/5/2019	11:22	2.0	21	1347	8	60	52	183	3	405	85	211	1.66	12.2	2690	2.8	< 100	1.8	817	364
ALPL	8/29/2019	14:20	2.2	21.2	1289	8.1	76	52	165	2.4	416	78	199	3.3	25.7	2530	2.5	< 100	5.5	824	404
AM_KB	2/5/2019	14:19	66.6	9.2	330	8.1	21	23	16	2	144	23	15	1.09	12.4	180	< 1	< 100	< 1	190	147
AMHAG	2/5/2019	14:55	66.4	10	340	8.2	21	24	16	2.1	146	24	15	1.1	12.6	200	< 1	< 100	< 1	194	151
AMNL	5/1/2019	14:10	1.4	20.5	844	8.3	41	79	39	3.4	477	60	27	< 0.1	12.1	630	< 1	< 100	< 1	507	427
AMP	9/5/2019	11:56	1.7	20.6	1363	8	58	49	187	4.1	397	83	220	0.95	10.5	2400	3.2	< 100	2.3	814	347
AVBLC	5/1/2019	13:35	9.8	22.2	557	8.2	51	32	23	2	278	62	10	< 0.1	14.9	280	< 1	< 100	< 1	340	260
AVNL	10/16/2018	14:45	7.9	16.9	435	7.9	33	17	25	2.2	162	40	29	< 0.1	12.2	200	2.3	< 100	< 1	239	152
AVNL	12/5/2018	14:40	4.0	12.1	571	7.8	31	18	56	3.1	126	55	86	0.34	12.9	220	1.4	< 100	< 1	326	152
AVNL	3/26/2019	14:33	51.6	11.4	332	8.4	31	16	18	1.9	140	29	14	0.13	11.2	100	1.2	< 100	< 1	195	144
AVNL	6/13/2019	12:40	9.4	13.9	383	7.8	24	15	24	1.5	154	35	15	< 0.1	10.7	140	< 1	< 100	< 1	202	122
AVNL	9/5/2019	14:54	0.4	19.4	497	7.9	38	18	46	2.4	191	44	41	< 0.1	15	620	1.7	< 100	< 1	299	168

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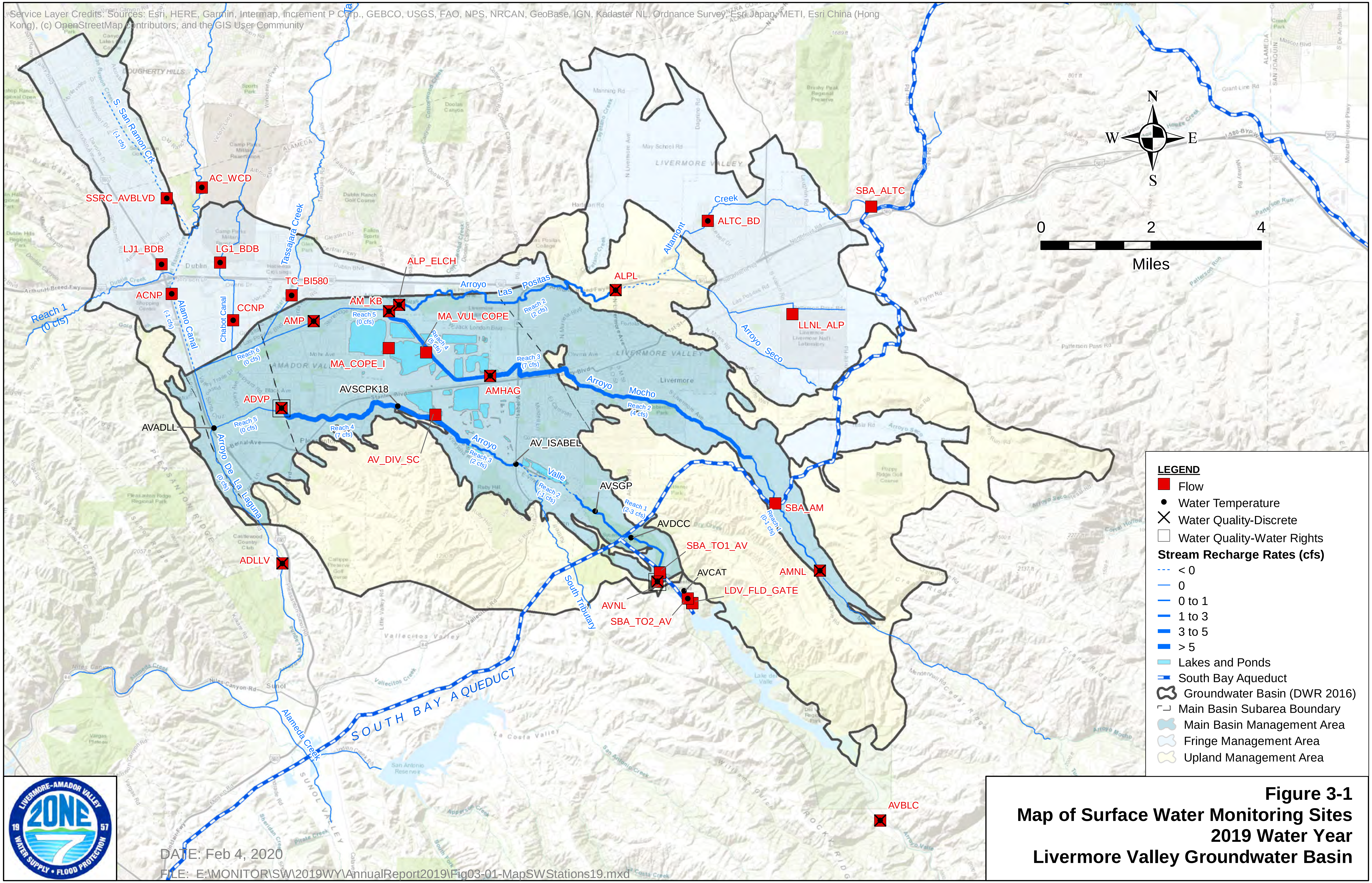

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Figure 3-1
Map of Surface Water Monitoring Sites
2019 Water Year
Livermore Valley Groundwater Basin

4 Mining Area

4.1 Program Description

4.1.1 Monitoring Network

The Chain of Lakes/Mining Area Monitoring Program includes water level measurements and water quality analysis for many of the mining area ponds or quarry lakes within the Livermore Valley.

All water generated during mining that is discharged to a non-quarry property is metered and tracked as it exits the Valley in the arroyos. This program also tracks mining evaporation and includes estimates of groundwater lost due to the export of moist gravels. In general, quarry pits have been excavated into the Upper Aquifer; however, recently a few have been excavated into layers that appear to connect to the Lower Aquifer, exposing lower aquifers to mining operation dewatering. Zone 7 is evaluating the impacts of these changes in mining activities. Groundwater is pumped from some of the pits and transferred to others or discharged to the arroyos to facilitate the gravel extraction in the pits being actively mined. In addition, backfill of former quarry ponds with fine-grained materials results in an impediment to groundwater flow in the aquifers.

Ownership of 10 mining quarry lakes ("Chain of Lakes" or "COL", Lakes A through I and Cope Lake) will ultimately be transferred to Zone 7 for future water resources management purposes. Zone 7 has received titles to two lakes so far; Lake I and Cope Lake. Project management actions on the COL Recharge Projects in the 2019 WY are discussed in *Section 12.6 Chain of Lakes Recharge Projects* of this report. For more detailed information on the Chain of Lakes/Mining Area Monitoring Program, see *Section 4.4, Chain of Lakes and Quarry Operations Monitoring*, of the Alternative GSP.

4.1.2 Program Changes for the Water Year

Pond P46 (Lake J) was added into the water elevation and quality monitoring program in the 2019 WY. The pit had previously not been included in the program because access was dangerous while that particular pit was actively mined. Active mining moved back to Pit P42 (Lake B) in the 2019 WY making P46 safer to access.

4.2 Results for the 2019 Water Year

4.2.1 Water Elevations

Table 4-1 summarizes the water levels observed in the mining area ponds for the 2019 WY. Water elevations were measured in most of the pits in the mining area that contained water (lakes and ponds) during the 2019 WY. *Figure 4-1* provides the groundwater elevation contours for the gravel mining pits and surrounding monitoring wells. The water elevations from the pits that are directly connected with the Upper Aquifer are included in the Groundwater Monitoring Program's dataset. This includes water elevations from mining area pits R24A (Lake E), R28 (Lake D), and P42 (Lake B), which appear to be in contact with both the Upper and Lower Aquifers. These three pond elevations are included in both the Upper and Lower Aquifer groundwater elevation contour maps presented in *Section 6*. Pond R24A is no longer being actively mined; however, its water level is kept low to facilitate reclamation activities. Ponds R3, R8 (Lake G), R22 (Lake F), and R23, are no longer considered connected to the Upper Aquifer due to their being filled with fine-grained materials resulting in a lack of correlation between pond water levels and surrounding Upper Aquifer groundwater elevations observed in surrounding monitoring wells.

4.2.2 Water Quality

Water quality was monitored in select mining ponds in April 2019. Salinity in the mining area ponds, measured as TDS, ranged from 229 mg/L in K18 (Lake Boris), which is supplied by Arroyo Valle, to 506 mg/L in pond P28 (future Lake A). See *Table 4-2* for the results of the water quality sampling conducted in the mining area.

Ponds K28 (Lake H) and K37 (Lake I) were sampled for per- and polyfluoroalkyl substances (PFAS) during the 2019 WY as part of Zone 7's assessment into the occurrence of PFAS in the groundwater basin. PFAS was detected in both lakes at levels just above the draft screening level (40 parts per trillion [ppt]) and below the preliminary remediation goal (70 ppt). The results are presented in *Section 7.2.6, PFAS*.

4.2.3 Mining Activities and Water Budget

Aggregate mining activities during the 2019 WY were conducted by Vulcan Materials (formerly Calmat) and CEMEX (formerly RMC Lonestar). Vulcan Materials continued mining operations in Pit R28 (future Lake D) while CEMEX focused its mining in Pit P42 (future Lake B) during the 2019 WY. Estimated groundwater transfers and losses associated with the mining area are shown in *Table 4-A* and discussed below.

Table 4-A: Estimated Groundwater Transfer and Losses in Mining Area (AF)

Activity	2019 WY	2018 WY
Mining Area Transfers*		
Vulcan to Cope Lake	13,864	15,562
Cope Lake to Lake I	11,879	14,181
Diverted to Shadow Cliffs	444	857
Mining Area Losses		
Processing Losses**	700	700
Net Pond Precip/Evaporation	2,920	3,536
Pumped GW Exported from Valley	0	0

* Transfers made to locations outside of the quarries.

** Estimated

Vulcan Materials did not discharge water into either Arroyo Mocho or Arroyo Valle during the 2019 WY. For the fifth consecutive year, all water discharges made by Vulcan Materials were captured in Cope Lake. In total, Vulcan discharged 13,864 AF of water into Cope Lake, of which an estimated 11,879 AF flowed into Lake I via the Cope-to-Lake I conduit during the 2019 WY. Although this extracted groundwater is not leaving the Basin, except by evaporation, the effect of dewatering in R24 (future Lake E) and R28 (future Lake D) contributed a localized groundwater depression in the Amador East Subarea groundwater levels (see *Section 6, Groundwater Elevations*). The westernmost CWS municipal supply wells (CWS 20 and CWS 24) also pull groundwater from this portion of the subarea.

CEMEX also did not discharge any pumped groundwater into the arroyos during the 2019 WY. The groundwater pumped from pits P46 (Lake J) and P42 (future Lake B) was transferred to other onsite ponds and used as a gravel wash water source. Consequently, some of this water evaporated or left the Valley as exported gravel moisture, and some percolated through the pond bottoms and sides, and back into the aquifer.

Based on ETo monitoring data for the 2019 WY and historic gravel sales information, an estimated total 2,920 AF of water evaporated from all the mining area ponds, and about 700 AF left the Basin as exported gravel moisture from the CEMEX and Vulcan operations during the 2019 WY.

Zone 7 continued its cooperative off-site recharge program with the EBRPD, using the Shadow Cliffs Lake as a spreading pond. The EBRPD operated its diversion equipment that siphons water from the Arroyo Valle into Shadow Cliffs diverting 444 AF during the 2019 WY, compared to 857 AF in the 2018 WY.

TABLE 4-1
SEMIANNUAL WATER LEVELS IN MINING AREA PONDS
2019 WATER YEAR

EXCAVATIONS							PONDS									
Pit	COL Name	Original Ground Elev	Deepest Mined Depth (ft)		Pit Area	Mining Status	Pond Area	Contact with Aquifer	Water Elev Status	Mining Use	Measurement Frequency		Pond Elevation (ft MSL, NAVD88)			
			Elev	*Depth*	*(acres)*		*(acres)*				*Levels*	*Quality*	*Fall 18*	*Spring 19*	*Fall 19*	*WY Diff*
CALROCK/RHODES & JAMIESON/VULCAN/PLEASANTON GRAVEL COMPANY/CALMAT																
C1/ Lake C	C	410	360	50	32.2	Excavated	0.1	Yes	Static	Unused	SA	A	372.2	368.06	361.9	-10.32
C2	C	410	360	50	6.1	Excavated										
C3	C	410	360	50	11.3	Excavated										
C4	C	400	390	10	1.7	Backfilled										
C5		400	290	110	19.2	Backfilled										
C6/ Lake C	C	400	385	15	12.4	Excavated										
C7/ Lake D	D	400	330	70	22.1	Backfilled										
C8A/ Lake D	D	410	330	80	20.2	Backfilled										
C8B/ Lake D	D	410	340	70	26.8	Backfilled										
C9/ Lake D	D	410	360	50	20.8	Active Mining										
C10/ Lake D	D	410	320	90	62.3	Active Mining										
R3		370	240	130	14.8	Excavated	5.9	No	Lined	Settling Pond	SA	A	344.8	342.69	343.6	-1.19
R4		380	240	140	16.5	Excavated	10.4	Yes	InFlux	Water Storage	SA	A	315.6	317.06	309.7	-5.954
R5		380	240	140	31.1	Backfilled										
R8/ Lake G	G	365	260	105	46	Excavated	42.4	No	Lined	Water Storage						
R10		380	370	10	2.2	Backfilled										
R11		390	370	20	3.4	Backfilled										
R12		370	240	130	39.4	Backfilled										
R13		370	270	100	28.3	Backfilled										
R14		400	380	20	11.5	Backfilled										
R21		380	280	100	44.2	Excavated	17.6	No	Lined	Settling Pond						
R22/ Lake F	F	380	290	90	79.3	Excavated	65.8	No	Lined	Water Storage	SA	A	366.1	364.94	366.3	0.197
R23		380	270	110	27.5	Excavated	21.4	No	Lined	Settling Pond	SA	A	361.6	361.7	359.7	-1.862
R24		390	200	190	86.9	Active Mining										
R24A/ Lake E	E	390	150	240	55.9	Active Mining	26.4	Yes	Depressed	Dewatering	SA	A	163.7	175.67	184.4	20.723
R25/ Lake E	E	395	300	95	43.7	Backfilled										
R27		380	300	80	59.5	Excavated	11.3	No	Lined	Unused						
R28/ Lake D	D	400	320	80	62.9	Active Mining	0.5	Yes	Depressed	Dewatering	SA	A	219.3	221.18	220.9	1.625

COL = Chain of Lake, A = Annual; SA = Semiannual,
WY Diff = Water Year Difference (Fall to Fall)

TABLE 4-1
SEMIANNUAL WATER LEVELS IN MINING AREA PONDS
2019 WATER YEAR

EXCAVATIONS							PONDS									
Pit	COL Name	Original Ground Elev	Deepest Mined Depth (ft)		Pit Area	Mining Status	Pond Area	Contact with Aquifer	Water Elev Status	Mining Use	Measurement Frequency		Pond Elevation (ft MSL, NAVD88)			
			Elev	*Depth*	*(acres)*		*(acres)*				*Levels*	*Quality*	*Fall 18*	*Spring 19*	*Fall 19*	*WY Diff*
KAISER GRAVELS/HANSON AGGREGATES																
K1		350	325	25	3.4	Backfilled										
K2		350	325	25	3.2	Backfilled										
K4		350	315	35	13	Backfilled										
K5		350	315	35	10.4	Backfilled										
K6		350	325	25	13.4	Backfilled										
K7		350	320	30	11.7	Backfilled										
K8		350	320	30	17.7	Backfilled										
K9		360	305	55	57.4	Backfilled										
K10		370	355	15	4.4	Backfilled										
K11		370	315	55	24	Backfilled										
K12		370	275	95	37.7	Backfilled										
K13		370	275	95	14.9	Backfilled										
K14		370	275	95	5.6	Backfilled										
K15/Shadow Cliffs	Shadow Cliffs	360	265	95	142.3	Excavated	83	Yes	Elevated	Water Storage	SA	A	332.8	331.31	331.3	-1.507
K18/ Lake Boris	Lake Boris	360	330	30	24.5	Excavated	10.8	Yes	Lined	Unused	SA	A	350.4	350.64	350.4	0.007
K19		350	335	15	11.1	Backfilled										
K19A		350	335	15	8	Excavated	2.1	Yes	Static	Unused						
K24		360	220	140	87.9	Backfilled										
K28/ Lake H	H	360	220	140	89.6	Reclaiming	58.2	Yes	Static	Water Storage	SA	A	318.3	319.7	316.2	-2.095
K30/ Cope Lake	Cope Lake	370	240	130	233.9	Reclaimed	188.4	No	Lined	Settling Pond	SA	A	332.8	334.23	333.4	0.603
K32		360	335	25	34.2	Backfilled										
K33		360	335	25	12.8	Backfilled										
K37/ Lake I	I	360	220	140	300.8	Reclaimed	236.4	Yes	Elevated	Water Storage	SA	A	317.2	319.18	314.8	-2.37

COL = Chain of Lake, A = Annual; SA = Semiannual,
WY Diff = Water Year Difference (Fall to Fall)

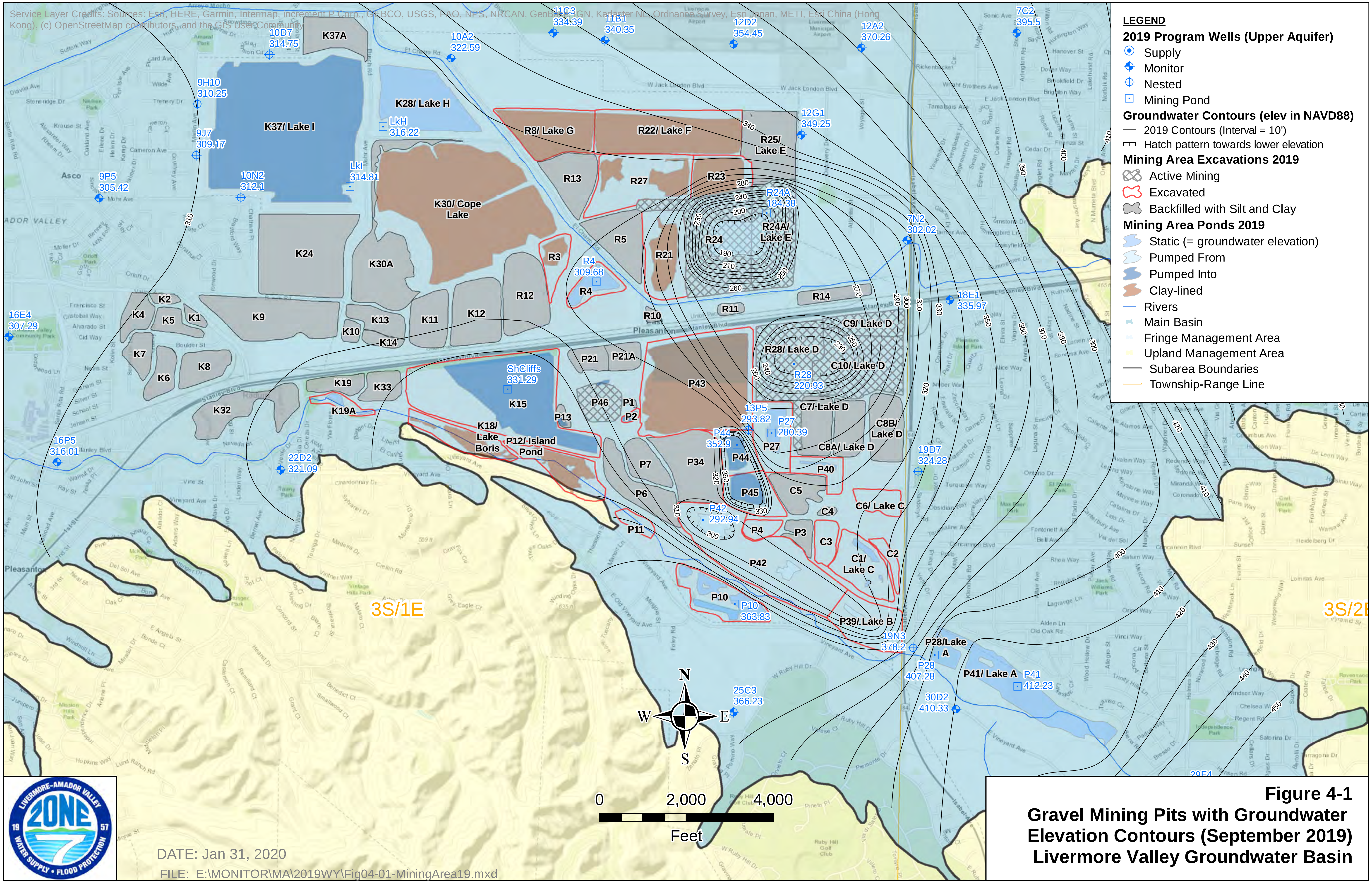
TABLE 4-1
SEMIANNUAL WATER LEVELS IN MINING AREA PONDS
2019 WATER YEAR

EXCAVATIONS							PONDS									
Pit	COL Name	Original Ground Elev	Deepest Mined Depth (ft)		Pit Area	Mining Status	Pond Area	Contact with Aquifer	Water Elev Status	Mining Use	Measurement Frequency		Pond Elevation (ft MSL, NAVD88)			
			Elev	*Depth*	*(acres)*		*(acres)*				*Levels*	*Quality*	*Fall 18*	*Spring 19*	*Fall 19*	*WY Diff*
PACIFIC AGGREGATE/RMC/LONESTAR/CEMEX																
P1		380	360	20	0.8	Backfilled										
P2		380	360	20	1.9	Excavated	1.2	Yes	Elevated	Water Storage						
P3	B	400	360	40	8.5	Backfilled										
P4	B	400	360	40	7.8	Excavated										
P6		380	280	100	28.8	Backfilled										
P7		380	280	100	16.7	Backfilled										
P10		400	340	60	34	Excavated	17.2	Yes	Static	Unused	SA	A	363.7	368.03	363.8	0.122
P11		380	340	40	6.9	Excavated										
P12/ Island Pond	Island Pond	360	330	30	29.5	Excavated	14.9	Yes	Lined	Unused	SA	A	351.7	351.18	351.4	-0.227
P13		380	300	80	2.6	Backfilled	1	Yes	Elevated	Water Storage						
P21		380	240	140	10.5	Backfilled										
P27		390	250	140	31	Excavated	6.8	Yes	Static	Water Storage	SA	A	280.5	282.06	280.4	-0.114
P28	A	420	360	60	24.6	Reclaiming	7.4	Yes	Static	Water Storage	SA	A	406.9	413.98	407.3	0.42
P34		380	270	110	46	Excavated										
P39/ Lake B	B	410	380	30	36.4	Excavated										
P40	C	390	260	130	14.5	Excavated	1.1	Yes	Static	Unused						
P41/ Lake A	A	410	370	40	91.3	Reclaiming	53	Yes	Static	Water Storage	SA	A	412	414.03	412.2	0.243
P42	B	380	250	130	101.8	Excavated	1.3	Yes	Depressed	Dewatering	SA	A	285.3	285.07	292.9	7.635
P43		390	240	150	130.9	Excavated	109.6	No	Lined	Settling Pond						
P44		390	250	140	20	Excavated	7.5	Yes	Elevated	Water Storage	SA	A	351.2	355.88	352.9	1.736
P45	B	380	310	70	25	Excavated	10.5	Yes	Elevated	Water Storage						
P46	J	380	80	300	0	Active Mining				Active Mining	SA	A		250.5		

COL = Chain of Lake, A = Annual; SA = Semiannual,
WY Diff = Water Year Difference (Fall to Fall)

TABLE 4-2
WATER QUALITY RESULTS FOR MINING AREA WATER SAMPLES
2019 WATER YEAR

		DTW	TEMP.	EC		Mineral Constituents (mg/L)									Select Metals (ug/L)				TDS	Hard
SITE ID	DATE	(Ft)	^{o}C	umhos/cm	pH	Ca	Mg	Na	K	HCO3	SO4	Cl	NO3	SiO2	B	As	Fe	Cr	mg/L	mg/L
MA-C 1	4/23/19	368.06	20.7	813	8.5	44	47	62	3.6	275	35	123	< 0.44	4.4	360	2.7	< 100	< 1	465	304
MA-K 15	4/18/19	331.31	25	727	8.6	32	32	80	4.1	188	57	104	< 0.44	5.9	430	1.7	< 100	< 1	414	212
MA-K 18	4/18/19	350.64	22.1	393	8.4	31	19	28	1.5	148	33	29	< 0.44	5.5	170	1.1	< 100	< 1	229	156
MA-K 28	4/18/19	319.7	25	834	8.6	36	53	74	2.6	270	52	112	< 0.44	6.5	640	2.5	< 100	< 1	482	308
MA-K 28	5/22/19	319.7	19.2	828	8.9	30	51	79	2.4	274	51	112	< 0.44	6.9	550	< 2	< 200	< 2	477	285
MA-K 30	4/18/19	334.23	21.3	669	8.7	37	45	41	2.1	211	45	81	2.88	4.4	290	1.3	< 100	1.4	378	277
MA-K 30	5/22/19	334.23	20.3	689	8.9	36	43	45	2.1	225	44	83	1.95	9	270	< 2	270	2.3	385	267
MA-K 37	4/18/19	319.18	20.9	758	8.6	33	51	55	2.5	237	51	100	0.66	4.4	440	2.6	< 100	< 1	425	292
MA-K 37	5/22/19	319.18	19.2	766	8.9	33	50	56	2.4	242	50	97	< 0.44	5.4	360	< 2	< 200	< 2	422	288
MA-P 10	4/23/19	368.03	23.6	415	8.6	28	18	35	2.7	160	18	47	< 0.44	0.6	170	< 1	< 100	< 1	234	144
MA-P 12	4/18/19	351.18	20.9	406	8.5	31	19	29	1.4	145	34	32	< 0.44	6.6	170	1.2	< 100	< 1	233	156
MA-P 27	4/23/19	282.06	22.3	654	8.5	40	28	56	1.8	183	50	96	< 0.44	10.5	370	< 1	< 100	< 1	379	215
MA-P 28	4/23/19	413.98	20.4	906	8.6	34	49	89	3.4	242	39	159	< 0.44	2	380	1.7	< 100	< 1	506	287
MA-P 41	4/23/19	414.03	20.7	876	8.6	34	46	82	3.2	236	41	149	< 0.44	2.4	360	1.6	< 100	< 1	488	275
MA-P 42	4/23/19	285.07	22.7	609	8.5	43	25	52	1.7	211	45	72	< 0.44	13.7	300	< 1	< 100	< 1	363	211
MA-P 44	4/23/19	355.88	21	625	8.6	39	28	54	2.2	173	48	85	< 0.44	10.7	340	< 1	< 100	< 1	359	213
MA-P 46	4/23/19	250.5	22.4	810	8	64	35	57	1.8	281	53	101	5.62	19	420	< 1	< 100	< 1	476	304
MA-R 28	4/23/19	221.18	19.5	683	8.2	47	32	50	1.7	222	47	89	2.21	14.6	340	< 1	< 100	< 1	395	250



ZONE 7 LIVERMORE-AMADOR VALLEY WATER SUPPLY • FLOOD PROTECTION 1957

DATE: Jan 31, 2020

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Figure 4-1
Gravel Mining Pits with Groundwater Elevation Contours (September 2019)
Livermore Valley Groundwater Basin

5 Surface Water-Groundwater Interaction

5.1 Program Description

5.1.1 Monitoring Network

Although Zone 7 continues to monitor locations across the Valley where groundwater may be high, the Springtown Alkali Sink in the May and Spring Subbasins is the only known area in the Livermore Valley Groundwater Basin that is thought to be a Groundwater Dependent Ecosystem (GDE) for the purposes of SGMA. However, the contribution of groundwater to surface water features is limited in this area and the effects are seasonal. The Alkali Sink supports an alkali-saline wetland habitat with seasonal surface ponding and shallow, seasonal, high-salinity groundwater. Salt-tolerant plants, vernal pool biota, and several protected species including the Palmate-Bracted Bird's Beak, California tiger salamander, and the fairy shrimp are found in the Alkali Sink area. The Alkali Sink has long been a focus of preservation and restoration efforts (including collaboration by Zone 7 with other agencies). The basic method for avoiding undesirable effects on the Alkali Sink is the preservation of natural groundwater levels and flow patterns, as there are no major groundwater extractors in this subarea. Background information regarding this program is provided in *Section 3.3.5, Surface Water-Groundwater Interaction* of the Alternative GSP.

Zone 7 monitors groundwater levels in two wells located in the vicinity of the Alkali Sink to ensure groundwater levels remain sufficiently high to support the Alkali Sink:

- Well 2S/2E 34E 1 is located at the southwestern, lower end of the sink.
- Well 2S/2E 27P 2 is located in the center portion of the sink.

The relative monitoring well locations can be seen in *Figure 5-1*. As part of its Groundwater Elevation Program (*Section 6, Groundwater Elevations*), Zone 7 also measures water levels in several other wells to monitor groundwater flow patterns in that portion of the Northeastern Fringe Management Area.

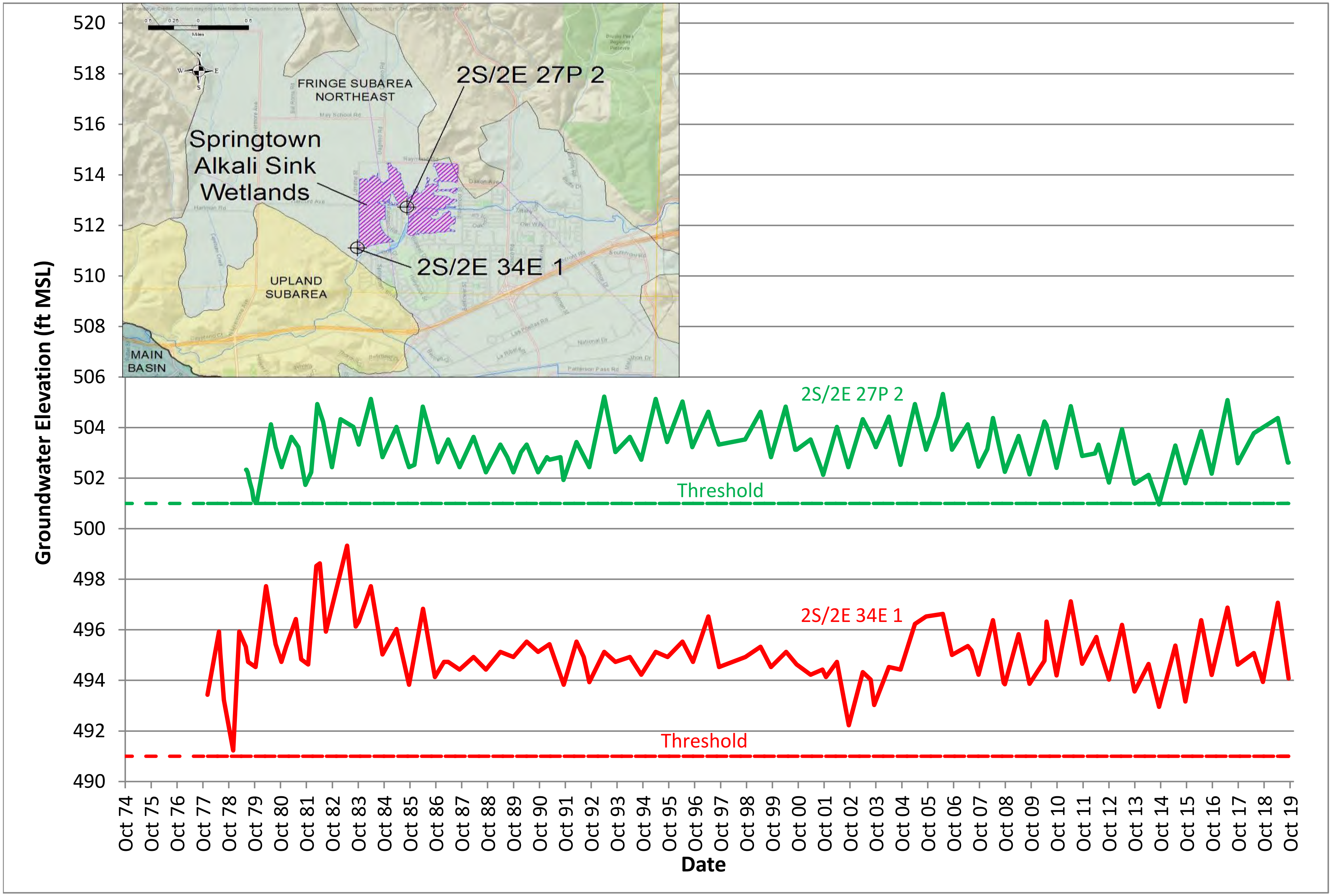
5.1.2 Program Changes for the Water Year

There were no changes to this program for the 2019 WY; however, additional potential GDEs will be investigated for the Alternative GSP Five-Year update in 2021.

5.2 Results for the 2019 WY

Ongoing monitoring by Zone 7 has verified steady groundwater levels and no increase in surface water depletion in the Alkali Sink since the late 1970s. *Figure 5-1* shows the hydrographs for the two monitored wells in the immediate vicinity of the Alkali Sink. As demonstrated by the hydrographs, groundwater levels fluctuated from 2 ft to 4 ft above the Minimum Thresholds during the 2019 WY. The gradient flow patterns in the area are shown on *Figure 6-4* (Spring 2019) and *Figure 6-5* (Fall 2019), and continue to remain relatively unchanged throughout its recorded history.

FIGURE 5-1
HYDROGRAPHS IN THE VICINITY OF THE ALKALI SINK AND SPRINGTOWN SPRINGS
LIVERMORE VALLEY GROUNDWATER BASIN



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2/13/2020

6 Groundwater Elevations

6.1 Program Description

6.1.1 Monitoring Network

The Groundwater Elevation Monitoring Program includes the measurement of groundwater levels in monitoring and production wells to confirm that management objectives are met, to assess groundwater supplies, and to define any new management objectives needed to maintain sustainability. The program focuses on the Main Basin, where groundwater is pumped for municipal uses. However, water levels are also measured in the Fringe Management Areas and in some of the Upland Management Areas.

As shown in *Figure 6-1* and *Table 6-1*, there were 220 wells in the Zone 7 Groundwater Elevation Monitoring Program for the 2019 WY. Groundwater elevations in the majority of these wells were measured at least two times during the water year (spring and fall). Well construction details for the program wells are shown in *Table 6-2*.

Water levels were also measured once per month in eight key index monitoring wells ("Key Wells") located in the central parts of the three largest subareas of the Main Basin (Bernal, Amador, and Mocho II); where the municipal pumping occurs. Because the Amador Subarea is more than twice the size of the other two subareas, it is split into the Amador West and Amador East Subareas. Each subarea is represented by an Upper and Lower Aquifer Key Well.

Spring and fall results from these eight Key Wells are combined with spring and fall water level data from three additional monitoring wells to satisfy Zone 7's California Statewide Groundwater Elevation Monitoring (CASGEM) Program obligation. The wells currently being monitored for the Key Well and CASGEM Programs are shown in *Table 6-A* below and *Figure 6-2*.

Table 6-A: Table of Key and CASGEM Wells for the 2019 Water Year

Well Number	Basin/Subarea	Aquifer	Key Well	CASGEM
3S/1E 20C 7	Bernal	Upper	x	x
3S/1E 20C 8	Bernal	Lower	x	x
3S/1E 9P 5	Amador West	Upper	x	x
3S/1E 9P10	Amador West	Lower	x	x
3S/1E 11G 1	Amador East	Upper	x	x
3S/1E 12K 3	Amador East	Lower	x	x
3S/2E 8K 2	Mocho II	Upper	x	x
3S/2E 8H 3	Mocho II	Lower	x	x
3S/1E 12K 4	Amador East	Lower		x
3S/1E 6F 3	Northern Fringe	Upper		x
3S/2E 19D 7	Southern Amador	Lower		x
3S/2E 29F 4*	Southern Amador	Upper		x

* = Voluntary CASGEM monitoring well.

6.1.2 Program Changes for the 2019 Water Year

Table 6-B below lists the changes that were made to the Groundwater Elevation Monitoring Program for the 2019 WY. These changes are also applicable to the Groundwater Quality Monitoring Program, which is discussed in *Section 7, Groundwater Quality* of this Annual Report.

Table 6-B: Program Wells Changes during the 2019 Water Year

Action	Reason	Note
Well 3S/2E 17E 2 Removed from program	Owner denied access to well	Zone 7 to investigate replacement
Well 3S/2E 32E 7 Added to program	Investigate groundwater down-gradient of Zone 7's Del Valle Water Treatment Plant	On Zone 7 property in Upland Management Area

Also in 2019, at the request of a member of the public, semi-annual groundwater levels from 3S/2E 29F 4 were uploaded to CASGEM as part of the Voluntary Program. Zone 7 will continue to upload groundwater water levels from this well to CASGEM as the data become available.

6.2 Results for the 2019 Water Year

6.2.1 Overview

Groundwater levels for the 2019 WY followed a typical historical seasonal pattern: rising in the beginning of the year with rainfall recharge and minimal pumping occurring, levelling off in late spring, and then dropping during the second half of the water year as rainfall ceased and pumping demands increased. Compared to the levels at the end of the 2018 WY, groundwater elevations generally varied little in the eastern portion of the Basin and rose in the western portion of the Basin. In general, groundwater elevations remained well above the threshold elevations (historic lows). However, dewatering operations created a localized depression in groundwater levels that exceeded the historic low in two of the mining area pits as discussed in *Section 4.2.1* above and *Section 6.2.3* below.

Graphs of Key Well water levels (*Figure 6-3*) demonstrate the annual seasonal trends in both the Upper and Lower Aquifer systems. The seasonal fluctuations are greater in the Lower Aquifer where more pumping occurs to meet higher demands in the warmer months, and when surface water treatment plant outages occur. Key Well water levels in the Bernal and Amador West Subareas ended the 2019 WY very close to those at the end of the 2018 WY (+/- 3.4 ft), whereas levels in the Amador East and Mocho II Subareas ended the 2019 WY up to about 7.3 ft above those from the previous year (*Table 6-C*).

Table 6-C: Groundwater Elevation Change in Key and CASGEM Wells from Fall 2018 to Fall 2019

		Groundwater Elevation (feet msl)		Change in Elevation (feet)		
				Seasonal		Annual
Well	Name	Spring 2019	Fall 2019	Fall 2018 to Spring 2019	Spring 2019 to Fall 2019	Fall 2018 to Fall 2019
3S/1E 20C 8	Key_Bern_U	296.3	301.9	298.5	5.6	-3.4
3S/1E 20C 9	Key_Bern_L	296.3	299.8	297.6	3.5	-2.2
3S/1E 9P 9	Key_AMW_U	308.0	308.2	305.4	0.1	-2.8
3S/1E 9P11	Key_AMW_L	295.6	294.0	294.4	-1.7	0.4
3S/1E 11G 2	Key_AME_U	318.0	317.4	317.2	-0.6	-0.3
3S/1E 12K 4	Key_AME_L	261.9	261.9	269.2	0.0	7.3
3S/2E 8N 2	Key_MO2_U	424.8	436.3	432.4	11.5	-3.9
3S/2E 8H 4	Key_MO2_L	416.6	430.9	426.7	14.3	-4.2
3S/1E 12K 4		275.7	289.8	288.2	14.2	-1.6
3S/1E 6F 3		323.9	325.8	324.7	1.9	-1.1
3S/2E 19D 7		322.9	324.7	324.3	1.8	-0.4
3S/2E 29F 4		449.0	449.1	449.2	0.1	0.1

msl = mean sea level

Table 6-3 contains spring (generally collected in April 2019) and fall (generally collected in September 2019) groundwater elevations for all program wells and includes a comparison with fall 2018. Upper and Lower Aquifer levels during the 2019 WY are described in more detail in *Sections 6.2.2* and *6.2.3* below; however, for more information on general groundwater gradient and water level trends, see *Section 2.3.3, Groundwater Occurrence and Flow*, and *Section 2.3.4, Groundwater Levels*, of the Alternative GSP.

6.2.2 Upper Aquifer Levels

Figure 6-4 and *Figure 6-5* show groundwater elevation contours in the Upper Aquifer for the spring and fall of the 2019 WY, representing the highest and lowest groundwater elevations observed, respectively. *Figure 6-6* illustrates the change in groundwater elevation in the Upper Aquifer from fall 2018 to fall 2019. *Figure 6-7* shows the depth to the top of the Upper Aquifer groundwater table at the end of the 2019 WY.

Except for water levels in the mining area, Upper Aquifer water levels in the central and western portion of the Main Basin remained relatively unchanged from fall 2018 to fall 2019 (*Figure 6-6*). Upper Aquifer water levels in the Mocho II Subbasin rose up to about 21 feet because of Zone 7's renewed stream recharge along the Arroyo Mocho (*Figure 6-6*).

The groundwater gradient in the Upper Aquifer was generally from east to west and ranged from 0.005 to 0.025. Quarry dewatering operations in the eastern Amador Subarea create groundwater depressions in the vicinity of the pits from which water is pumped. The water extracted from these pits is held or recharged through adjacent pits. The same conditions have been observed during previous years but will revert back to the basin average once dewatering operations cease.

Water levels in wells in the southwestern portion of the Basin near the Arroyo de la Laguna (as indicated primarily by the Bernal Upper Key Well, 3S/1E 20C 7, and Well 3S/1E 29M 4) were at or slightly above the upper threshold elevation at which basin overflow occurs. Consequently, approximately 809 AF (*Section 11, Groundwater Storage*) of water overflowed from the Upper Aquifer into the Arroyo de la Laguna during the 2019 WY.

Groundwater levels in the Fringe Management Areas (which only have an Upper Aquifer) stayed relatively constant throughout 2019 WY, generally varying by less than 5 ft (*Figure 6-6*). For more information regarding historic elevations and trends observed for the Fringe Management Area and Subareas, refer to *Section 2.2.2.4, Fringe Management Area and Subareas*, of the Alternative GSP.

6.2.3 Lower Aquifer Levels

Figure 6-8 and *Figure 6-9* show groundwater elevation contours in the Lower Aquifer for the spring and fall of the 2019 WY, respectively. In general, the groundwater gradient in the Mocho II and Amador Subareas in the Lower Aquifer was from east to the west and ranged from 0.001 to 0.05. In the Bernal Subarea, the gradient was slightly to the north and east and was typically less than 0.01. Piezometric depressions were created around several wellfields because of municipal pumping around the time of the spring and fall measurements. Other depressions exist in the vicinity of three mining pits (Lakes B, D, and E) that appear to extend into the lower aquifer. The lowest groundwater elevations in the Lower Aquifer corresponded to the ponds in mining excavations for Lake D (MA-R28 at 221 ft above mean sea level [msl]) and Lake E (MA-R24A at 184 ft above msl).

As is usually the case, groundwater elevations in the Mocho II Subarea during the 2019 WY were about 60 to 70 ft higher than those to the west, across the Livermore Fault in the Amador Subarea. Groundwater elevations in the Dublin/Camp/Bishop Fringe Subareas were 20–30 ft higher than those across the Main Basin Boundary to the south.

As shown in *Figure 6-10*, Lower Aquifer water levels in the western portion of the Basin varied only slightly (+/- about 10 ft) from fall 2018 to fall 2019. However, water levels in the eastern portion of the Basin rose by over 25 ft in some places from renewed recharge on the Arroyo Mocho. At the end of the 2019 WY, groundwater levels in the vicinity of the Bernal Subarea were more than 120 ft above the historic low (*Figure 6-11).* In the Amador Subarea, levels were generally 40–100 ft above the historic lows except in the immediate vicinity of two mining excavations that were being dewatered during the 2019 WY; the water level in Lake D was 7 ft above the historic low, while Lake E was about 35 ft below the historic low. The water from the dewatering of Lake D was discharged into other adjacent clay-lined mining pits; while the water from Lake E was eventually discharged into Cope Lake, after which it flowed into Lake I and recharged back into the groundwater basin. Over the majority of the Mocho II Subarea, the end-of-year groundwater levels were 90–150 ft above historical lows; however, in the northwest portion of the subarea, a lack of groundwater elevation data makes the results less certain.

Since 2012, water levels resulting from mining dewatering in the immediate vicinity of MA-R24A (Lake E) have been below the historic low water level of 215 ft msl with no observed undesirable results. Similar to the overall basin hydrology, groundwater levels just beyond the capture area of the mining pit dewatering operations declined during the drought from 2012 through 2016, but have returned to the pre-drought levels since then.

TABLE 6-1
GROUNDWATER ELEVATION PROGRAM
WELLS WITH MONITORING FREQUENCY
2019 WATER YEAR

SITE INFORMATION				***Montoring Frequency***	***Other GW Elevation Programs***				
State Name	***Well Name***	***Subbasin***	***Aq***		***Key***	***CASGEM***	***GW/SW***	***WR***	***Muni***
1S/4E 31P 5	CASGEM Tracy WAPA	Tracy	U	SA		√			
2S/1E 32E 1	End of Arnold Rd	None	U	SA					
2S/1E 32N 1	Camp Parks	Camp	U	SA					
2S/1E 32Q 1	Summer Glen Dr	Camp	U	SA					
2S/1E 33L 1	Gleason Dr @ Tassajara	None	U	SA					
2S/1E 33P 2	Central Pkwy at Emerald Gle	Camp	U	SA					
2S/1E 33R 1	Central Pkwy @ Grafton	None	U	SA					
2S/1W 15F 1	BOLLINGER	Bishop	U	SA					
2S/1W 26C 2	PINE VALLEY	Dublin	U	SA					
2S/1W 36E 3	Kolb Park	Dublin	U	SA					
2S/1W 36F 1	Dublin High shallow	Dublin	L	SA					
2S/1W 36F 2	Dublin High mid	Dublin	L	SA					
2S/1W 36F 3	Dublin High deep	Dublin	L	SA					
2S/2E 27C 2	Dagnino Rd	Spring	U	SA					
2S/2E 27P 2	hartford ave east	Spring	U	SA			√		
2S/2E 28D 2	May School	May	U	SA					
2S/2E 28J 2	FCC Well	May	L	SA					
2S/2E 28Q 1	hartford ave	May	U	SA					
2S/2E 32K 2	jenson's N liv. Ave	Cayetano	U	SA					
2S/2E 34E 1	Mud City	May	U	SA			√		
2S/2E 34Q 2	Hollyhock & Crocus	Spring	U	SA					
2S/3E 1D 1	CASGEM Tracy PGE	Tracy	U	SA		√			
3S/1E 1F 2	Constitution Dr	Camp	U	SA					
3S/1E 1H 3	Collier Canyon g1	Camp	U	SA					
3S/1E 1L 1	Kitty Hawk	Camp	U	SA					
3S/1E 1P 2	Airport gas g5	Amador	U	SA					
3S/1E 1P 3	New airport well	Amador	L	SA					
3S/1E 2J 2	Maint. Bldg	Camp	U	SA					
3S/1E 2J 3	Doolan Rd East	Camp	U	SA					
3S/1E 2K 2	Doolan Rd West	Camp	U	SA					
3S/1E 2M 3	Friesman Rd North	Camp	U	SA					
3S/1E 2N 6	Friesman Rd South	Amador	U	SA					
3S/1E 2P 3	Crosswinds Church	Camp	L	SA					
3S/1E 2Q 1	LPGC #1	Amador	U	SA					
3S/1E 2R 1	Beebs	Amador	U	SA					
3S/1E 3G 2	fallon rd	Camp	U	SA					
3S/1E 4A 1	SMP-DUB-2	Camp	U	SA					
3S/1E 4J 5	Pimlico shallow	Camp	U	SA					
3S/1E 4J 6	Pimlico deep	Camp	U	SA					
3S/1E 4Q 2	gulfstream	Amador	U	SA					
3S/1E 5K 6	Rosewood shallow	Camp	U	SA					
3S/1E 5K 7	Rosewood deep	Camp	L	SA					
3S/1E 5L 3	Oracle	Camp	U	SA					
3S/1E 5P 6	Owens Park	Camp	U	SA					

Aq = Aquifer: U = Upper; L = Lower; D = Deep

Frequency: R = Recorder; M = Monthly; Q = Quarterly; SA = Semiannually; A = Annually

OTHER: Key = Key Wells; GW/SW = Groundwater Surface Water Interaction; WR = Water Rights; Muni = Municipal wells

SITE INFORMATION				*Montoring Frequency*	*Other GW Elevation Programs*				
State Name	*Well Name*	*Subbasin*	*Aq*		*Key*	*CASGEM*	*GW/SW*	*WR*	*Muni*
3S/1E 6F 3	Dublin Ct	Dublin	U	SA		√			
3S/1E 6G 5	Nissan Repair	Dublin	L	SA					
3S/1E 6N 2	DSRSD MW-3	Dublin	U	SA					
3S/1E 7B 2	Hopyard rd	Dublin	L	SA					
3S/1E 7B12	Hacienda Arch	Dublin	U	SA					
3S/1E 7G 7	Chabot Well	Dublin	U	SA					
3S/1E 7J 5	Thomas Hart School	Dublin	U	SA					
3S/1E 8B 1	Lizard Well	Amador	U	SA					
3S/1E 8G 4	Apache	Amador	U	SA					
3S/1E 8H 9	Mocho 4 Nested Shallow	Amador	L	SA					√
3S/1E 8H10	Mocho 4 Nested Middle	Amador	L	SA					√
3S/1E 8H11	Mocho 4 Nested deep	Amador	D	SA					√
3S/1E 8H13	Mocho 3 mon	Amador	D	SA					√
3S/1E 8H18	Mocho 4	Amador	L	SA					√
3S/1E 8K 1	Cockroach well	Amador	U	SA					
3S/1E 8N 1	sports park	Bernal	U	SA					
3S/1E 9H10	NW Lake I Shallow	Amador	U	SA					
3S/1E 9H11	NW Lake I Deep	Amador	L	SA					
3S/1E 9J 7	SW Lake I Shallow	Amador	U	SA					
3S/1E 9J 8	SW Lake I Middle	Amador	L	SA					
3S/1E 9J 9	SW Lake I Deep	Amador	L	SA					
3S/1E 9M 2	Mocho 1	Amador	L	SA					√
3S/1E 9M 3	Mocho 2	Amador	L	SA					√
3S/1E 9M 4	Mocho 3	Amador	L	SA					√
3S/1E 9P 5	Key_AmW_U (Mohr Key)	Amador	U	M	√	√			
3S/1E 9P 9	Mohr Ave Shallow	Amador	L	M					
3S/1E 9P10	Key_AmW_L	Amador	L	M	√	√			
3S/1E 9P11	Mohr Ave Deep	Amador	L	M					
3S/1E 10A 2	El C harro Rd	Amador	U	SA					
3S/1E 10B 8	Kaiser Rd Shallow	Amador	L	SA					
3S/1E 10B 9	Kaiser Rd Middle 1	Amador	L	SA					
3S/1E 10B10	Kaiser Rd Middle 2	Amador	L	SA					
3S/1E 10B11	Kaiser Rd Deep	Amador	D	SA					
3S/1E 10B14	COL 5 Monitoring	Amador	L	SA					
3S/1E 10D 2	Stoneridge Shallow	Amador	L	SA					
3S/1E 10D 3	Stoneridge Middle 1	Amador	L	SA					
3S/1E 10D 4	Stoneridge Middle 2	Amador	L	SA					
3S/1E 10D 5	Stoneridge Deep	Amador	D	SA					
3S/1E 10D 7	North Lake I Shallow	Amador	U	SA					
3S/1E 10D 8	North Lake I Cluster 2	Amador	L	SA					
3S/1E 10K 2	COL 1 Monitoring	Amador	L	M					√
3S/1E 10N 2	South Lake I Shallow	Amador	U	SA					
3S/1E 10N 3	South Lake I Deep	Amador	L	SA					
3S/1E 11B 1	Airport West	Amador	U	SA					
3S/1E 11C 3	LAVWMA ROW	Amador	U	SA					
3S/1E 11G 1	Key_AmE_U	Amador	U	M	√	√			
3S/1E 11G 2	Rancho Charro Middle 1	Amador	L	M					
3S/1E 11G 3	Rancho Charro Middle 2	Amador	L	M					
3S/1E 11G 4	Rancho Charro Deep	Amador	D	M					
3S/1E 11M 2	COL 2 Monitoring	Amador	L	SA					√

Aq = Aquifer: U = Upper; L = Lower; D = Deep

Frequency: R = Recorder; M = Monthly; Q = Quarterly; SA = Semiannually; A = Annually

OTHER: Key = Key Wells; GW/SW = Groundwater Surface Water Interaction; WR = Water Rights; Muni = Municipal wells

SITE INFORMATION				***Montoring Frequency***	***Other GW Elevation Programs***				
State Name	***Well Name***	***Subbasin***	***Aq***		***Key***	***CASGEM***	***GW/SW***	***WR***	***Muni***
3S/1E 11P 6	New Jamieson Residence	Amador	L	SA					
3S/1E 12A 2	Airport South	Amador	U	SA					
3S/1E 12D 2	LWRP G6	Amador	U	SA					
3S/1E 12G 1	Oaks Park Shallow	Amador	U	SA					
3S/1E 12H 4	LWRP Shallow	Amador	L	SA					
3S/1E 12H 5	LWRP Middle 1	Amador	L	SA					
3S/1E 12H 6	LWRP Middle 2	Amador	L	SA					
3S/1E 12H 7	LWRP Deep	Amador	D	SA					
3S/1E 12K 2	Oaks Park Mid	Amador	L	M					
3S/1E 12K 3	Key_AmE_L	Amador	L	M	√	√			
3S/1E 12K 4	Oaks Park Deep	Amador	D	M		√			
3S/1E 13P 5	LGA Grant Nested 1	Amador	U	M					
3S/1E 13P 6	LGA Grant Nested 2	Amador	L	M					
3S/1E 13P 7	LGA Grant Nested 3	Amador	L	M					
3S/1E 13P 8	LGA Grant Nested 4	Amador	L	M					
3S/1E 14B 1	Industrial Asphalt	Amador	L	SA					
3S/1E 14D 2	South Cope Lake	Amador	L	SA					
3S/1E 15F 3	kaiser #8	Amador	L	SA					
3S/1E 15J 3	shadow cliff	Amador	L	SA					
3S/1E 15M 3	Bush/Valley South	Amador	L	SA					
3S/1E 16A 4	Bush/Valley Mid	Amador	L	SA					
3S/1E 16B 1	Bush/Valley North	Amador	D	SA					
3S/1E 16C 2	Santa Rita Valley Shallow	Amador	L	SA					
3S/1E 16C 3	Santa Rita Valley Middle	Amador	L	SA					
3S/1E 16C 4	Santa Rita Valley Deep	Amador	L	SA					
3S/1E 16E 4	black ave - cultural	Amador	U	SA					
3S/1E 16L 2	Pleas 4	Amador	L	SA					
3S/1E 16P 5	Vervais Monitor	Amador	U	M				√	
3S/1E 16R 1	Stanley Berry Farm	Amador	L	SA					
3S/1E 17B 4	Casterson	Amador	L	SA					
3S/1E 17D 3	Hopyard Nested Shallow	Bernal	L	SA					√
3S/1E 17D 4	Hopyard Nested Middle 1	Bernal	L	SA					√
3S/1E 17D 5	Hopyard Nested Middle 2	Bernal	L	SA					√
3S/1E 17D 6	Hopyard Nested Middle 3	Bernal	L	SA					√
3S/1E 17D 7	Hopyard Nested Deep	Bernal	D	SA					√
3S/1E 17D10	Hopyard 7	Bernal	L	SA					
3S/1E 17D11	Hopyard 9 Monitoring Well	Bernal	L	SA					√
3S/1E 18A 5	Pleas 7	Bernal	L	SA					
3S/1E 18E 4	Valley Trails II	Bernal	U	SA					
3S/1E 18J 2	camino segura	Bernal	U	SA					
3S/1E 18N 1	merritt	Bernal	L	SA					
3S/1E 19A10	SFWD South (B)	Bernal	L	SA					√
3S/1E 19A11	SFWD North (A)	Bernal	L	SA					√
3S/1E 19C 4	del valle & laguna	Bernal	U	SA					
3S/1E 19K 1	680/bernal	Bernal	U	SA					
3S/1E 20B 2	Fairgrounds Potable	Bernal	L	SA					
3S/1E 20C 7	Key_Bern_U	Bernal	U	M	√	√		√	
3S/1E 20C 8	Key_Bern_L	Bernal	L	M	√	√			
3S/1E 20C 9	Fair Nested Deep	Bernal	L	M					
3S/1E 20J 4	civic center	Bernal	U	SA					

Aq = Aquifer: U = Upper; L = Lower; D = Deep	Frequency: R = Recorder; M = Monthly; Q = Quarterly; SA = Semiannually; A = Annually
OTHER: Key = Key Wells; GW/SW = Groundwater Surface Water Interaction; WR = Water Rights; Muni = Municipal wells	

SITE INFORMATION				***Montoring Frequency***	***Other GW Elevation Programs***				
State Name	***Well Name***	***Subbasin***	***Aq***		***Key***	***CASGEM***	***GW/SW***	***WR***	***Muni***
3S/1E 20M11	S.F "M"LINE	Bernal	U	SA					
3S/1E 20Q 2	20Q2	Bernal	U	SA					
3S/1E 22D 2	vineyard trailer	Amador	U	SA					
3S/1E 23J 1	1627 vineyard trailer	Amador	L	SA					
3S/1E 24Q 1	Ruby Hills	Amador	L	SA					
3S/1E 25C 3	Katz Winery Mansion	Amador	U	SA					
3S/1E 29M 4	f.c. channel	Castle	U	M				√	
3S/1E 29P 2	castlewood dr	Bernal	U	SA					
3S/1W 1B 9	DSRSD Shallow	Dublin	L	SA					
3S/1W 1B10	DSRSD Middle	Dublin	L	SA					
3S/1W 1B11	DSRSD Deep	Dublin	L	SA					
3S/1W 2A 2	McNamara's	Dublin	U	SA					
3S/1W 12B 2	Stoneridge Mall Rd	Dublin	U	SA					
3S/1W 12J 1	DSRSD South	Dublin	U	SA					
3S/1W 13J 1	muirwood dr	Castle	U	SA					
3S/2E 1F 2	Brisa at Circuit City	Spring	U	SA					
3S/2E 2B 2	south front rd	Spring	U	SA					
3S/2E 3A 1	Bluebell	Spring	U	SA					
3S/2E 3K 3	first & S. front rd	Mocho I	U	SA					
3S/2E 5N 1	Spider Well	Mocho II	M	SA					
3S/2E 7C 2	york way - jaws - G4	Mocho II	U	SA					
3S/2E 7H 2	dakota	Mocho II	U	SA					
3S/2E 7N 2	Isabel & Arroyo Mocho	Amador	U	SA					
3S/2E 7P 3	CWS 24	Amador	L	SA					√
3S/2E 7R 2	CWS 31 Monitoring	Mocho II	D	SA					
3S/2E 7R 3	CWS 31	Upland	L	SA					√
3S/2E 8H 2	North k	Mocho II	U	SA					
3S/2E 8H 3	Key_Mo2_L	Mocho II	L	M	√	√			
3S/2E 8H 4	N Liv Ave Deep	Mocho II	L	M					
3S/2E 8K 2	Key_Mo2_U (Livermore Key)	Mocho II	U	M	√	√			
3S/2E 8N 2	CWS 14	Mocho II	L	SA					√
3S/2E 8P 1	CWS 8	Mocho II	L	SA					
3S/2E 8Q 9	D-2	Mocho II	L	SA					√
3S/2E 9Q 4	school st	Mocho II	U	SA					
3S/2E 10F 3	hexcel	Mocho I	U	SA					
3S/2E 10Q 1	almond	Mocho II	U	SA					
3S/2E 10Q 2	LLNL W-703	Mocho II	L	SA					
3S/2E 11C 1	joan way	Mocho I	U	SA					
3S/2E 12C 4	LLNL W-486	Spring	U	SA					
3S/2E 12J 3	LLNL W-017A	Spring	L	SA					
3S/2E 14A 3	S. vasco @east ave	Mocho I	U	SA					
3S/2E 14B 1	5763 east ave	Mocho I	L	SA					
3S/2E 15E 2	Retzlaff Winery	Mocho II	L	SA					
3S/2E 15L 1	Concannon 2	Mocho II	U	SA					
3S/2E 15M 2	Concannon 1	Mocho II	U	SA					
3S/2E 15Q 6	Concannon Old Pumping	Mocho II	L	SA					
3S/2E 15R17	Buena Vista Shallow	Mocho II	U	SA					
3S/2E 15R18	Buena Vista Deep	Mocho II	L	SA					
3S/2E 16A 3	Memory Gardens	Mocho II	L	SA					
3S/2E 16C 1	CWS 15	Mocho II	L	SA					√

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OTHER: Key = Key Wells; GW/SW = Groundwater Surface Water Interaction; WR = Water Rights; Muni = Municipal wells

SITE INFORMATION				*Montoring Frequency*	*Other GW Elevation Programs*				
State Name	*Well Name*	*Subbasin*	*Aq*		*Key*	*CASGEM*	*GW/SW*	*WR*	*Muni*
3S/2E 16E 4	pepper tree	Mocho II	U	SA					
3S/2E 18B 1	CWS 20	Amador	L	SA					√
3S/2E 18E 1	E. stanley	Amador	U	SA					
3S/2E 19D 7	Isabel Shallow	Amador	U	M		√			
3S/2E 19D 8	Isabel Middle 1	Amador	L	M					
3S/2E 19D 9	Isabel Middle 2	Amador	L	M					
3S/2E 19D10	Isabel Deep	Amador	L	M					
3S/2E 19N 3	Shallow Cemex Nested	Amador	U	M					
3S/2E 19N 4	Deep Cemex Nested	Amador	L	M					
3S/2E 20M 1	Alden Lane	Amador	L	SA					
3S/2E 22B 1	grapes	Mocho II	U	SA					
3S/2E 23E 1	Mines Nested Shallow	Mocho II	U	SA					
3S/2E 23E 2	Mines Nested Deep	Mocho II	L	SA					
3S/2E 24A 1	S. greenville	Mocho I	U	SA					
3S/2E 26J 2	mines rd	Mocho II	U	SA					
3S/2E 29F 4	usgs wetmore	Amador	U	M		√		√	
3S/2E 30C 1	Vineyard 30C 1	Amador	L	M					
3S/2E 30D 2	vineyard	Amador	U	M				√	
3S/2E 32E 7	DVWTP 32E7	Upland	U	SA					
3S/2E 33G 1	Crohare	Amador	U	M				√	
3S/2E 33K 1	VA	Amador	U	Q					
3S/2E 33L 1	VA/CROHARE FENCE	Amador	U	Q					
3S/3E 6Q 3	PPWTP South Monitoring	Altamont	U	SA					
3S/3E 6Q 4	PPWTP North Monitoring	Altamont	U	SA					
3S/3E 7D 2	7D 2	Spring	U	SA					
TOTALS:				**219**	**8**	**14**	**2**	**6**	**24**

Aq = Aquifer: U = Upper; L = Lower; D = Deep	Frequency: R = Recorder; M = Monthly; Q = Quarterly; SA = Semiannually; A = Annually
OTHER: Key = Key Wells; GW/SW = Groundwater Surface Water Interaction; WR = Water Rights; Muni = Municipal wells	

TABLE 6-2
GROUNDWATER PROGRAM
WELL CONSTRUCTION DETAILS
2019 WATER YEAR

Site	*Type*	*Other Name*	*Owner*	*Basin*	*Aquifer*	*RP*	*TD*	*Dia*	*Perf*
1S/4E 31P 5	monitor	CASGEM Tracy WAPA	WESTERN AREA POWER A	Tracy	Upper	60	24	4	8 - 23
2S/1E 32E 1	monitor	End of Arnold Rd	Zone 7	None	Upper	392.56	70	2	55 - 70
2S/1E 32N 1	monitor	Camp Parks	Zone 7	Camp	Upper	360.79	44	2.5	35 - 41
2S/1E 32Q 1	monitor	Summer Glen Dr	Zone 7	Camp	Upper	367.55	45	2	30 - 45
2S/1E 33L 1	monitor	Gleason Dr @ Tassajara	<Null>	None	Upper	389.46	80	2	65 - 80
2S/1E 33P 2	monitor	Central Pkwy at Emerald Glen	Zone 7	Camp	Upper	370.05	55	2	45 - 55
2S/1E 33R 1	monitor	Central Pkwy @ Grafton	Zone 7	None	Upper	358.5	60	2	40 - 60
2S/1W 15F 1	monitor	BOLLINGER	Zone 7	Bishop	Upper	439.44	60	2.5	50.3 - 55.3
2S/1W 26C 2	monitor	PINE VALLEY	Zone 7	Dublin	Upper	406.53	50	2.5	40 - 45
2S/1W 36E 3	monitor	Kolb Park	Zone 7	Dublin	Upper	346.51	60	2.5	50 - 55
2S/1W 36F 1	nested	Dublin High shallow	<Null>	Dublin	Lower	342.71	190	2	140 - 180
2S/1W 36F 2	nested	Dublin High mid	DSRSD	Dublin	Lower	342.71	320	2	270 - 310
2S/1W 36F 3	nested	Dublin High deep	DSRSD	Dublin	Lower	342.71	520	2	440 - 510
2S/2E 27C 2	domestic	Dagnino Rd	JACK PIECEFIELD	Spring	Upper	542.14	108	8	41 - 56
2S/2E 27P 2	monitor	hartford ave east	Zone 7	Spring	Upper	505.43	68	4	35 - 63
2S/2E 28D 2	monitor	May School	Zone 7	May	Upper	555.15	55	2.5	45 - 50
2S/2E 28J 2	industrial	FCC Well	FCC	May	Lower	522.292	230	6	50 - 230
2S/2E 28Q 1	monitor	hartford ave	<Null>	May	Upper	513.04	28	2.5	17.6 - 22.6
2S/2E 32K 2	monitor	jenson's N liv. Ave	Zone 7	Cayetano	Upper	507.43	43	2.5	33 - 38
2S/2E 34E 1	monitor	Mud City	Zone 7	May	Upper	499.73	49	2.5	40 - 45
2S/2E 34Q 2	monitor	Hollyhock & Crocus	Zone 7	Spring	Upper	507.24	50	2	25 - 50
2S/3E 1D 1	irrigation	CASGEM Tracy PGE	PG&E	Tracy	Upper	90	80	6	40 - 80
3S/1E 1F 2	monitor	Constitution Dr	Zone 7	Camp	Upper	428.44	40	2	25 - 40
3S/1E 1H 3	monitor	Collier Canyon g1	Zone 7	Camp	Upper	422.8	80	2.5	70 - 75
3S/1E 1L 1	monitor	Kitty Hawk	Zone 7	Camp	Upper	403.04	70	2	60 - 70
3S/1E 1P 2	monitor	Airport gas g5	Zone 7	Amador	Upper	389.64	50	2.5	40 - 45
3S/1E 1P 3	supply	New airport well	CITY OF LIVERMORE	Amador	Lower	394.44	480	12	245 - 460
3S/1E 2J 2	monitor	Maint. Bldg	Zone 7	Camp	Upper	380.89	41	2	31 - 41
3S/1E 2J 3	monitor	Doolan Rd East	Zone 7	Camp	Upper	406.35	65	2	55 - 65
3S/1E 2K 2	monitor	Doolan Rd West	Zone 7	Camp	Upper	397.04	46	2.5	36.5 - 41.5
3S/1E 2M 3	monitor	Friesman Rd North	Zone 7	Camp	Upper	365.04	50	2	35 - 50
3S/1E 2N 6	monitor	Friesman Rd South	Zone 7	Amador	Upper	366.14	55	2	40 - 55
3S/1E 2P 3	domestic	Crosswinds Church	Crosswinds Church	Camp	Lower	371.73	380	10	340 - 372
3S/1E 2Q 1	monitor	LPGC #1	Zone 7	Amador	Upper	369.92	45	2	35 - 45
3S/1E 2R 1	monitor	Beebs	Zone 7	Amador	Upper	376.29	33	2.5	21 - 26
3S/1E 3G 2	monitor	fallon rd	Zone 7	Camp	Upper	354.24	50	2.5	40 - 45
3S/1E 4A 1	monitor	SMP-DUB-2	Zone 7	Camp	Upper	350.67	49.5	2	29.5 - 49.5
3S/1E 4J 5	monitor	Pimlico shallow	Zone 7	Camp	Upper	345.2	47	2	22 - 47
3S/1E 4J 6	monitor	Pimlico deep	Zone 7	Camp	Upper	345.55	110	2	68 - 110
3S/1E 4Q 2	monitor	gulfstream	Zone 7	Amador	Upper	345.42	90	2.5	80 - 85
3S/1E 5K 6	monitor	Rosewood shallow	Zone 7	Camp	Upper	346.05	75	4	40 - 70
3S/1E 5K 7	monitor	Rosewood deep	Zone 7	Camp	Lower	346.19	150	4	134 - 144
3S/1E 5L 3	monitor	Oracle	Zone 7	Camp	Upper	339.43	40	2	15 - 40
3S/1E 5P 6	monitor	Owens Park	Zone 7	Camp	Upper	336.65	35	2	25 - 35

RP = Reference Point Elevation (in feet above MSL)
Dia = Diameter of well casing (in inches)

TD = Total Depth of well (in feet below ground surface)
Perf = Preferated interval (in feet below ground surface), uppermost - lowermost

Site	Type	Other Name	Owner	Basin	Aquifer	RP	TD	Dia	Perf
3S/1E 6F 3	monitor	Dublin Ct	Zone 7	Dublin	Upper	329.82	36	2.5	27 - 32
3S/1E 6G 5	supply	Nissan Repair	VALLEY NISSAN/VOLVO	Dublin	Lower	332.22	200	8	103 - 178
3S/1E 6N 2	monitor	DSRSD MW-3	DSRSD	Dublin	Upper	335.2	67	4	47 - 67
3S/1E 7B 2	monitor	Hopyard rd	Zone 7	Dublin	Lower	327.77	152	4	143 - 149
3S/1E 7B12	monitor	Hacienda Arch	Zone 7	Dublin	Upper	327.82	70	2	50 - 70
3S/1E 7G 7	monitor	Chabot Well	Zone 7	Dublin	Upper	327.33	55	2	35 - 55
3S/1E 7J 5	monitor	Thomas Hart School	Zone 7	Dublin	Upper	326.78	50	2	30 - 50
3S/1E 8B 1	monitor	Lizard Well	Zone 7	Amador	Upper	338.28	148	4	55 - 82
3S/1E 8G 4	monitor	Apache	Zone 7	Amador	Upper	341.47	85	2	60 - 85
3S/1E 8H 9	nested	Mocho 4 Nested Shallow	DSRSD	Amador	Lower	338.53	240	2	210 - 230
3S/1E 8H10	nested	Mocho 4 Nested Middle	DSRSD	Amador	Lower	339.26	440	2	290 - 430
3S/1E 8H11	nested	Mocho 4 Nested deep	DSRSD	Amador	Deep	339.26	720	2	520 - 720
3S/1E 8H13	monitor	Mocho 3 mon	Zone 7	Amador	Deep	338.96	800	2	570 - 790
3S/1E 8H18	muni	Mocho 4	Zone 7	Amador	Lower	341.94	745	20	515 - 730
3S/1E 8K 1	monitor	Cockroach well	Zone 7	Amador	Upper	332.37	99	2.5	89 - 94
3S/1E 8N 1	monitor	sports park	Zone 7	Bernal	Upper	323.68	72	2.5	62 - 67
3S/1E 9H10	nested	NW Lake I Shallow	Zone 7	Amador	Upper	352.89	145	2	120 - 140
3S/1E 9H11	nested	NW Lake I Deep	Zone 7	Amador	Lower	353.04	190	2	165 - 185
3S/1E 9J 7	nested	SW Lake I Shallow	Zone 7	Amador	Upper	357.36	505	2	120 - 140
3S/1E 9J 8	nested	SW Lake I Middle	Zone 7	Amador	Lower	357.55	305	2	280 - 300
3S/1E 9J 9	nested	SW Lake I Deep	Zone 7	Amador	Lower	357.68	505	2	480 - 500
3S/1E 9M 2	muni	Mocho 1	Zone 7	Amador	Lower	343.95	530	16	150 - 510
3S/1E 9M 3	muni	Mocho 2	Zone 7	Amador	Lower	347.47	575	18	250 - 570
3S/1E 9M 4	muni	Mocho 3	Zone 7	Amador	Lower	342.89	498	20	315 - 493
3S/1E 9P 5	monitor	Key_AmW_U (Mohr Key)	Zone 7	Amador	Upper	349.4	105	2.5	95 - 100
3S/1E 9P 9	nested	Mohr Ave Shallow	Zone 7	Amador	Lower	349.59	210	2	185 - 205
3S/1E 9P10	nested	Key_AmW_L	Zone 7	Amador	Lower	349.51	310	2	285 - 305
3S/1E 9P11	nested	Mohr Ave Deep	Zone 7	Amador	Lower	349.44	425	2	405 - 420
3S/1E 10A 2	monitor	El C harro Rd	Zone 7	Amador	Upper	367.35	88	4	70 - 80
3S/1E 10B 8	nested	Kaiser Rd Shallow	<Null>	Amador	Lower	353.6	200	2	100 - 190
3S/1E 10B 9	nested	Kaiser Rd Middle 1	DSRSD	Amador	Lower	353.49	294	2	244 - 284
3S/1E 10B10	nested	Kaiser Rd Middle 2	DSRSD	Amador	Lower	353.52	600	2	400 - 590
3S/1E 10B11	nested	Kaiser Rd Deep	DSRSD	Amador	Deep	353.52	810	2	660 - 800
3S/1E 10B14	monitor	COL 5 Monitoring	Zone 7	Amador	Lower	355.591	690	2	390 - 690
3S/1E 10D 2	nested	Stoneridge Shallow	DSRSD	Amador	Lower	349.32	212	2	182 - 212
3S/1E 10D 3	nested	Stoneridge Middle 1	DSRSD	Amador	Lower	349.28	322	2	262 - 312
3S/1E 10D 4	nested	Stoneridge Middle 2	DSRSD	Amador	Lower	349.3	616	2	366 - 606
3S/1E 10D 5	nested	Stoneridge Deep	DSRSD	Amador	Deep	349.32	790	2	710 - 780
3S/1E 10D 7	nested	North Lake I Shallow	Zone 7	Amador	Upper	361.06	145	2	118 - 138
3S/1E 10D 8	nested	North Lake I Cluster 2	Zone 7	Amador	Lower	361.02	215	2	190 - 210
3S/1E 10K 2	monitor	COL 1 Monitoring	Zone 7	Amador	Lower	358.68	590.6	4	195.5 - 585.6
3S/1E 10N 2	nested	South Lake I Shallow	Zone 7	Amador	Upper	358.16	195	2	125 - 145
3S/1E 10N 3	nested	South Lake I Deep	Zone 7	Amador	Lower	358	195	2	170 - 190
3S/1E 11B 1	monitor	Airport West	Zone 7	Amador	Upper	369.35	43	2.5	33 - 38
3S/1E 11C 3	monitor	LAVWMA ROW	Zone 7	Amador	Upper	364.82	55	2	35 - 55
3S/1E 11G 1	nested	Key_AmE_U	DSRSD	Amador	Upper	371.62	120	2	100 - 110
3S/1E 11G 2	nested	Rancho Charro Middle 1	DSRSD	Amador	Lower	371.61	350	2	230 - 340
3S/1E 11G 3	nested	Rancho Charro Middle 2	DSRSD	Amador	Lower	371.64	590	2	380 - 580
3S/1E 11G 4	nested	Rancho Charro Deep	DSRSD	Amador	Deep	371.68	790	2	620 - 780
3S/1E 11M 2	monitor	COL 2 Monitoring	Zone 7	Amador	Lower	365.96	700	4.5	199 - 699
3S/1E 11P 6	domestic	New Jamieson Residence	DOUG JAMIESON	Amador	Lower	376.67	400	5	240 - 380

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Dia = Diameter of well casing (in inches)
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Site	*Type*	*Other Name*	*Owner*	*Basin*	*Aquifer*	*RP*	*TD*	*Dia*	*Perf*
3S/1E 12A 2	monitor	Airport South	Zone 7	Amador	Upper	401.35	69	2.5	63.7 - 68.7
3S/1E 12D 2	monitor	LWRP G6	Zone 7	Amador	Upper	384.45	44.6		36 - 41
3S/1E 12G 1	monitor	Oaks Park Shallow	Zone 7	Amador	Upper	404.47	73	2.5	63 - 68
3S/1E 12H 4	nested	LWRP Shallow	CITY OF LIVERMORE	Amador	Lower	407.75	270	2	185 - 260
3S/1E 12H 5	nested	LWRP Middle 1	CITY OF LIVERMORE	Amador	Lower	407.78	400	2	360 - 390
3S/1E 12H 6	nested	LWRP Middle 2	CITY OF LIVERMORE	Amador	Lower	407.75	480	2	410 - 468
3S/1E 12H 7	nested	LWRP Deep	CITY OF LIVERMORE	Amador	Deep	407.67	684	2	609 - 674
3S/1E 12K 2	nested	Oaks Park Mid	Zone 7	Amador	Lower	406.29	300	2	210 - 295
3S/1E 12K 3	nested	Key_AmE_L	Zone 7	Amador	Lower	406.83	475	2	355 - 470
3S/1E 12K 4	nested	Oaks Park Deep	Zone 7	Amador	Deep	406.71	575	2	550 - 570
3S/1E 13P 5	nested	LGA Grant Nested 1	Zone 7	Amador	Upper	399.97	135	2	110 - 130
3S/1E 13P 6	nested	LGA Grant Nested 2	Zone 7	Amador	Lower	399.93	255	2	230 - 250
3S/1E 13P 7	nested	LGA Grant Nested 3	Zone 7	Amador	Lower	399.97	375	2	350 - 370
3S/1E 13P 8	nested	LGA Grant Nested 4	Zone 7	Amador	Lower	399.94	605	2	580 - 600
3S/1E 14B 1	industrial	Industrial Asphalt	VULCAN MATERIALS	Amador	Lower	384.2	435	8	200 - 410
3S/1E 14D 2	monitor	South Cope Lake	Zone 7	Amador	Lower	371.83	740	16	170 - 740
3S/1E 15F 3	supply	kaiser #8	KAISER	Amador	Lower	368.99	640	14	195 - 615
3S/1E 15J 3	supply	shadow cliff	EAST BAY REGIONAL PARK	Amador	Lower	344.59	196	8	154 - 184
3S/1E 15M 3	monitor	Bush/Valley South	Zone 7	Amador	Lower	362.88	600	2	280 - 590
3S/1E 16A 4	monitor	Bush/Valley Mid	Zone 7	Amador	Lower	359.36	603	2	260 - 580
3S/1E 16B 1	monitor	Bush/Valley North	Zone 7	Amador	Deep	355.81	805	2	605 - 800
3S/1E 16C 2	nested	Santa Rita Valley Shallow	Zone 7	Amador	Lower	344.38	190	2	165 - 185
3S/1E 16C 3	nested	Santa Rita Valley Middle	Zone 7	Amador	Lower	344.27	305	2	280 - 300
3S/1E 16C 4	nested	Santa Rita Valley Deep	Zone 7	Amador	Lower	344.16	375	2	355 - 370
3S/1E 16E 4	monitor	black ave - cultural	Zone 7	Amador	Upper	351.69	105	2.5	95 - 100
3S/1E 16L 2	monitor	Pleas 4	CITY OF PLEASANTON	Amador	Lower	355.86	151	12	56 - 136
3S/1E 16P 5	monitor	Vervais Monitor	Zone 7	Amador	Upper	354.51	75	2.5	64 - 69
3S/1E 16R 1	supply	Stanley Berry Farm	R.L. IRBY	Amador	Lower	362.5	239	10	70 - 226
3S/1E 17B 4	supply	Casterson	LLOYD HAINES	Amador	Lower	337.69	248	8	0 - 248
3S/1E 17D 3	nested	Hopyard Nested Shallow	Zone 7	Bernal	Lower	325.13	108	4	92 - 98
3S/1E 17D 4	nested	Hopyard Nested Middle 1	Zone 7	Bernal	Lower	325.14	236	4	206 - 226
3S/1E 17D 5	nested	Hopyard Nested Middle 2	Zone 7	Bernal	Lower	325.13	308	4	266 - 286
3S/1E 17D 6	nested	Hopyard Nested Middle 3	Zone 7	Bernal	Lower	325.12	408	4	378 - 398
3S/1E 17D 7	nested	Hopyard Nested Deep	Zone 7	Bernal	Deep	325.13	684	4	654 - 674
3S/1E 17D10	monitor	Hopyard 7	Zone 7	Bernal	Lower	328.13	425	24	185 - 415
3S/1E 17D11	monitor	Hopyard 9 Monitoring Well	Zone 7	Bernal	Lower	324.84	603	2	340 - 505
3S/1E 18A 5	muni	Pleas 7	CITY OF PLEASANTON	Bernal	Lower	329.05	454	18	120 - 440
3S/1E 18E 4	monitor	Valley Trails II	Zone 7	Bernal	Upper	320.21	83	4	69 - 79
3S/1E 18J 2	monitor	camino segura	Zone 7	Bernal	Upper	323.02	71	2.5	61 - 66
3S/1E 18N 1	supply	merritt	RALPH MERRITT	Bernal	Lower	319.43	708	12	229 - 610
3S/1E 19A10	muni	SFWD South (B)	SFPUC	Bernal	Lower	337.02	331		189 - 327
3S/1E 19A11	muni	SFWD North (A)	SFPUC	Bernal	Lower	334.27	330	18	196 - 320
3S/1E 19C 4	monitor	del valle & laguna	Zone 7	Bernal	Upper	322.23	78	4	68 - 73
3S/1E 19K 1	monitor	680/bernal	Zone 7	Bernal	Upper	321.54	57.6	2.5	47.6 - 52.6
3S/1E 20B 2	supply	Fairgrounds Potable	ALAMEDA COUNTY	Bernal	Lower	344.03	500	12	218 - 500
3S/1E 20C 7	monitor	Key_Bern_U	Zone 7	Bernal	Upper	338.66	153	2	65 - 145
3S/1E 20C 8	nested	Key_Bern_L	Zone 7	Bernal	Lower	338.67	315	2	295 - 315
3S/1E 20C 9	nested	Fair Nested Deep	Zone 7	Bernal	Lower	338.78	515	2	495 - 515
3S/1E 20J 4	monitor	civic center	Zone 7	Bernal	Upper	331.62	72	2.5	62 - 67
3S/1E 20M11	monitor	S.F "M"LINE	Zone 7	Bernal	Upper	325.73	71	2.5	61 - 66
3S/1E 20Q 2	supply	20Q2	CITY OF PLEASANTON	Bernal	Upper	325.82	65	10	45 - 53

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Site	Type	Other Name	Owner	Basin	Aquifer	RP	TD	Dia	Perf
3S/1E 22D 2	monitor	vineyard trailer	Zone 7	Amador	Upper	368.05	72	2.5	62 - 67
3S/1E 23J 1	supply	1627 vineyard trailer	D. SAFRENO	Amador	Lower	428.2	120	8	0 - 120
3S/1E 24Q 1	supply	Ruby Hills	RUBY HILLS	Amador	Lower	427.5	440	14	200 - 400
3S/1E 25C 3	monitor	Katz Winery Mansion	RUBY HILLS	Amador	Upper	454.16	146	2	70 - 140
3S/1E 29M 4	monitor	f.c. channel	Zone 7	Castle	Upper	310.94	57	2.5	47 - 52
3S/1E 29P 2	monitor	castlewood dr	Zone 7	Bernal	Upper	302.82	42	2.5	32 - 37
3S/1W 1B 9	nested	DSRSD Shallow	DSRSD	Dublin	Lower	333.56	162	2	122 - 152
3S/1W 1B10	nested	DSRSD Middle	DSRSD	Dublin	Lower	333.57	414	2	274 - 404
3S/1W 1B11	nested	DSRSD Deep	DSRSD	Dublin	Lower	333.74	560	2	480 - 550
3S/1W 2A 2	monitor	McNamara's	Zone 7	Dublin	Upper	369.4	47	2.5	37 - 42
3S/1W 12B 2	monitor	Stoneridge Mall Rd	Zone 7	Dublin	Upper	342.89	39.5	4	20 - 50
3S/1W 12J 1	monitor	DSRSD South	Zone 7	Dublin	Upper	329.31	62	2.5	52 - 57
3S/1W 13J 1	monitor	muirwood dr	Zone 7	Castle	Upper	343.94	48	2.5	39 - 44
3S/2E 1F 2	monitor	Brisa at Circuit City	Zone 7	Spring	Upper	572.99	68.6	2.5	59 - 64
3S/2E 2B 2	monitor	south front rd	Zone 7	Spring	Upper	539.45	46	2.5	36.9 - 41.9
3S/2E 3A 1	monitor	Bluebell	Zone 7	Spring	Upper	517.63	54	2.5	44 - 49
3S/2E 3K 3	monitor	first & S. front rd	Zone 7	Mocho I	Upper	522.83	60	2.5	50 - 55
3S/2E 5N 1	supply	Spider Well	TRAILER RANCH	Mocho II	Mixed	444	210	10	0 - 210
3S/2E 7C 2	monitor	york way - jaws - G4	Zone 7	Mocho II	Upper	420.84	49	2.5	39 - 44
3S/2E 7H 2	monitor	dakota	CITY OF LIVERMORE	Mocho II	Upper	442.85	54	2	44 - 54
3S/2E 7N 2	monitor	Isabel & Arroyo Mocho	Zone 7	Amador	Upper	422	162	2	132 - 152
3S/2E 7P 3	muni	CWS 24	CAL WATER SERVICE	Amador	Lower	431.46	510	16	300 - 490
3S/2E 7R 2	monitor	CWS 31 Monitoring	CAL WATER SERVICE	Mocho II	Deep	446	805	2	750 - 805
3S/2E 7R 3	muni	CWS 31	CAL WATER SERVICE	Upland	Lower	446	583	16	410 - 528
3S/2E 8H 2	monitor	North k	Zone 7	Mocho II	Upper	469.61	46	2.5	36 - 41
3S/2E 8H 3	nested	Key_Mo2_L	Zone 7	Mocho II	Lower	477.25	195	2	170 - 190
3S/2E 8H 4	nested	N Liv Ave Deep	Zone 7	Mocho II	Lower	476.97	385	2	360 - 380
3S/2E 8K 2	monitor	Key_Mo2_U (Livermore Key)	Zone 7	Mocho II	Upper	464.78	74	2.5	64 - 69
3S/2E 8N 2	muni	CWS 14	CAL WATER SERVICE	Mocho II	Lower	453.64	526	10	140 - 515
3S/2E 8P 1	muni	CWS 8	CAL WATER SERVICE	Mocho II	Lower	468.2	273	10	122 - 263
3S/2E 8Q 9	monitor	D-2	B&C GAS	Mocho II	Lower	464.7	114	2	99 - 114
3S/2E 9Q 4	monitor	school st	Zone 7	Mocho II	Upper	504.495	80	2.5	70 - 75
3S/2E 10F 3	monitor	hexcel	Zone 7	Mocho I	Upper	534.84	45	2.5	35 - 40
3S/2E 10Q 1	monitor	almond	Zone 7	Mocho II	Upper	555.36	43.5	2.5	33.5 - 39
3S/2E 10Q 2	monitor	LLNL W-703	LLNL	Mocho II	Lower	549.33	325	4.5	298 - 325
3S/2E 11C 1	monitor	joan way	Zone 7	Mocho I	Upper	557.1	66.2	2.5	56.2 - 61.2
3S/2E 12C 4	monitor	LLNL W-486	LLNL	Spring	Upper	591.46	108	4.5	100 - 108
3S/2E 12J 3	monitor	LLNL W-017A	LLNL	Spring	Lower	628.84	160	5	127 - 157
3S/2E 14A 3	monitor	S. vasco @east ave	Zone 7	Mocho I	Upper	601.87	110	2.5	100 - 105
3S/2E 14B 1	domestic	5763 east ave	LAS POSITAS SWIM CLUB	Mocho I	Lower	593.36	300	9	146 - 234
3S/2E 15E 2	irrigation	Retzlaff Winery	BOB TAYLOR	Mocho II	Lower	549.69	192	8	104 - 189
3S/2E 15L 1	monitor	Concannon 2	CONCANNON	Mocho II	Upper	561.5	40.5	2	20 - 40.5
3S/2E 15M 2	monitor	Concannon 1	CONCANNON	Mocho II	Upper	549.46	45	2	25 - 45
3S/2E 15Q 6	irrigation	Concannon Old Pumping	CONCANNON	Mocho II	Lower	577.56	301	12	220 - 301
3S/2E 15R17	nested	Buena Vista Shallow	Zone 7	Mocho II	Upper	592.41	63	2	38 - 58
3S/2E 15R18	nested	Buena Vista Deep	Zone 7	Mocho II	Lower	592.47	138	2	113 - 133
3S/2E 16A 3	irrigation	Memory Gardens	MEMORY GARDENS	Mocho II	Lower	527.06	240	10	91 - 240
3S/2E 16C 1	muni	CWS 15	CAL WATER SERVICE	Mocho II	Lower	510.97	584	16	150 - 523
3S/2E 16E 4	monitor	pepper tree	Zone 7	Mocho II	Upper	506.26	45	2.5	35 - 40
3S/2E 18B 1	muni	CWS 20	CAL WATER SERVICE	Amador	Lower	438.56	497	16	190 - 465
3S/2E 18E 1	monitor	E. stanley	Zone 7	Amador	Upper	423.86	133.8	2.5	123.8 - 128.8

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Site	Type	Other Name	Owner	Basin	Aquifer	RP	TD	Dia	Perf
3S/2E 19D 7	nested	Isabel Shallow	Zone 7	Amador	Upper	415.07	180	2	100 - 180
3S/2E 19D 8	nested	Isabel Middle 1	Zone 7	Amador	Lower	415.04	260	2	210 - 260
3S/2E 19D 9	nested	Isabel Middle 2	Zone 7	Amador	Lower	414.98	390	2	280 - 390
3S/2E 19D10	nested	Isabel Deep	Zone 7	Amador	Lower	414.89	470	2	420 - 470
3S/2E 19N 3	nested	Shallow Cemex Nested	CEMEX - Rob Walker	Amador	Upper	418.45	120	2	105 - 115
3S/2E 19N 4	nested	Deep Cemex Nested	CEMEX - Rob Walker	Amador	Lower	417.96	203	2	188 - 198
3S/2E 20M 1	supply	Alden Lane	ALDEN LANE NURSERY	Amador	Lower	478.79	184	12	0 - 184
3S/2E 22B 1	monitor	grapes	Zone 7	Mocho II	Upper	585.88	31.9	2.5	21.9 - 26.9
3S/2E 23E 1	nested	Mines Nested Shallow	Zone 7	Mocho II	Upper	613.36	40	2	20 - 35
3S/2E 23E 2	nested	Mines Nested Deep	Zone 7	Mocho II	Lower	613.23	110	2	95 - 105
3S/2E 24A 1	monitor	S. greenville	Zone 7	Mocho I	Upper	717.7	46.3	2.5	36.3 - 41.3
3S/2E 26J 2	monitor	mines rd	Zone 7	Mocho II	Upper	689.92	44	2.5	34 - 39
3S/2E 29F 4	monitor	usgs wetmore	Zone 7	Amador	Upper	457.5	36	2.5	26 - 31
3S/2E 30C 1	supply	Vineyard 30C 1	WHITE OAK LANDSCAPE	Amador	Lower	439.41	150	6	125 - 145
3S/2E 30D 2	monitor	vineyard	Zone 7	Amador	Upper	431.6	44	4	24 - 39
3S/2E 32E 7	monitor	DVWTP 32E7	Zone 7	Upland	Upper	610.94	37	6	19 - 34
3S/2E 33G 1	monitor	Crohare	Zone 7	Amador	Upper	511.52	17	2.5	9 - 14
3S/2E 33K 1	monitor	VA	Zone 7	Amador	Upper	546.83	15	2.5	7 - 12
3S/2E 33L 1	monitor	VA/CROHARE FENCE	Zone 7	Amador	Upper	557.63	25	2.5	11 - 16
3S/3E 6Q 3	monitor	PPWTP South Monitoring	Zone 7	Altamont	Upper	681.07	30	2	20 - 30
3S/3E 6Q 4	monitor	PPWTP North Monitoring	Zone 7	Altamont	Upper	690.04	30	2	20 - 30
3S/3E 7D 2	monitor	7D 2	Zone 7	Spring	Upper	622.84	72	2.5	64 - 69

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TABLE 6-3
SEMIANNUAL GROUNDWATER LEVELS
(Feet above Mean Sea Level, NAVD88)
FALL 2018 TO FALL 2019

				Fall 2018		Spring 2019		Fall 2019		Change in Elevation (ft)		
										Seasonal		Annual
Well Number	Well Depth	Aquifer	Subarea	Depth to Water	GW Elev	Depth to Water (ft)	GW Elev	Depth to Water (ft)	GW Elev	Fall 18 to Spring 19	Spring 19 to Fall 19	Fall 18 to Fall 19
1S/4E 31P 5	24	U	Tracy	16.8	43.2	16.9	43.2	17.6	42.4	0.0	-0.8	-0.8
2S/1E 32E 1	70	U	None	36.5	356.0	32.5	360.0	34.5	358.0	4.0	-2.0	2.0
2S/1E 32N 1	44	U	Camp	19.6	341.2	16.1	344.7	17.7	343.1	3.5	-1.5	2.0
2S/1E 32Q 1	45	U	Camp	27.5	340.1	25.2	342.4	26.1	341.5	2.3	-0.9	1.4
2S/1E 33L 1	80	U	None	50.7	338.8	49.7	339.8	48.1	341.3	1.1	1.5	2.6
2S/1E 33P 2	55	U	Camp	31.9	338.2	30.7	339.4	30.4	339.7	1.2	0.3	1.5
2S/1E 33R 1	60	U	None	19.9	338.6	18.3	340.2	17.9	340.6	1.6	0.4	2.0
2S/1W 15F 1	60	U	Bishop	10.1	429.3	8.8	430.7	9.8	429.6	1.4	-1.1	0.3
2S/1W 26C 2	50	U	Dublin	25.6	380.9	20.9	385.6	23.9	382.6	4.7	-3.0	1.7
2S/1W 36E 3	60	U	Dublin	4.8	341.8	2.8	343.7	4.1	342.4	2.0	-1.3	0.6
2S/1W 36F 1	190	L	Dublin	20.3	322.5	10.7	332.1	10.5	332.2	9.6	0.2	9.8
2S/1W 36F 2	320	L	Dublin	14.2	328.5	10.2	332.5	7.8	335.0	4.0	2.4	6.4
2S/1W 36F 3	520	L	Dublin	29.5	313.2	19.2	323.6	15.6	327.2	10.3	3.6	14.0
2S/2E 27C 2	108	U	Spring	4.7	537.4	12.5	529.7	12.5	529.7	-7.8	0.0	-7.8
2S/2E 27P 2	68	U	Spring	3.2	502.2	1.1	504.4	2.8	502.6	2.1	-1.8	0.4
2S/2E 28D 2	55	U	May	31.3	523.9	30.7	524.5	30.6	524.6	0.6	0.2	0.8
2S/2E 28J 2	230	L	May	6.2	516.1	5.4	516.9	6.6	515.7	0.8	-1.2	-0.4
2S/2E 28Q 1	28	U	May	6.7	506.3	2.7	510.4	6.7	506.3	4.1	-4.1	0.0
2S/2E 32K 2	43	U	Cayetano	8.8	498.6	7.0	500.4	8.7	498.8	1.8	-1.7	0.1
2S/2E 34E 1	49	U	May	5.8	493.9	2.7	497.1	5.7	494.1	3.1	-3.0	0.1
2S/2E 34Q 2	50	U	Spring	4.9	502.4	2.2	505.1	3.7	503.6	2.7	-1.5	1.2
2S/3E 1D 1	80	U	Tracy	10.5	79.6	6.8	83.2	9.4	80.7	3.6	-2.5	1.1
3S/1E 1F 2	40	U	Camp	19.5	408.9	19.2	409.2	18.8	409.6	0.3	0.4	0.7
3S/1E 1H 3	80	U	Camp	26.5	396.3	23.9	398.9	25.6	397.3	2.6	-1.7	0.9
3S/1E 1L 1	70	U	Camp	51.3	351.8	50.2	352.8	51.7	351.3	1.1	-1.5	-0.4
3S/1E 1P 2	50	U	Amador	18.9	370.8	17.4	372.2	19.4	370.2	1.5	-2.0	-0.5
3S/1E 1P 3	480	L	Amador	121.0	273.5	122.2	272.2	118.9	275.6	-1.3	3.3	2.1
3S/1E 2J 2	41	U	Camp	13.7	367.2	9.4	371.5	13.3	367.6	4.3	-3.9	0.4
3S/1E 2J 3	65	U	Camp	25.6	380.8	25.0	381.3	25.2	381.2	0.6	-0.2	0.4
3S/1E 2K 2	46	U	Camp	25.5	371.6	23.5	373.5	24.9	372.1	1.9	-1.4	0.5
3S/1E 2M 3	50	U	Camp	16.6	348.5	13.8	351.3	15.6	349.4	2.8	-1.8	1.0
3S/1E 2N 6	55	U	Amador	29.5	336.6	25.0	341.1	28.9	337.3	4.5	-3.9	0.6
3S/1E 2P 3	380	L	Camp	97.7	274.0	111.9	259.8	97.0	274.8	-14.2	15.0	0.7
3S/1E 2Q 1	45	U	Amador	19.2	350.7	14.5	355.5	19.2	350.7	4.7	-4.7	0.0
3S/1E 2R 1	33	U	Amador	17.0	359.3	12.1	364.2	17.0	359.3	4.9	-4.9	0.1
3S/1E 3G 2	50	U	Camp	11.2	343.1	7.7	346.5	8.4	345.8	3.5	-0.7	2.8
3S/1E 4A 1	50	U	Camp	16.4	334.3	14.8	335.9	15.1	335.6	1.6	-0.2	1.3
3S/1E 4J 5	47	U	Camp	14.5	330.7	12.1	333.1	13.4	331.8	2.4	-1.3	1.1
3S/1E 4J 6	110	U	Camp	15.1	330.4	13.5	332.0	13.9	331.7	1.6	-0.4	1.3
3S/1E 4Q 2	90	U	Amador	30.9	314.5	30.4	315.0	33.8	311.7	0.5	-3.4	-2.9
3S/1E 5K 6	75	U	Camp	13.7	332.4	11.8	334.2	12.8	333.3	1.8	-1.0	0.8
3S/1E 5K 7	150	L	Camp	16.8	329.4	15.9	330.3	16.5	329.7	0.9	-0.6	0.4
3S/1E 5L 3	40	U	Camp	12.6	326.8	12.2	327.2	12.5	327.0	0.4	-0.3	0.2
3S/1E 5P 6	35	U	Camp	10.6	326.0	10.3	326.4	10.7	326.0	0.3	-0.4	-0.1
3S/1E 6F 3	36	U	Dublin	5.9	323.9	4.0	325.8	5.1	324.7	1.9	-1.1	0.8
3S/1E 6G 5	200	L	Dublin	9.4	322.8	7.2	325.0	7.9	324.3	2.2	-0.7	1.5
3S/1E 6N 2	67	U	Dublin	14.0	321.2	11.9	323.3	13.0	322.2	2.1	-1.1	1.1
3S/1E 7B 2	152	L	Dublin	9.0	318.8	7.8	320.0	8.4	319.4	1.2	-0.6	0.6
3S/1E 7B12	70	U	Dublin	10.8	317.1	9.7	318.1	10.6	317.2	1.0	-0.9	0.1
3S/1E 7G 7	55	U	Dublin	12.0	315.4	10.9	316.5	11.7	315.6	1.1	-0.8	0.2
3S/1E 7J 5	50	U	Dublin	14.0	312.8	13.4	313.4	13.9	312.9	0.7	-0.5	0.1
3S/1E 8B 1	148	U	Amador	32.5	305.8	32.4	305.9	34.3	304.0	0.1	-1.9	-1.8
3S/1E 8G 4	85	U	Amador	35.3	306.2	35.4	306.1	37.4	304.1	-0.1	-2.1	-2.2
3S/1E 8H 9	240	L	Amador	43.3	295.2	47.5	291.1	42.7	295.9	-4.1	4.8	0.7
3S/1E 8H10	440	L	Amador	50.3	289.0	53.1	286.2	46.7	292.5	-2.8	6.3	3.6
3S/1E 8H11	720	D	Amador	57.0	282.3	85.3	253.9	53.5	285.8	-28.3	31.8	3.5
3S/1E 8H13	800	D	Amador	54.6	284.3	77.7	261.3	52.8	286.1	-23.1	24.9	1.8
3S/1E 8H18	745	L	Amador	61.2	280.8	NA	-	57.9	284.1	-	-	3.3
3S/1E 8K 1	99	U	Amador	32.4	300.0	31.7	300.6	33.6	298.8	0.6	-1.8	-1.2
3S/1E 8N 1	72	U	Bernal	24.3	299.4	22.1	301.6	24.6	299.1	2.2	-2.5	-0.3
3S/1E 9H10	145	U	Amador	39.3	313.6	39.0	313.9	42.6	310.3	0.3	-3.6	-3.3
3S/1E 9H11	190	L	Amador	50.5	302.6	51.3	301.8	52.3	300.8	-0.8	-1.0	-1.8
3S/1E 9J 7	505	U	Amador	45.0	312.4	44.7	312.7	48.2	309.2	0.3	-3.5	-3.2
3S/1E 9J 8	305	L	Amador	62.0	295.6	63.7	293.8	62.8	294.7	-1.8	0.9	-0.8
3S/1E 9J 9	505	L	Amador	75.6	282.1	82.6	275.1	72.2	285.5	-6.9	10.4	3.5
3S/1E 9M 2	530	L	Amador	NA	-	NA	-	48.0	296.0	-	-	-
3S/1E 9M 3	575	L	Amador	55.0	292.5	59.7	287.8	51.8	295.7	-4.7	7.9	3.2
3S/1E 9M 4	498	L	Amador	NA	-	NA	-	32.7	310.2	-	-	-
3S/1E 9P 5	105	U	Amador	41.4	308.0	41.2	308.2	44.0	305.4	0.1	-2.8	-2.6
3S/1E 9P 9	210	L	Amador	46.8	302.8	47.3	302.3	48.9	300.7	-0.5	-1.6	-2.1
3S/1E 9P10	310	L	Amador	53.9	295.6	55.6	294.0	55.1	294.4	-1.7	0.4	-1.2

U = Upper; L = Lower; NM = Not Measured; NA = Not Available
OBS = Obstructed; - = Not Applicable; highlight = Key Well
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TABLE 6-3
SEMIANNUAL GROUNDWATER LEVELS
(Feet above Mean Sea Level, NAVD88)
FALL 2018 TO FALL 2019

				Fall 2018		Spring 2019		Fall 2019		Change in Elevation (ft)		
										Seasonal		Annual
Well Number	Well Depth	Aquifer	Subarea	Depth to Water	GW Elev	Depth to Water (ft)	GW Elev	Depth to Water (ft)	GW Elev	Fall 18 to Spring 19	Spring 19 to Fall 19	Fall 18 to Fall 19
1S/4E 31P 5	24	U	Tracy	16.8	43.2	16.9	43.2	17.6	42.4	0.0	-0.8	-0.8
2S/1E 32E 1	70	U	None	36.5	356.0	32.5	360.0	34.5	358.0	4.0	-2.0	2.0
2S/1E 32N 1	44	U	Camp	19.6	341.2	16.1	344.7	17.7	343.1	3.5	-1.5	2.0
2S/1E 32Q 1	45	U	Camp	27.5	340.1	25.2	342.4	26.1	341.5	2.3	-0.9	1.4
2S/1E 33L 1	80	U	None	50.7	338.8	49.7	339.8	48.1	341.3	1.1	1.5	2.6
2S/1E 33P 2	55	U	Camp	31.9	338.2	30.7	339.4	30.4	339.7	1.2	0.3	1.5
3S/1E 9P11	425	L	Amador	67.1	282.3	70.9	278.5	65.9	283.5	-3.8	5.0	1.2
3S/1E 10A 2	88	U	Amador	42.7	324.7	41.5	325.9	44.8	322.6	1.2	-3.3	-2.1
3S/1E 10B 8	200	L	Amador	48.8	304.9	48.2	305.4	49.0	304.6	0.6	-0.8	-0.3
3S/1E 10B 9	294	L	Amador	60.3	293.2	61.9	291.6	61.5	292.0	-1.6	0.4	-1.3
3S/1E 10B10	600	L	Amador	74.2	279.3	81.0	272.5	73.1	280.4	-6.8	7.9	1.1
3S/1E 10B11	810	D	Amador	74.2	279.3	83.7	269.8	75.9	277.6	-9.5	7.8	-1.8
3S/1E 10B14	690	L	Amador	79.1	276.5	86.5	269.1	78.5	277.1	-7.3	8.0	0.6
3S/1E 10D 2	212	L	Amador	47.9	301.4	48.9	300.4	49.6	299.7	-1.0	-0.7	-1.7
3S/1E 10D 3	322	L	Amador	55.4	293.9	57.7	291.6	56.0	293.3	-2.3	1.7	-0.6
3S/1E 10D 4	616	L	Amador	68.4	280.9	76.0	273.3	65.0	284.3	-7.7	11.1	3.4
3S/1E 10D 5	790	D	Amador	69.9	279.4	85.5	263.9	70.0	279.3	-15.6	15.5	-0.1
3S/1E 10D 7	145	U	Amador	43.6	317.5	42.1	319.0	46.3	314.8	1.5	-4.2	-2.8
3S/1E 10D 8	215	L	Amador	59.1	302.0	60.0	301.1	60.7	300.3	-0.9	-0.7	-1.6
3S/1E 10K 2	591	L	Amador	67.0	291.7	69.4	289.3	68.6	290.1	-2.4	0.8	-1.6
3S/1E 10N 2	195	U	Amador	43.2	315.0	42.2	315.9	46.1	312.1	1.0	-3.8	-2.9
3S/1E 10N 3	195	L	Amador	55.1	302.9	55.6	302.4	57.2	300.8	-0.5	-1.6	-2.1
3S/1E 11B 1	43	U	Amador	29.3	340.1	28.4	341.0	29.0	340.4	0.9	-0.6	0.3
3S/1E 11C 3	55	U	Amador	30.3	334.5	28.8	336.0	30.4	334.4	1.5	-1.6	-0.1
3S/1E 11G 1	120	U	Amador	53.6	318.0	54.2	317.4	54.4	317.2	-0.6	-0.3	-0.8
3S/1E 11G 2	350	L	Amador	100.5	271.1	110.9	260.8	99.1	272.6	-10.4	11.8	1.4
3S/1E 11G 3	590	L	Amador	96.8	274.8	116.2	255.4	95.2	276.5	-19.4	21.0	1.6
3S/1E 11G 4	790	D	Amador	93.2	278.5	117.5	254.2	95.2	276.5	-24.3	22.3	-2.0
3S/1E 11M 2	700	L	Amador	81.3	284.7	89.1	276.9	81.7	284.3	-7.8	7.4	-0.4
3S/1E 11P 6	400	L	Amador	NA	-	103.8	272.9	99.6	277.1	-	4.2	-
3S/1E 12A 2	69	U	Amador	32.9	368.5	31.0	370.4	31.1	370.3	1.9	-0.1	1.8
3S/1E 12D 2	45	U	Amador	29.0	355.5	31.0	353.5	30.0	354.5	-2.0	1.0	-1.0
3S/1E 12G 1	73	U	Amador	55.4	349.1	55.9	348.6	55.2	349.3	-0.5	0.7	0.2
3S/1E 12H 4	270	L	Amador	143.7	264.1	146.2	261.5	140.5	267.3	-2.6	5.8	3.2
3S/1E 12H 5	400	L	Amador	135.2	272.6	153.6	254.2	133.0	274.7	-18.3	20.5	2.2
3S/1E 12H 6	480	L	Amador	133.3	274.5	152.0	255.7	131.9	275.8	-18.8	20.1	1.3
3S/1E 12H 7	684	D	Amador	153.1	254.6	115.4	292.3	113.3	294.4	37.7	2.1	39.8
3S/1E 12K 2	300	L	Amador	160.2	246.1	152.0	254.3	153.8	252.5	8.2	-1.8	6.4
3S/1E 12K 3	475	L	Amador	144.9	261.9	144.9	261.9	139.9	267.0	0.0	5.0	5.1
3S/1E 12K 4	575	D	Amador	131.1	275.7	116.9	289.8	118.5	288.2	14.2	-1.6	12.6
3S/1E 13P 5	135	U	Amador	106.0	294.0	105.9	294.1	106.2	293.8	0.1	-0.3	-0.2
3S/1E 13P 6	255	L	Amador	123.1	276.9	125.8	274.1	121.9	278.1	-2.8	4.0	1.2
3S/1E 13P 7	375	L	Amador	124.8	275.2	129.3	270.7	121.5	278.4	-4.5	7.7	3.2
3S/1E 13P 8	605	L	Amador	134.0	265.9	109.1	290.9	106.6	293.3	24.9	2.4	27.4
3S/1E 14B 1	435	L	Amador	108.3	275.9	117.6	266.6	107.9	276.3	-9.3	9.8	0.4
3S/1E 14D 2	740	L	Amador	83.0	288.8	84.5	287.3	83.7	288.1	-1.5	0.8	-0.7
3S/1E 15F 3	640	L	Amador	85.2	283.8	79.5	289.5	80.5	288.5	5.7	-1.0	4.7
3S/1E 15J 3	196	L	Amador	61.1	283.5	72.6	272.0	62.0	282.6	-11.5	10.6	-0.9
3S/1E 15M 3	600	L	Amador	84.1	278.8	75.3	287.6	83.0	279.9	8.9	-7.7	1.1
3S/1E 16A 4	603	L	Amador	76.4	283.0	76.7	282.7	75.3	284.0	-0.3	1.4	1.1
3S/1E 16B 1	805	D	Amador	74.4	281.4	78.1	277.7	77.7	278.1	-3.7	0.4	-3.3
3S/1E 16C 2	190	L	Amador	48.8	295.6	49.6	294.8	50.6	293.8	-0.8	-1.1	-1.8
3S/1E 16C 3	305	L	Amador	61.1	283.2	57.8	286.5	62.9	281.4	3.4	-5.1	-1.7
3S/1E 16C 4	375	L	Amador	63.4	280.8	62.5	281.7	67.0	277.2	0.9	-4.5	-3.6
3S/1E 16E 4	105	U	Amador	43.0	308.7	41.8	309.9	44.4	307.3	1.2	-2.6	-1.4
3S/1E 16L 2	151	L	Amador	48.0	298.3	49.2	297.1	50.2	296.1	-1.2	-1.0	-2.2
3S/1E 16P 5	75	U	Amador	38.1	316.4	37.0	317.6	38.5	316.0	1.2	-1.5	-0.4
3S/1E 16R 1	239	L	Amador	68.8	293.7	69.2	293.3	70.1	292.5	-0.4	-0.9	-1.3
3S/1E 17B 4	248	L	Amador	40.4	297.3	35.9	301.8	38.3	299.4	4.5	-2.4	2.1
3S/1E 17D 3	108	L	Bernal	29.3	295.8	24.0	301.1	27.0	298.1	5.3	-3.0	2.3
3S/1E 17D 4	236	L	Bernal	30.8	294.4	24.4	300.8	27.0	298.1	6.4	-2.6	3.8
3S/1E 17D 5	308	L	Bernal	29.8	295.4	23.9	301.2	27.0	298.2	5.9	-3.1	2.8
3S/1E 17D 6	408	L	Bernal	28.4	296.8	23.7	301.4	26.9	298.3	4.6	-3.1	1.5
3S/1E 17D 7	684	D	Bernal	20.5	304.7	19.7	305.4	19.7	305.4	0.8	0.0	0.8
3S/1E 17D10	425	L	Bernal	32.5	295.7	26.8	301.3	29.9	298.2	5.7	-3.1	2.6
3S/1E 17D11	603	L	Bernal	27.6	297.3	23.3	301.5	26.4	298.4	4.2	-3.1	1.1
3S/1E 18A 5	454	L	Bernal	44.3	283.0	36.2	291.1	32.2	295.1	8.1	4.0	12.1
3S/1E 18E 4	83	U	Bernal	22.4	297.8	19.3	300.9	22.8	297.4	3.1	-3.5	-0.4
3S/1E 18J 2	71	U	Bernal	24.1	299.0	21.0	302.0	24.5	298.5	3.1	-3.5	-0.4
3S/1E 18N 1	708	L	Bernal	25.1	294.3	22.6	296.8	24.3	295.1	2.5	-1.7	0.8
3S/1E 19A10	331	L	Bernal	40.6	296.4	36.2	300.8	39.9	297.2	4.4	-3.6	0.8

U = Upper; L = Lower; NM = Not Measured; NA = Not Available
OBS = Obstructed; - = Not Applicable; highlight = Key Well

TABLE 6-3
SEMIANNUAL GROUNDWATER LEVELS
(Feet above Mean Sea Level, NAVD88)
FALL 2018 TO FALL 2019

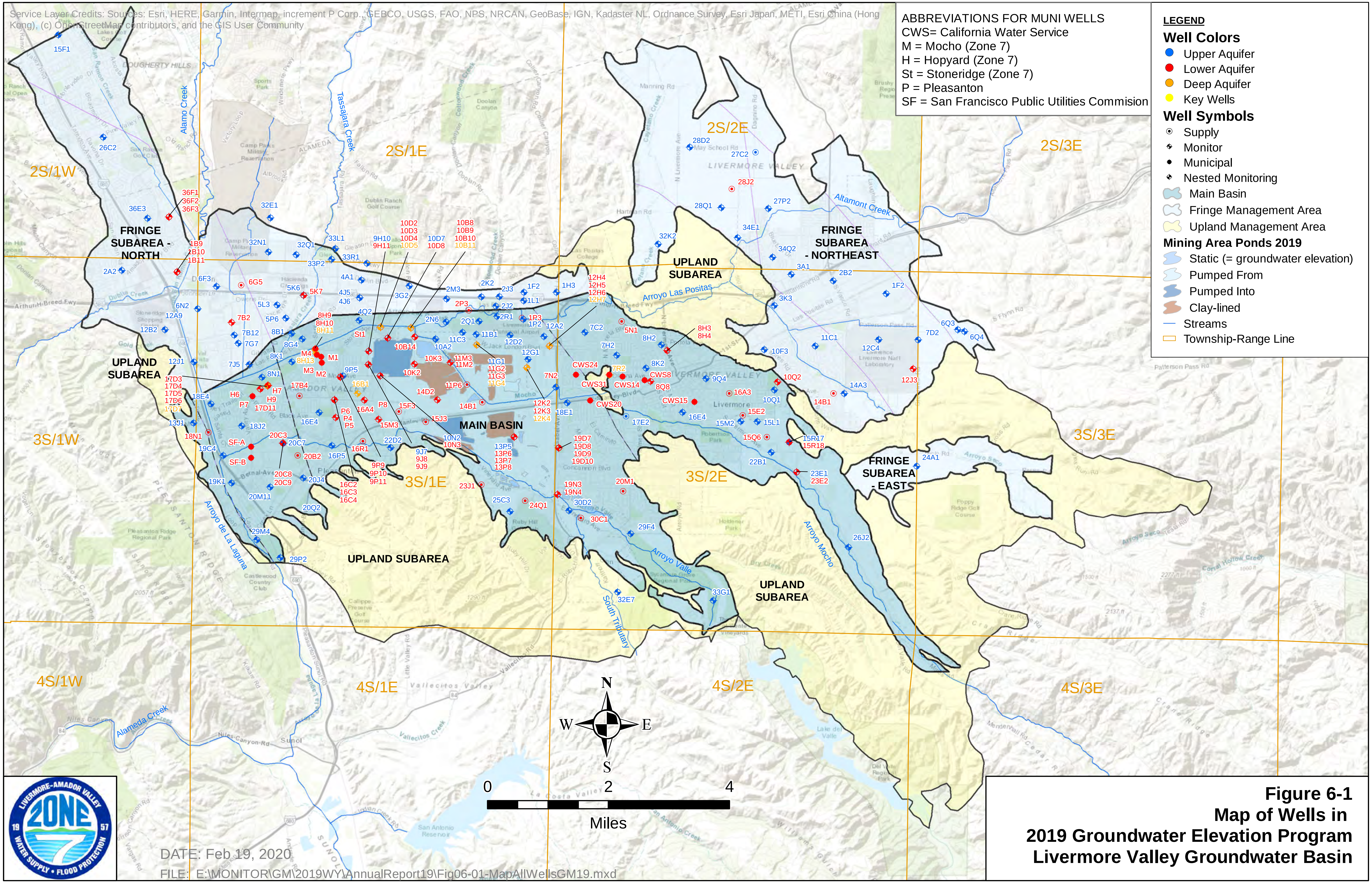
				Fall 2018		Spring 2019		Fall 2019		Change in Elevation (ft)		
										Seasonal		Annual
Well Number	Well Depth	Aquifer	Subarea	Depth to Water	GW Elev	Depth to Water (ft)	GW Elev	Depth to Water (ft)	GW Elev	Fall 18 to Spring 19	Spring 19 to Fall 19	Fall 18 to Fall 19
1S/4E 31P 5	24	U	Tracy	16.8	43.2	16.9	43.2	17.6	42.4	0.0	-0.8	-0.8
2S/1E 32E 1	70	U	None	36.5	356.0	32.5	360.0	34.5	358.0	4.0	-2.0	2.0
2S/1E 32N 1	44	U	Camp	19.6	341.2	16.1	344.7	17.7	343.1	3.5	-1.5	2.0
2S/1E 32Q 1	45	U	Camp	27.5	340.1	25.2	342.4	26.1	341.5	2.3	-0.9	1.4
2S/1E 33L 1	80	U	None	50.7	338.8	49.7	339.8	48.1	341.3	1.1	1.5	2.6
2S/1E 33P 2	55	U	Camp	31.9	338.2	30.7	339.4	30.4	339.7	1.2	0.3	1.5
3S/1E 19A11	330	L	Bernal	36.5	297.8	32.1	302.2	34.3	299.9	4.4	-2.3	2.2
3S/1E 19C 4	78	U	Bernal	22.5	299.7	19.4	302.9	22.7	299.5	3.1	-3.4	-0.2
3S/1E 19K 1	58	U	Bernal	24.5	297.1	20.7	300.8	24.0	297.5	3.8	-3.3	0.5
3S/1E 20C 7	153	U	Bernal	39.4	299.3	36.7	301.9	40.1	298.5	2.6	-3.4	-0.8
3S/1E 20C 8	315	L	Bernal	42.4	296.3	38.9	299.8	41.1	297.6	3.5	-2.2	1.3
3S/1E 20C 9	515	L	Bernal	41.7	297.1	38.4	300.4	41.4	297.4	3.3	-3.0	0.2
3S/1E 20J 4	72	U	Bernal	31.2	300.4	28.0	303.6	31.5	300.1	3.2	-3.5	-0.3
3S/1E 20M11	71	U	Bernal	23.7	302.1	20.3	305.4	24.0	301.8	3.3	-3.6	-0.3
3S/1E 20Q 2	65	U	Bernal	17.8	308.0	15.6	310.2	18.7	307.2	2.2	-3.0	-0.9
3S/1E 22D 2	72	U	Amador	48.0	320.1	45.1	323.0	47.0	321.1	2.9	-1.9	1.0
3S/1E 23J 1	120	L	Amador	90.4	337.8	83.9	344.3	87.6	340.6	6.5	-3.7	2.8
3S/1E 24Q 1	440	L	Amador	95.5	332.0	96.8	330.7	86.0	341.5	-1.3	10.8	9.6
3S/1E 25C 3	146	U	Amador	89.8	364.4	87.3	366.9	87.9	366.2	2.4	-0.6	1.8
3S/1E 29M 4	57	U	Castle	16.3	294.6	12.2	298.7	16.3	294.6	4.1	-4.1	0.0
3S/1E 29P 2	42	U	Bernal	26.8	276.0	24.7	278.1	26.8	276.0	2.1	-2.1	-0.1
3S/1W 1B 9	162	L	Dublin	12.7	320.9	7.6	326.0	8.5	325.1	5.1	-0.9	4.2
3S/1W 1B10	414	L	Dublin	9.4	324.2	6.5	327.1	4.3	329.3	2.8	2.2	5.1
3S/1W 1B11	560	L	Dublin	20.6	313.2	11.8	322.0	8.2	325.5	8.8	3.5	12.4
3S/1W 2A 2	47	U	Dublin	26.5	343.0	19.9	349.5	24.8	344.6	6.6	-4.9	1.7
3S/1W 12B 2	40	U	Dublin	21.6	321.3	8.0	334.9	20.9	322.0	13.5	-12.9	0.7
3S/1W 12J 1	62	U	Dublin	16.8	312.5	14.5	314.8	16.2	313.1	2.3	-1.7	0.6
3S/1W 13J 1	48	U	Castle	30.6	313.4	17.7	326.3	29.9	314.0	12.9	-12.2	0.7
3S/2E 1F 2	69	U	Spring	24.7	548.3	23.6	549.4	23.5	549.5	1.1	0.1	1.2
3S/2E 2B 2	46	U	Spring	10.0	529.4	8.3	531.2	9.6	529.9	1.7	-1.3	0.4
3S/2E 3A 1	54	U	Spring	8.6	509.0	4.1	513.5	5.6	512.0	4.5	-1.5	3.0
3S/2E 3K 3	60	U	Mocho I	13.8	509.0	13.2	509.7	13.6	509.3	0.6	-0.4	0.2
3S/2E 5N 1	210	M	Mocho II	35.3	408.7	26.9	417.1	29.8	414.2	8.3	-2.8	5.5
3S/2E 7C 2	49	U	Mocho II	26.7	394.1	23.9	397.0	25.3	395.5	2.8	-1.4	1.4
3S/2E 7H 2	54	U	Mocho II	31.7	411.2	24.2	418.6	27.1	415.7	7.4	-2.9	4.6
3S/2E 7N 2	162	U	Amador	130.7	291.3	111.5	310.5	120.0	302.0	19.2	-8.5	10.7
3S/2E 7P 3	510	L	Amador	NA	-	137.1	294.4	136.4	295.0	-	0.6	-
3S/2E 7R 2	805	D	Mocho II	3.5	442.5	2.7	443.3	3.2	442.8	0.8	-0.5	0.3
3S/2E 7R 3	583	L	Upland	100.8	345.2	68.4	377.6	85.5	360.5	32.4	-17.1	15.2
3S/2E 8H 2	46	U	Mocho II	40.1	429.5	24.9	444.7	29.6	440.1	15.2	-4.7	10.6
3S/2E 8H 3	195	L	Mocho II	60.7	416.6	46.4	430.9	50.6	426.7	14.3	-4.2	10.1
3S/2E 8H 4	385	L	Mocho II	119.5	357.4	97.3	379.7	105.2	371.8	22.2	-7.9	14.4
3S/2E 8K 2	74	U	Mocho II	40.0	424.8	28.5	436.3	32.4	432.4	11.5	-3.9	7.6
3S/2E 8N 2	526	L	Mocho II	65.9	387.8	41.0	412.7	48.4	405.3	24.9	-7.4	17.5
3S/2E 8P 1	273	L	Mocho II	49.3	418.9	35.1	433.1	39.3	428.9	14.2	-4.2	9.9
3S/2E 8Q 9	114	L	Mocho II	35.3	429.4	22.2	442.5	26.2	438.5	13.1	-4.1	9.1
3S/2E 9Q 4	80	U	Mocho II	32.3	472.1	16.3	488.0	22.0	482.5	15.9	-5.5	10.4
3S/2E 10F 3	45	U	Mocho I	13.8	521.0	11.8	523.1	13.1	521.8	2.1	-1.3	0.8
3S/2E 10Q 1	44	U	Mocho II	26.0	529.3	18.2	537.1	24.1	531.3	7.8	-5.9	1.9
3S/2E 10Q 2	325	L	Mocho II	32.8	516.8	NA	-	29.4	520.2	-	-	3.4
3S/2E 11C 1	66	U	Mocho I	27.8	529.3	26.3	530.8	27.1	530.0	1.5	-0.8	0.7
3S/2E 12C 4	108	U	Spring	56.4	533.7	55.5	534.6	NA	-	0.9	-	-
3S/2E 12J 3	160	L	Spring	84.3	544.4	83.7	545.0	83.5	545.2	0.6	0.2	0.8
3S/2E 14A 3	110	U	Mocho I	69.9	533.1	NA	-	69.3	532.5	-	-	-0.5
3S/2E 14B 1	300	L	Mocho I	64.3	529.1	62.9	530.5	109.6	483.8	1.4	-46.7	-45.3
3S/2E 15E 2	192	L	Mocho II	51.2	498.5	30.6	519.1	27.1	522.6	20.7	3.5	24.1
3S/2E 15L 1	41	U	Mocho II	35.4	526.1	16.2	545.3	12.4	549.1	19.2	3.8	23.0
3S/2E 15M 2	45	U	Mocho II	43.2	506.3	22.2	527.3	30.7	518.7	21.0	-8.6	12.5
3S/2E 15Q 6	301	L	Mocho II	58.9	518.7	52.2	525.4	51.1	526.5	6.7	1.1	7.8
3S/2E 15R17	63	U	Mocho II	13.4	579.1	9.5	582.9	13.1	579.4	3.8	-3.5	0.3
3S/2E 15R18	138	L	Mocho II	20.0	572.5	10.2	582.3	22.0	570.5	9.8	-11.8	-2.0
3S/2E 16A 3	240	L	Mocho II	44.5	482.6	25.9	501.2	32.8	494.2	18.6	-7.0	11.6
3S/2E 16C 1	584	L	Mocho II	100.0	411.0	80.1	430.9	75.0	436.0	19.9	5.1	25.0
3S/2E 16E 4	45	U	Mocho II	27.7	478.6	15.4	490.9	16.2	490.1	12.3	-0.8	11.5
3S/2E 18B 1	497	L	Amador	NA	-	139.4	299.2	138.2	300.4	-	1.2	-
3S/2E 18E 1	134	U	Amador	91.4	332.5	66.6	357.2	87.9	336.0	24.8	-21.3	3.5
3S/2E 19D 7	180	U	Amador	92.2	322.9	90.4	324.7	90.8	324.3	1.8	-0.4	1.4
3S/2E 19D 8	260	L	Amador	91.0	324.1	91.0	324.1	91.2	323.8	0.0	-0.3	-0.3
3S/2E 19D 9	390	L	Amador	137.3	277.7	124.2	290.8	120.5	294.5	13.1	3.8	16.8
3S/2E 19D10	470	L	Amador	130.1	284.8	100.5	314.4	98.1	316.8	29.7	2.3	32.0
3S/2E 19N 3	120	U	Amador	NA	-	39.4	379.1	40.3	378.2	-	-0.9	-

U = Upper; L = Lower; NM = Not Measured; NA = Not Available
OBS = Obstructed; - = Not Applicable; highlight = Key Well

TABLE 6-3
SEMIANNUAL GROUNDWATER LEVELS
(Feet above Mean Sea Level, NAVD88)
FALL 2018 TO FALL 2019

				Fall 2018		**Spring 2019**		**Fall 2019**		**Change in Elevation (ft)**		
										Seasonal		**Annual**
Well Number	**Well Depth**	**Aquifer**	**Subarea**	**Depth to Water**	**GW Elev**	**Depth to Water (ft)**	**GW Elev**	**Depth to Water (ft)**	**GW Elev**	**Fall 18 to Spring 19**	**Spring 19 to Fall 19**	**Fall 18 to Fall 19**
1S/4E 31P 5	24	U	Tracy	16.8	43.2	16.9	43.2	17.6	42.4	0.0	-0.8	-0.8
2S/1E 32E 1	70	U	None	36.5	356.0	32.5	360.0	34.5	358.0	4.0	-2.0	2.0
2S/1E 32N 1	44	U	Camp	19.6	341.2	16.1	344.7	17.7	343.1	3.5	-1.5	2.0
2S/1E 32Q 1	45	U	Camp	27.5	340.1	25.2	342.4	26.1	341.5	2.3	-0.9	1.4
2S/1E 33L 1	80	U	None	50.7	338.8	49.7	339.8	48.1	341.3	1.1	1.5	2.6
2S/1E 33P 2	55	U	Camp	31.9	338.2	30.7	339.4	30.4	339.7	1.2	0.3	1.5
3S/2E 19N 4	203	L	Amador	NA	-	32.3	385.7	32.0	385.9	-	0.2	-
3S/2E 20M 1	184	L	Amador	53.5	425.3	41.2	437.6	49.9	428.9	12.4	-8.7	3.7
3S/2E 22B 1	32	U	Mocho II	NA	-	13.6	572.3	15.1	570.8	-	-1.5	-
3S/2E 23E 1	40	U	Mocho II	16.8	596.6	15.9	597.5	16.8	596.6	0.9	-0.9	0.0
3S/2E 23E 2	110	L	Mocho II	15.1	598.1	13.5	599.7	14.6	598.7	1.6	-1.0	0.6
3S/2E 24A 1	46	U	Mocho I	19.7	698.0	18.1	699.6	19.8	698.0	1.6	-1.6	0.0
3S/2E 26J 2	44	U	Mocho II	11.1	678.8	6.4	683.5	10.5	679.5	4.7	-4.0	0.6
3S/2E 29F 4	36	U	Amador	8.5	449.0	8.4	449.1	8.3	449.2	0.1	0.1	0.3
3S/2E 30C 1	150	L	Amador	28.1	411.3	19.8	419.6	24.2	415.3	8.3	-4.3	3.9
3S/2E 30D 2	44	U	Amador	21.4	410.2	21.6	410.0	21.3	410.3	-0.2	0.3	0.2
3S/2E 32E 7	37	U	Upland	NA	-	19.5	591.4	19.5	591.5	-	0.0	-
3S/2E 33G 1	17	U	Amador	8.7	502.8	8.8	502.7	9.1	502.5	-0.1	-0.3	-0.3
3S/3E 6Q 3	30	U	Altamont	6.8	674.3	6.7	674.4	8.9	672.2	0.1	-2.2	-2.1
3S/3E 6Q 4	30	U	Altamont	11.6	678.5	NA	-	NA	-	-	-	-
3S/3E 7D 2	72	U	Spring	46.9	575.5	NA	-	46.2	576.3	-	-	0.7

U = Upper; L = Lower; NM = Not Measured; NA = Not Available
OBS = Obstructed; - = Not Applicable; highlight = Key Well



ABBREVIATIONS FOR MUNI WELLS
CWS= California Water Service
M = Mocho (Zone 7)
H = Hopyard (Zone 7)
St = Stoneridge (Zone 7)
P = Pleasanton
SF = San Francisco Public Utilities Commision

LEGEND

Well Colors

- ● Upper Aquifer
- ● Lower Aquifer
- ● Deep Aquifer
- ● Key Wells

Well Symbols

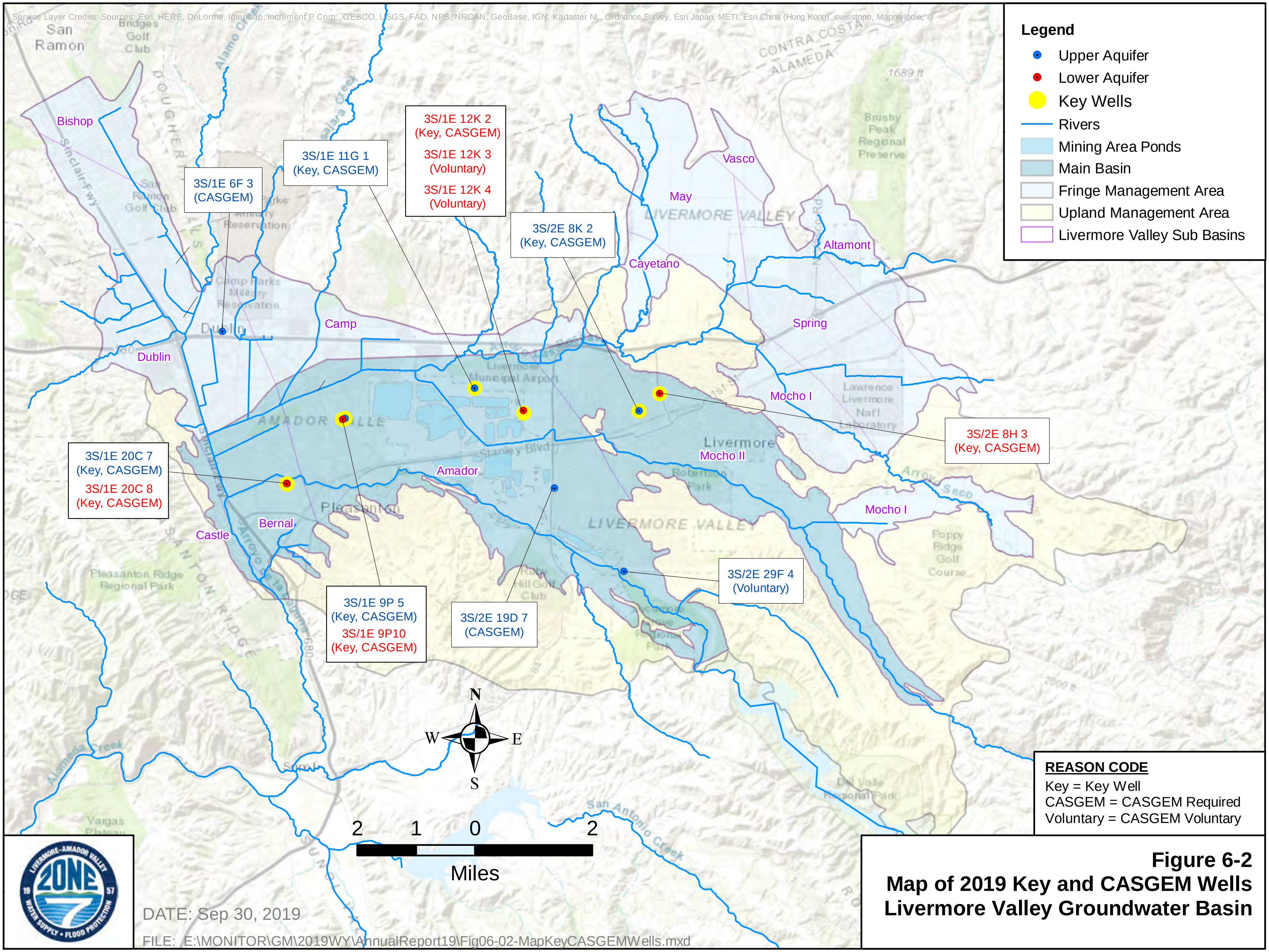
- ⊙ Supply
- ◆ Monitor
- • Municipal
- ◆ Nested Monitoring
- ▨ Main Basin
- ▨ Fringe Management Area
- ▨ Upland Management Area

Mining Area Ponds 2019

- ▨ Static (= groundwater elevation)
- ▨ Pumped From
- ▨ Pumped Into
- ▨ Clay-lined
- — Streams
- ☐ Township-Range Line

DATE: Feb 19, 2020
FILE: E:\MONITOR\GM\2019WY\AnnualReport19\Fig06-01-MapAllWellsGM19.mxd

Figure 6-1
Map of Wells in
2019 Groundwater Elevation Program
Livermore Valley Groundwater Basin

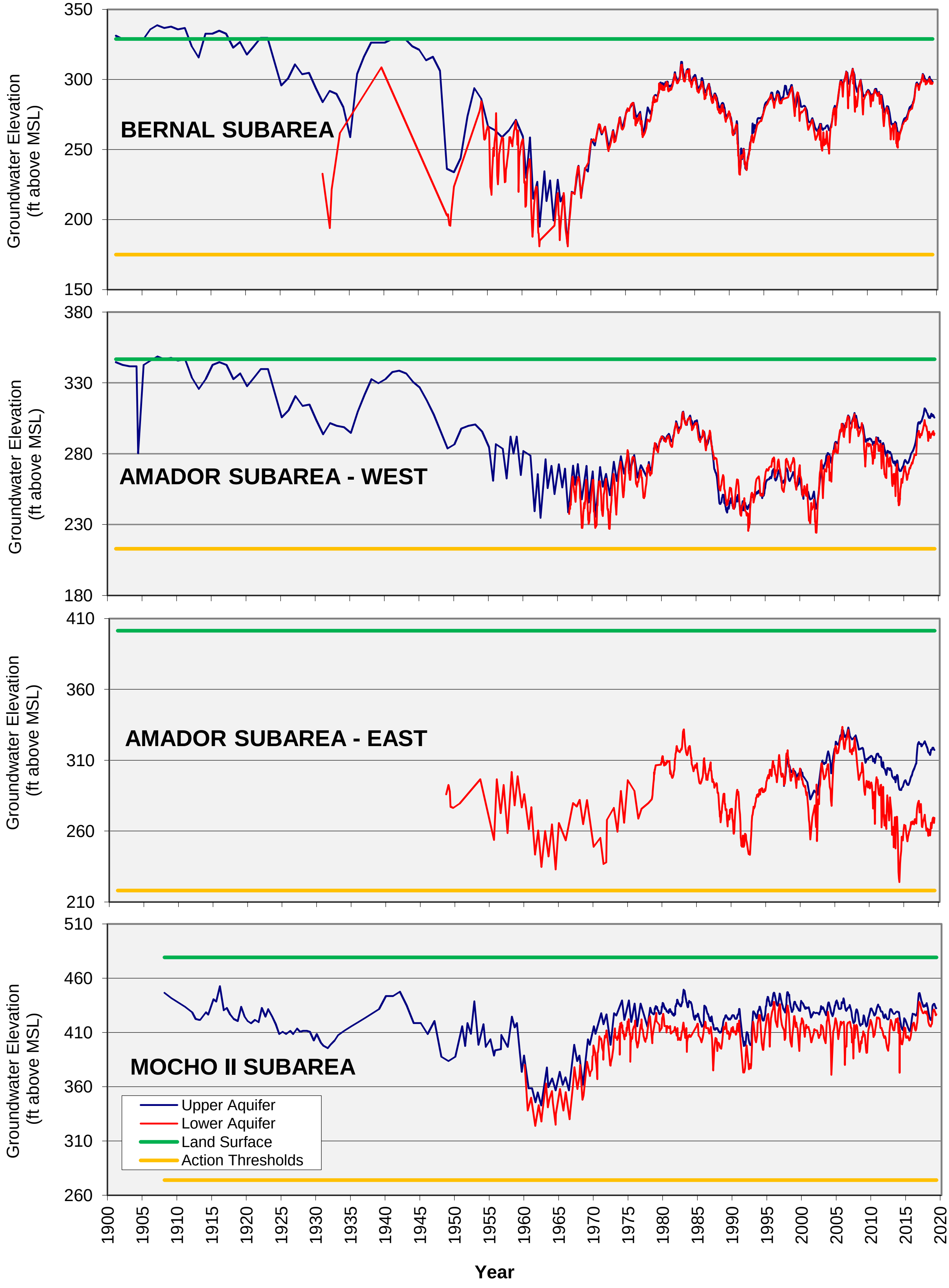


DATE: Sep 30, 2019

FILE: E:\MONITOR\GM\2019WY\AnnualReport19\Fig06-02-MapKeyCASGEMWells.mxd

Figure 6-2
Map of 2019 Key and CASGEM Wells
Livermore Valley Groundwater Basin

FIGURE 6-3
HISTORICAL KEY WELL HYDROGRAPHS
1901 to 2019 WATER YEARS



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12/13/2019

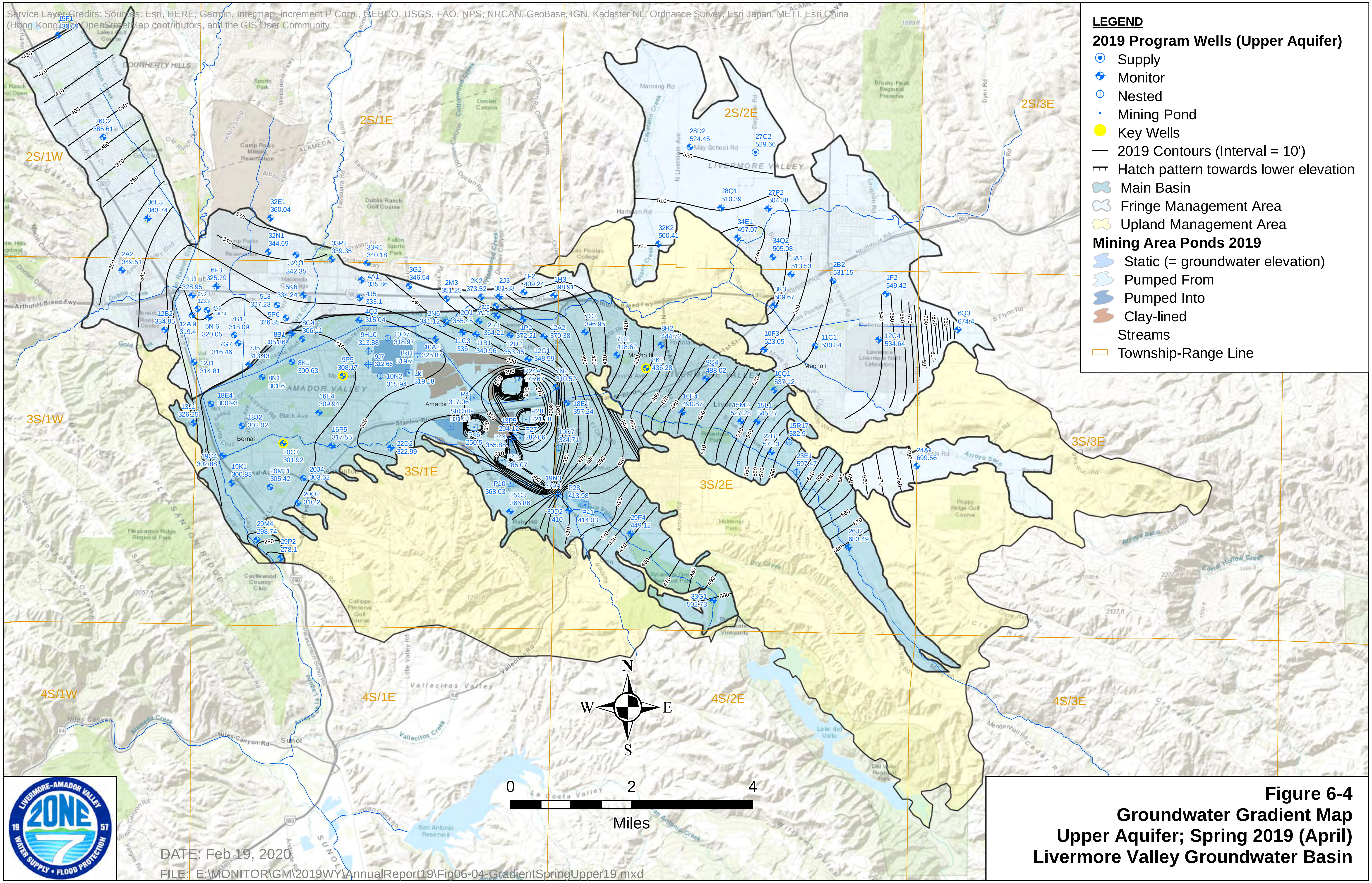


Figure 6-4
Groundwater Gradient Map
Upper Aquifer; Spring 2019 (April)
Livermore Valley Groundwater Basin

DATE: Feb 19, 2020

FILE: E:\MONITOR\GM\2019WY\AnnualReport19\Fig06-04-GradientSpringUpper19.mxd

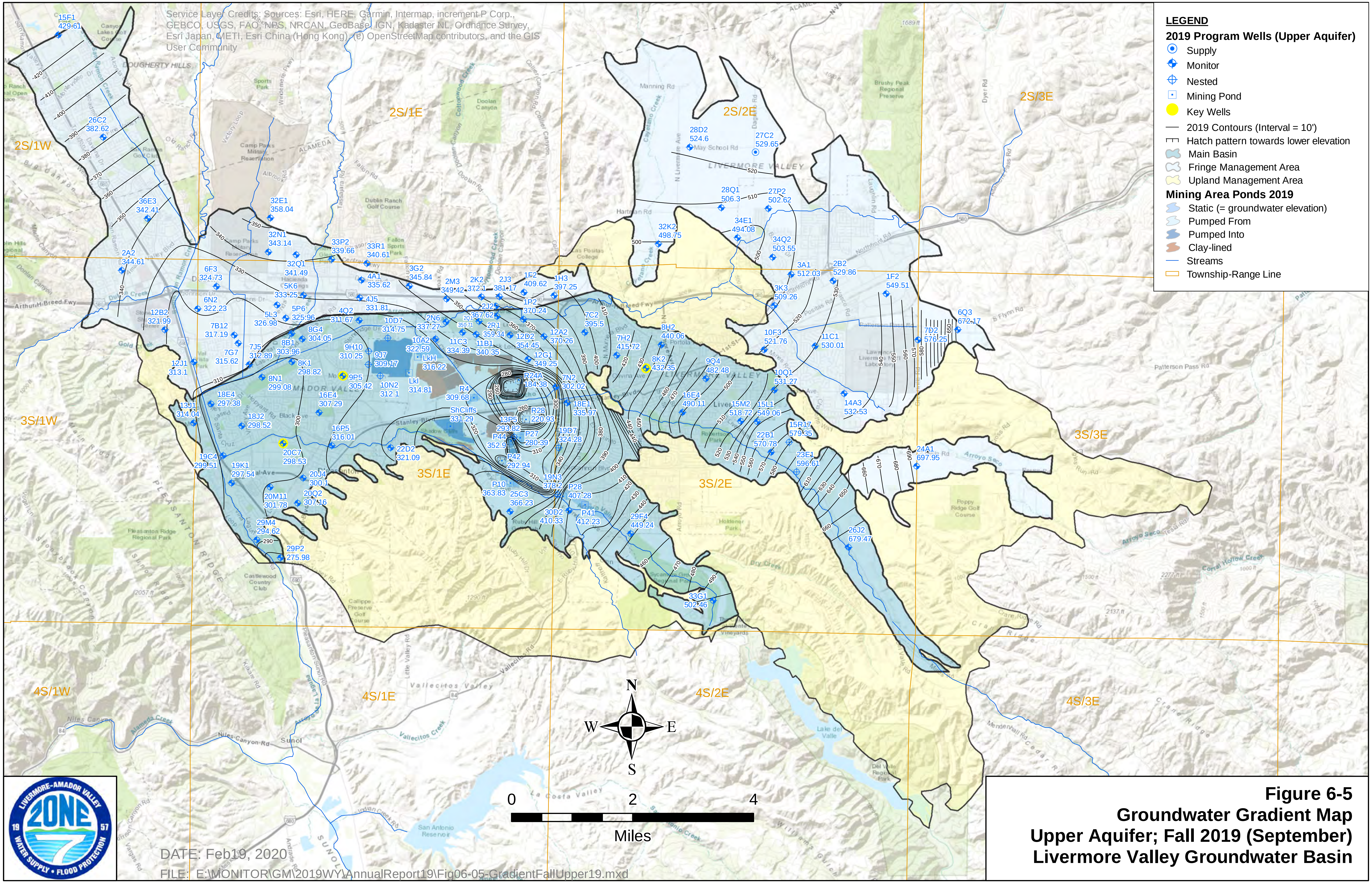
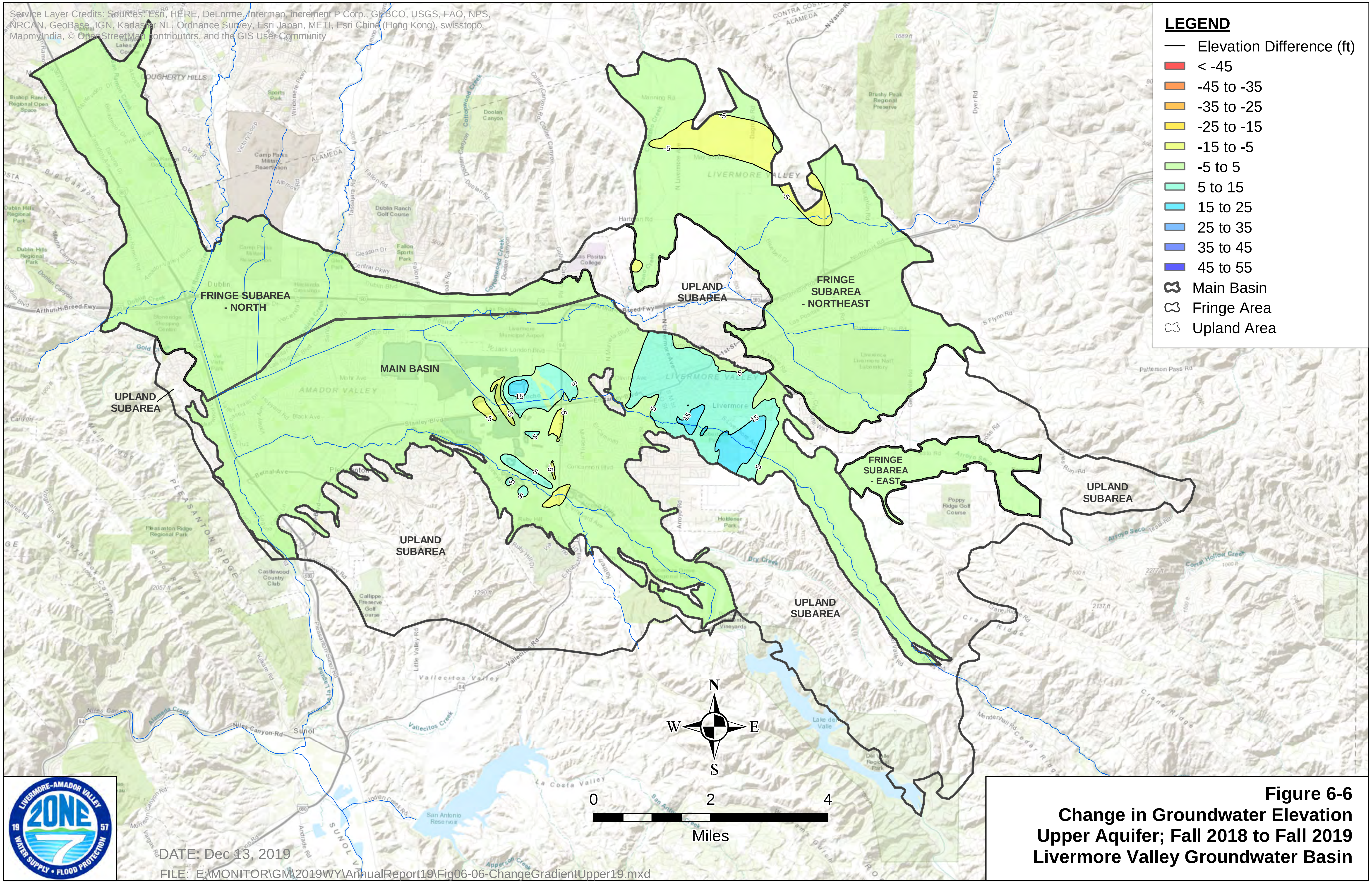


Figure 6-5
Groundwater Gradient Map
Upper Aquifer; Fall 2019 (September)
Livermore Valley Groundwater Basin

DATE: Feb19, 2020

FILE: E:\MONITOR\GM\2019WY\AnnualReport19\Fig06-05-GradientFallUpper19.mxd

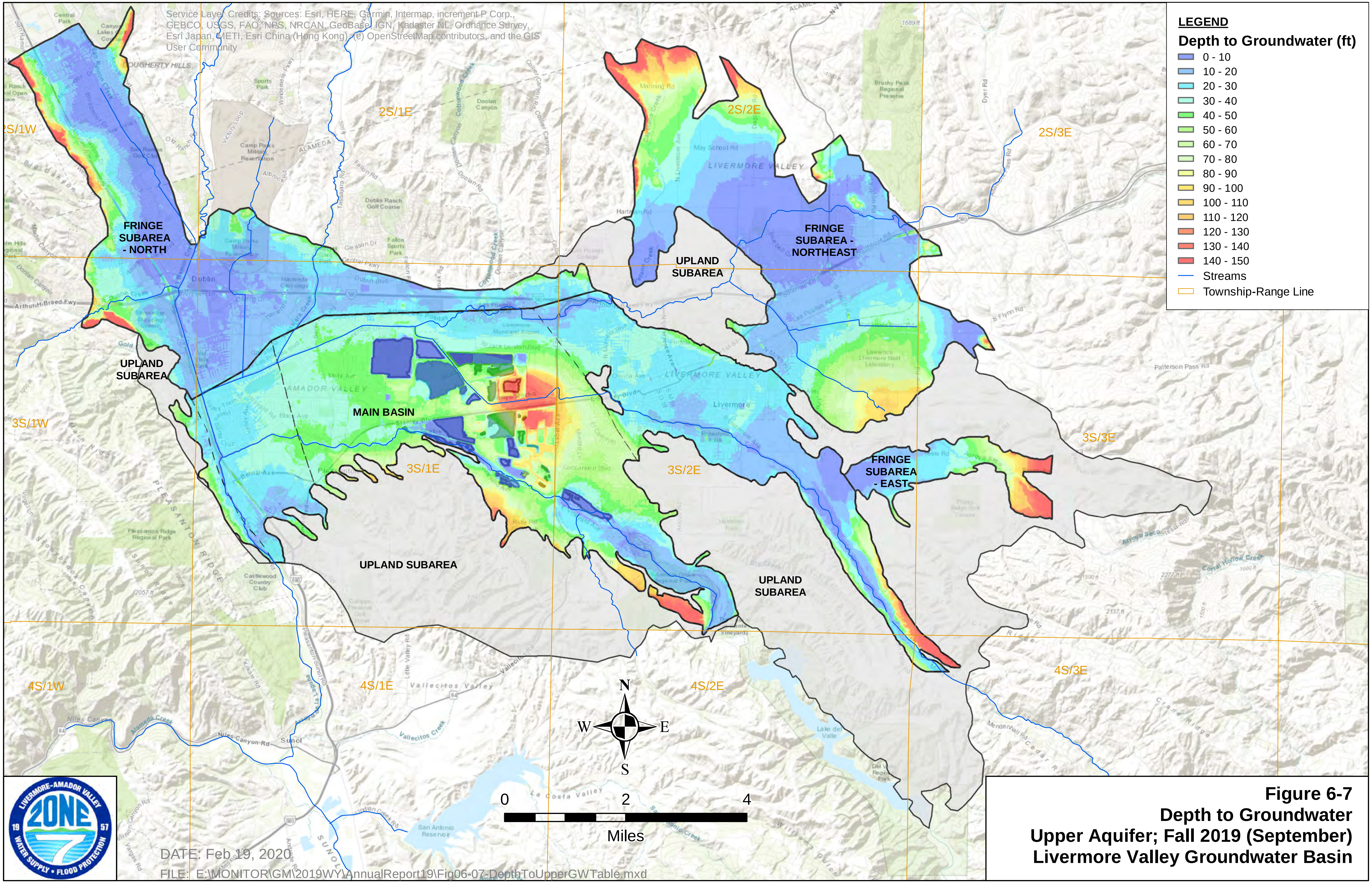


Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Figure 6-6
Change in Groundwater Elevation
Upper Aquifer; Fall 2018 to Fall 2019
Livermore Valley Groundwater Basin

DATE: Dec 13, 2019

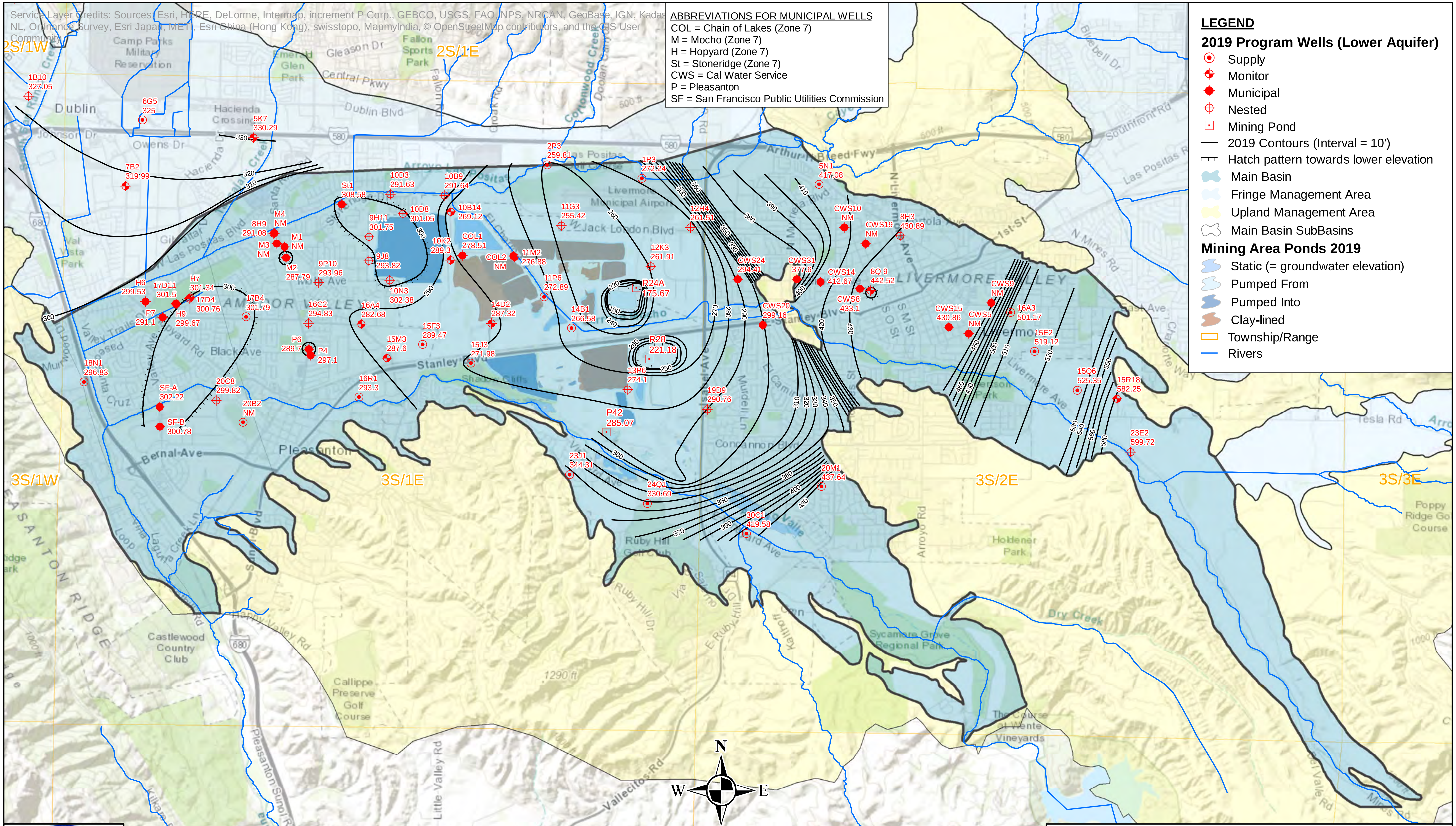
FILE: E:\MONITOR\GM\2019WY\AnnualReport19\Fig06-06-ChangeGradientUpper19.mxd



DATE: Feb 19, 2020

FILE: E:\MONITOR\GM\2019WY\AnnualReport19\Fig06-07-DepthToUpperGWTable.mxd

Figure 6-7
Depth to Groundwater
Upper Aquifer; Fall 2019 (September)
Livermore Valley Groundwater Basin



Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

ABBREVIATIONS FOR MUNICIPAL WELLS
COL = Chain of Lakes (Zone 7)
M = Mocho (Zone 7)
H = Hopyard (Zone 7)
St = Stoneridge (Zone 7)
CWS = Cal Water Service
P = Pleasanton
SF = San Francisco Public Utilities Commission

LEGEND

2019 Program Wells (Lower Aquifer)

⊙	Supply
⊕	Monitor
●	Municipal
⊕	Nested
▫	Mining Pond
—	2019 Contours (Interval = 10')
┬┬	Hatch pattern towards lower elevation
▨	Main Basin
▨	Fringe Management Area
▨	Upland Management Area
▢	Main Basin SubBasins

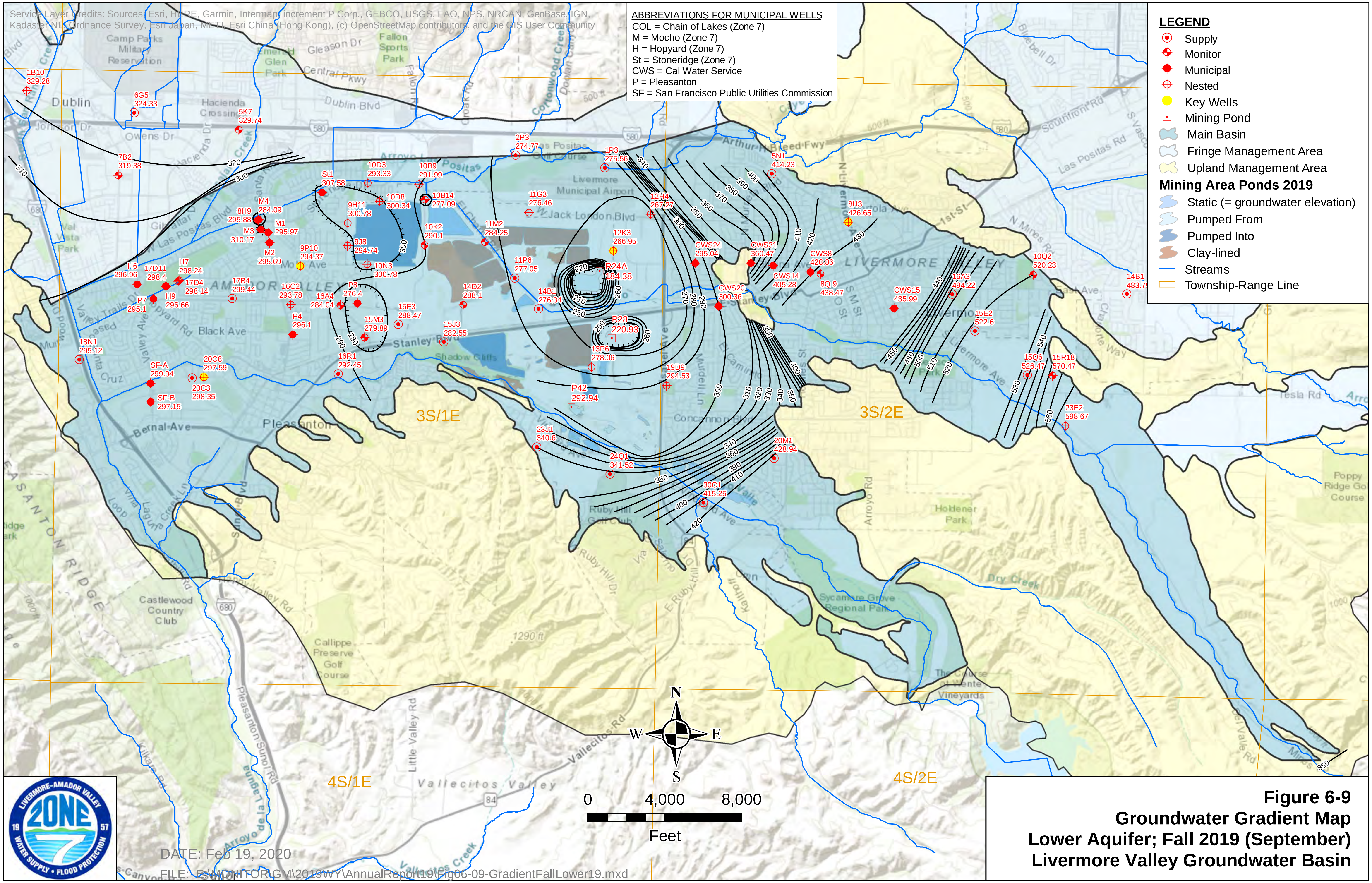
Mining Area Ponds 2019

▨	Static (= groundwater elevation)
▨	Pumped From
▨	Pumped Into
▨	Clay-lined
▭	Township/Range
—	Rivers

DATE: Dec 16, 2019

FILE: F:\MONITOR\GM\2019WY\AnnualReport19\Fig06-08-GradientSpringLower19.mxd

Figure 6-8
Groundwater Gradient Map
Lower Aquifer; Spring 2019 (April)
Livermore Valley Groundwater Basin



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H = Hopyard (Zone 7)
St = Stoneridge (Zone 7)
CWS = Cal Water Service
P = Pleasanton
SF = San Francisco Public Utilities Commission

LEGEND

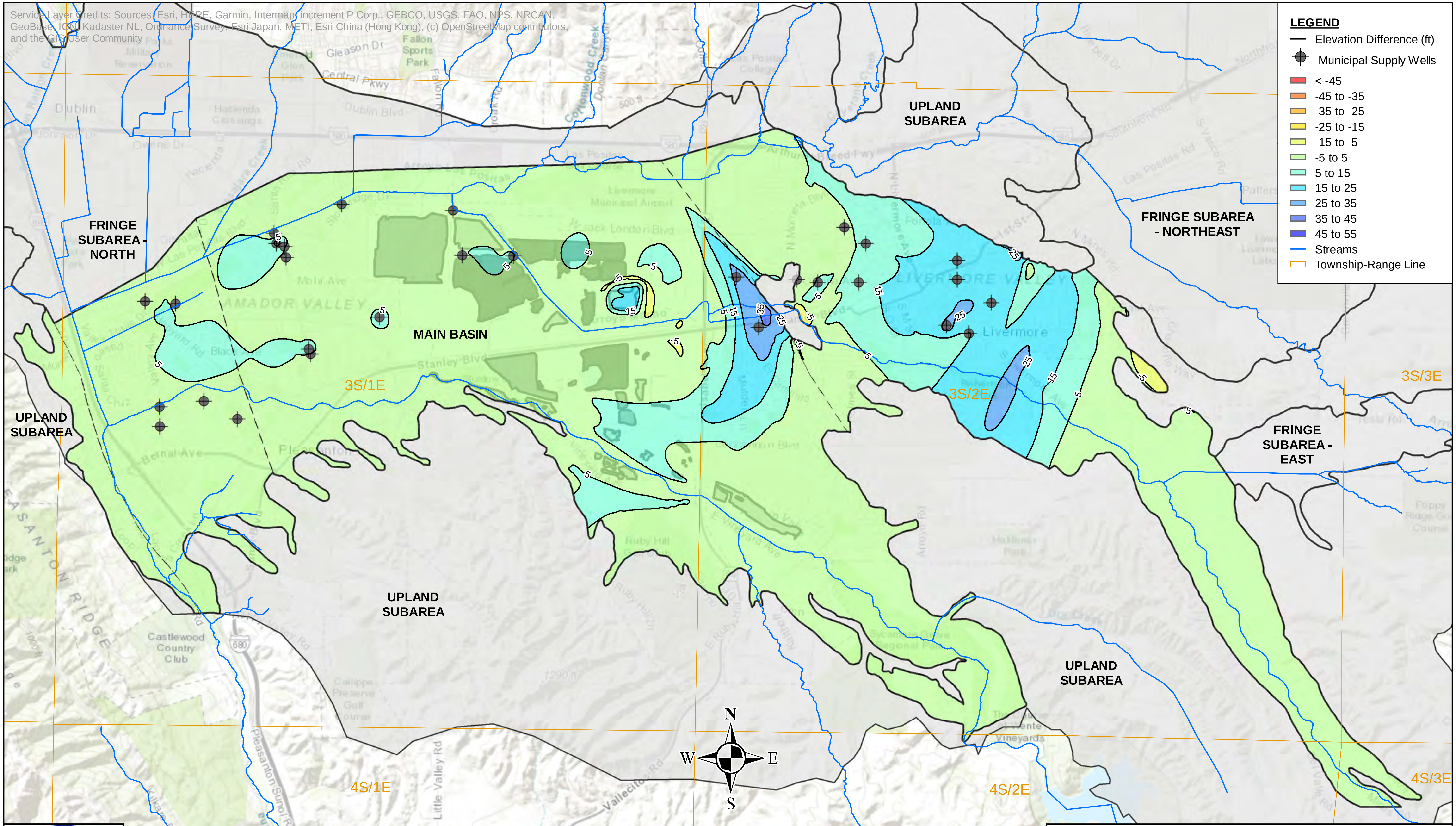
- ⊙ Supply
- ⊕ Monitor
- ● Municipal
- ⊕ Nested
- ● Key Wells
- ▫ Mining Pond
- Main Basin
- Fringe Management Area
- Upland Management Area

Mining Area Ponds 2019

- Static (= groundwater elevation)
- Pumped From
- Pumped Into
- Clay-lined
- Streams
- Township-Range Line

DATE: Feb 19, 2020
FILE: F:\MONITOR\GM\2019WY\AnnualReport19\Fig06-09-GradientFallLower19.mxd

Figure 6-9
Groundwater Gradient Map
Lower Aquifer; Fall 2019 (September)
Livermore Valley Groundwater Basin



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DATE: Feb 19, 2020

FILE: F:\MONITOR\GM\2019WY\AnnualReport19\Fig06-10-ChangeGradientLower19.mxd

Figure 6-10
Change in Groundwater Elevation Lower Aquifer; Fall 2018 to Fall 2019 Livermore Valley Main Groundwater Basin

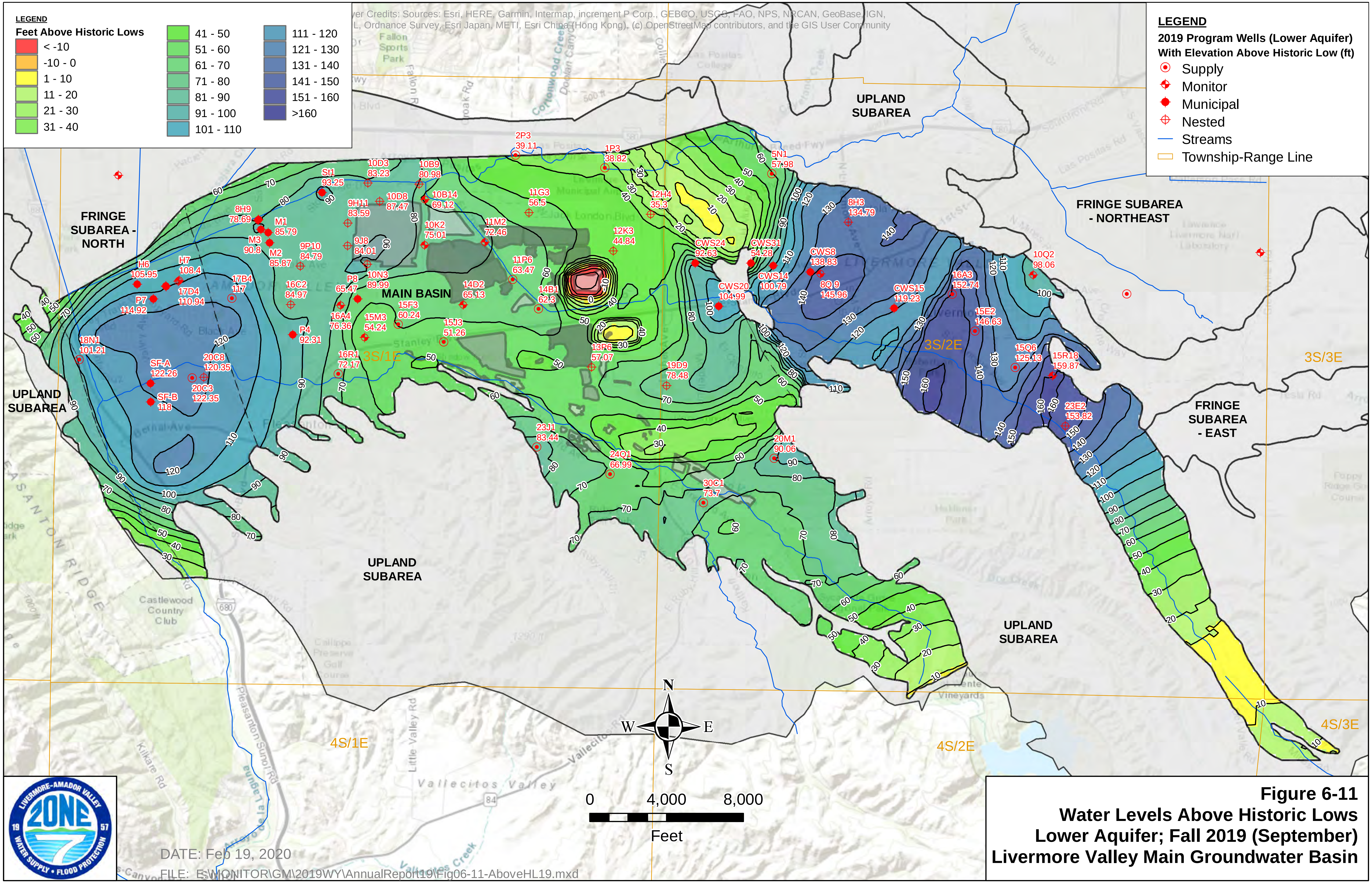

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Figure 6-11
Water Levels Above Historic Lows
Lower Aquifer; Fall 2019 (September)
Livermore Valley Main Groundwater Basin

7 Groundwater Quality

7.1 Program Description

7.1.1 Monitoring Network

The main purpose of monitoring groundwater quality is to assure that remediation of past groundwater degradation is proceeding, and that no new degradation has occurred or is occurring. Details regarding Zone 7's groundwater quality monitoring network are provided in *Section 4.6*, *Groundwater Quality Monitoring* of the Alternative GSP. Zone 7 maintains a robust monitoring network of 222 wells that are sampled at least annually for water quality analyses. Each well in the program was sampled to fulfill one or more specific monitoring objectives. *Table 7-1* lists all of the wells in the routine sampling program, the represented subbasin and aquifer, the frequency of sampling, and any other programs that are satisfied by their sampling. Additional well construction details for each of the wells in the program are provided in *Table 6-2*. *Figure 7-1* shows the well locations.

7.1.2 Constituents of Concern

7.1.2.1 Metals and Minerals

Zone 7 conducts annual sampling and analysis for inorganic constituents-of-concern (CEC) for meeting the Livermore Valley Groundwater Basin (Basin) groundwater quality objectives. The primary CEC include: TDS, nitrate, boron, and total chromium. The following is a summary of the groundwater quality objectives and minimum thresholds for these CEC.

- TDS (Main Basin): 500 mg/L, (State secondary maximum contaminant level [MCL], recommended range)
- TDS (Fringe Areas): 1,000 mg/L, (State secondary MCL, upper range)
- Nitrate (as N): 10 mg/L (State primary MCL)
- Boron: 1.4 mg/L (1,400 micrograms per liter [µg/L]) (an agricultural and human health target)
- Total Chromium (Cr): 0.05 mg/L (50 µg/L) (State primary MCL)

7.1.2.2 Other CECs

Per- and polyfluoroalkyl substances (PFAS) are a large group of human-made substances that do not occur naturally in the environment. PFAS are classified by the Environmental Protection Agency (EPA) as "contaminants of emerging concern". These substances have been used extensively in the United States since the 1940's, particularly in surface coating and protectant formulations due to their ability to repel oil, grease, and water. There is limited research to date, but some studies show that they may cause adverse health effects. Additional research is needed to determine the full scope of PFAS impacts on human health.

While there are no current federal or California State limits (e.g., MCLs) for any PFAS compounds, in December 2019, the EPA published draft screening levels of 40 ppt and Preliminary Remediation goals (PRGs) of 70 ppt for perfluorooctanesulfonic acid (PFOS) and/or perfluorooctanoic acid (PFOA) (combined or individually) for groundwater that is a current or potential source of drinking water. The California State Water Resources Control Board Division of Drinking Water's (DDW) has also issued a Notifications Level (NL) for PFOS at 6.5 ppt and for PFOA at 5.1 ppt in August 2019. The DDW's recommended Response Level (RL) for PFOA and PFOS combined is 70 ppt, which is consistent with the U.S. Environmental Protection Agency's PRG.

7.1.3 Program Changes for the Water Year

The Sampling Program changes made in the 2019 WY involved the same monitoring well changes identified in *Section 6.1.2* for the Groundwater Elevation Program, and shown below in *Table 7-A.*

Table 7-A: Program Wells Changes during the Water Year

Action	Reason	Note
Well 3S/2E 17E 2 **Removed from program**	Owner denied access to well	Zone 7 to investigate replacement
Well 3S/2E 32E 7 **Added to program**	Investigate groundwater down-gradient of DVWTP	On Zone 7 property in Upland Management Area

DVWTP = Zone 7's Del Valle Water Treatment Plant

Up until recently, California Water Service (CWS) did not consistently test their Livermore municipal supply wells for all four constituents-of-concern (TDS, Nitrate, Boron, and Chromium) discussed in this report. At Zone 7's request, starting in the 2020 WY, CWS will test their well samples for all four constituents of concern and will supply the results to Zone 7.

In March 2019, the DDW launched a state-wide phased investigation and issued orders to operators of hundreds of susceptible drinking water sources, including Zone 7 and City of Pleasanton, to conduct quarterly PFAS monitoring for at least one year. Since then, DDW also issued orders to operators of selected landfills, airports, and chrome-plating facilities to conduct PFAS monitoring and investigations.

During the 2019 WY, 57 wells and three mining area lakes were sampled and tested for PFAS compounds (see *Section 7.1.2.2* above), some more than once. This total includes data from ten Zone 7 and three City of Pleasanton municipal wells. In addition to the DDW-required quarterly monitoring of the municipal wells, Zone 7 sampled and tested several other monitoring program wells for PFAS to determine if PFAS contamination is widespread. Due to the prevalence of PFAS in the environment and the extremely low reporting limits (i.e., parts per trillion), the groundwater from these wells was sampled using DDW's PFAS Sampling Guidelines. The testing results from these wells are presented and discussed in *Section 7.2.6*.

7.2 Results for the 2019 Water Year

7.2.1 Introduction

Concentrations and spatial distribution of the constituents tracked by Zone 7 are presented in the following figures and tables:

- *Table 7-2* contains the groundwater quality results for select metals and minerals from groundwater samples collected for the Groundwater Quality Program during the 2019 WY.
- *Table 7-3* contains a summary of the PFAS results for the 2019 WY.
- *Figure 7-1* shows the locations of all wells sampled for the water quality monitoring program in the 2019 WY.
- *Figure 7-2* shows graphs of historical and recent TDS concentrations in the eight Key Wells.
- *Figure 7-3* through *Figure 7-10* are isoconcentration maps of TDS, nitrate, boron, and total Cr for the Upper and Lower Aquifers, respectively.
- *Figure 7-11* and *Figure 7-12* show the PFOS concentration results in map view for the Upper and Lower Aquifers, respectively.
- *Figure 7-13* through *Figure 7-16* are groundwater hydro-chemographs showing time-series trends of TDS, nitrate, and boron concentrations with respect to groundwater levels for select wells in each of the major subareas.

7.2.2 Total Dissolved Solids

7.2.2.1 Upper Aquifer Zone

TDS concentrations in groundwater in the Upper Aquifer Zone are influenced by the volume, TDS concentration, and proximity of recharging waters; leaching of salts from subsurface sediments and bedrock; and vadose zone thickness. Over the last 40 years there has been a general upward trend in TDS concentrations, principally in the western portion of the Main Basin. Concentrations in the eastern and central portions of the valley have stayed relatively low, especially during times of significant stream recharge.

During the 2019 WY, the TDS concentrations in groundwater were lowest in the areas adjacent to the Arroyo Valle and the Arroyo Mocho, where they were generally less than 500 mg/L. There continues to be two main areas of the groundwater basin where TDS concentrations exceed 1,000 mg/L in the Upper Aquifer Zone (*Figure 7-3)*:

- In the southern portion of the North Fringe Subarea, extending into the northwestern Main Basin subareas. This high TDS area is most likely due to the combination of the concentrating effects of urban irrigation, leaching of buried lacustrine and marine sediments, recharge of poorer quality water from Arroyo Las Positas, and legacy wastewater and sludge disposal practices in the Pleasanton and Livermore areas.
- In the eastern portion of the Northeast Fringe Subarea. This high-TDS area is likely due to poorer quality water that runs off of the marine sediments on the east and north of the groundwater basin and recharges the Basin along the hill-fronts.

7.2.2.2 Lower Aquifer Zone

Water from the Lower Aquifer Zone is generally of good drinking water quality. The Basin Objective and minimum threshold of 500 mg/L is met in the central portion of the Main Basin. Around the margins of the Main Basin, TDS concentrations are slightly higher, generally ranging from 500 mg/L to 700 mg/L in the 2019 WY (see *Figure 7-4*). The distribution of TDS concentrations is likely caused by deep percolation of low-TDS surface waters in the central portion and higher TDS water being pulled laterally and downward from the North Fringe Subarea and the Upper Aquifer by the municipal pumping occurring in the Lower Aquifer in Pleasanton.

Many of the municipal supply wells in the Pleasanton area produced water having TDS concentrations greater than the minimum threshold of 500 mg/L during the 2019 WY. The highest concentrations were detected as follows:

- The Mocho wellfield had two wells above 800 mg/L (801 mg/L in Mocho 3 and 962 mg/L in Mocho 4).

- One of the San Francisco Public Utilities Commission (SFPUC) wells in the Bernal wellfield (SF-B) detected TDS at 829 mg/L.

- A monitoring well (3S/1E 17B 4) located central to four active wellfields (Mocho, Hopyard, Bernal, and Busch Valley) used for municipal and public supply had TDS at 921 mg/L.

The source of these high TDS concentrations is believed to be the Upper Aquifer Zone, which has TDS concentrations as high as 2,000 mg/L in the same area directly above the Mocho well screened intervals. When the Mocho wells are pumped, a very large vertical gradient is created between the Upper and Lower Aquifer Zones, inducing flow between the two zones. The sealing of three onsite abandoned cross-zoned wells in 2013 does not appear to have slowed the rising TDS trend observed in the Mocho wellfield. Zone 7 has the ability to strip and export much of the salts from the water produced by the Mocho wells with its onsite groundwater demineralization facility (MGDP). See *Section 13.4.2.3* for details on the MGDP’s use in the 2019 WY. Other planned corrective actions and strategies are described in *Section 5.3.3.2, Salt Management Strategy* of the Alternative GSP. Additionally, Zone 7 plans to revisit the strategies and their effectiveness for the 5-year update to the Alternative GSP in 2022.

7.2.3 Nitrates

7.2.3.1 Upper Aquifer Zone

Nitrate occurrences within the Livermore Groundwater Basin, as well as its nitrate loading and assimilative capacity, were studied as part of Zone 7's NMP (*Zone 7, 2015b*). The NMP was approved by the RWQCB in 2016 and submitted as part of the Alternative GSP later that year. The complete NMP is also available on the Zone 7 website (www.Zone7Water.com).

The NMP identified ten local high nitrate Areas of Concern (AOCs) where nitrate concentrations persist above the Basin Objective and minimum threshold (*Figure 7-5)*. Also, the NMP commits Zone 7 to monitoring the conditions in these AOC's and promoting Best Management Practices (BMPs) that lead to reductions in nutrient loading. The following are the nitrate monitoring results for the ten AOCs during the 2019 WY.

- **Bernal**—This AOC is based on nitrate concentrations from one well (3S/1E 22D 2) in the southern portion of the Upper Aquifer of the Amador West Subarea. The long-term trend of concentrations in this well has been slowly declining. In the 2019 WY, the concentration was just above the MCL of 10 mg/L at 10.5 mg/L (10.7 mg/L for the 2018 WY).
- **Staples Ranch**—This AOC is in the eastern portion of the Northern Fringe management Area. It extends westward from monitoring well 3S/1E 2M 3 along the Main Basin boundary. In the 2019 WY, the nitrate concentration dropped below the threshold (4.25 mg/L in 2019 WY compared to 14.8 mg/L in 2018 WY). A second area of elevated concentrations in this AOC existed historically to the west near Tassajara Creek; however, for the 2019 WY and 2018 WY, nitrate concentrations in this portion of the AOC have dropped below the minimum threshold (9.07 mg/L in 2019 WY and 9.09 mg/L in 2018 WY, both in 3S/1E 5K 6).
- **Jack London**—This AOC extends from the eastern portion of the Mocho II Subarea to the northeastern portion of the Amador Subarea. Several wells in the Upper Aquifer have consistently had nitrate concentrations above the MCL. The highest nitrate concentration detected in this AOC during the 2019 WY was 18.2 mg/L (3S/1E 12D 2) compared to last year's highest concentration at 19.6 mg/L (3S/1E 2R 1).
- **Constitution**—This AOC exists near the boundary of the Mocho II, Camp, and Amador Subareas, and is up-gradient from the Las Positas Golf Course in Livermore. Nitrate concentrations were detected above the MCL in 3S/1E 1H 3, at 16.8 mg/L during the 2019 WY which is consistent with the past few years (17 mg/L in 2018 WY).
- **May School**—Historically, the nitrate concentration in this AOC has been characterized annually by the results of a single monitoring well (2S/2E 28D 2); however, the associated nitrate plume has been further delineated by historical data from several domestic supply wells located in the Bel Roma neighborhood. For the 2019 WY, only 2S/2E 28D 2 was sampled. The result was 32.3 mg/L versus 25.9 mg/L in the 2018 WY. Over the last five years the nitrate concentrations in the monitoring wells have varied between 16.7 mg/L and 42.8 mg/L.

- **Charlotte Way**—The high nitrate in this AOC exists in the western portion of the Mocho I Subarea and may be commingled with Buena Vista's nitrate plume in the eastern portion of the Mocho II Subarea. Elevated nitrate concentrations have been typically detected in three monitoring wells in this AOC. However, in the 2019 WY, only two of the four wells sampled exceeded the minimum threshold; 11.0 mg/L in 3S/2E 10F 3 and 12.0 mg/L in 3S/2E 14A 3, compared to 13.5 mg/L and 12.4 mg/L, respectively in 2018 WY. Nitrate concentrations in 3S/2E 3K 3 dropped slightly from 9.52 mg/L to 9.15 mg/L between the 2018 WY and the 2019 WY.

- **Buena Vista**—This nitrate plume is defined by several wells in the central and eastern portion of the Mocho II Subarea in both the Upper and Lower Aquifers. During the 2019 WY, the highest concentration was detected in the northeastern portion of the plume at 16.6 mg/L in 3S/2E 10Q 1 compared to 18.9 mg/L in 2018 WY.

- **Greenville**—This Fringe Area East AOC is situated primarily along Tesla Road, east of Vasco Road. It is routinely characterized by the results of a single monitoring well (3S/2E 24A 1); however, the associated nitrate plume was further delineated during a study conducted during the 2015 WY (*Zone 7, 2016a*). In the 2019 WY, 3S/2E 24A 1 had a concentration of 25.4 mg/L (28.3 mg/L in 2018 WY).

- **Mines Road**—This AOC is monitored by a single well (3S/2E 26J 2) located in the Upper Aquifer in the southern portion of the Main Basin along Mines Road. Nitrate concentrations in this well have fluctuated widely, ranging from non-detect to a maximum of 21.4 mg/L in October 2011. For the 2019 WY, the nitrate concentration in 3S/2E 26J 2 was below the MCL at 3.67 mg/L but up from 0.56 mg/L in 2018 WY.

- **Happy Valley**—Nitrate concentrations were not monitored in this Upland AOC in the 2019 WY; however, when studied in the 2013 WY by Zone 7 and ACDEH, the nitrate occurrences were found to be stable.

7.2.3.2 Lower Aquifer Zone

In the Lower Aquifer, nitrate was only detected above the minimum threshold in the Buena Vista AOC during the 2019 WY *(Figure 7-6*).

- **Buena Vista**—The general location of this plume underlies the Buena Vista nitrate plume in the Upper Aquifer, suggesting that some of the nitrate in the Upper Aquifer has migrated into the Lower Aquifer. This plume also appears to have migrated towards, and possibly co-mingled with, the Jack London plume. In the 2019 WY, nitrate concentrations exceeded the minimum threshold in two monitoring wells and one municipal supply well (10.2 mg/L in 3S/2E 5N 1, 10.0 mg/L in 3S/2E 15E 2, and 11.0 mg/L in CWS 19). Four other wells, including two municipal supply wells located in the same AOC had nitrate concentrations that approached the minimum threshold (9.57 mg/L in CWS 10, 9.367 mg/L in CWS 9, 9.49 mg/L in 3S/2E 8H 3, and 8.67 mg/L in 3S/2E 16A 3). Overall this Lower Aquifer nitrate plume has been relatively stable over the last five years.

7.2.4 Boron

7.2.4.1 Introduction

Boron is a naturally-occurring element; in the Livermore Valley Groundwater Basin, elevated concentrations likely are caused by natural processes affecting alkali/marine sediments (particularly prevalent in eastern watersheds). While there is no MCL for boron, the United States Environmental Protection Agency (USEPA) has identified a Health Reference Level (HRL) of 1,400 µg/L. Boron also becomes a problem for irrigated crops when present at levels above 1,000 or 2,000 µg/L, depending on the crop sensitivity. Boron is a groundwater parameter of interest for the valley's agriculture and golf communities because of its potential for impact on certain irrigated crops and turf. The minimum threshold was set at 1,400 µg/L.

7.2.4.2 Upper Aquifer Zone

Boron exists at elevated concentrations in the Upper Aquifer in the following areas of the groundwater basin *(Figure 7-7*):

- There is a plume of elevated boron concentrations that extends along the boundary between the North Fringe Subarea and the Main Basin. This localized concentration of boron has been relatively stable for many years. The highest concentration measured in the 2019 WY (9,880 µg/L) was found near the center of this area in 3S/1E 4J 5, compared to 8,240 µg/L in the 2018 WY.

- Elevated boron concentrations were also detected in parts of the Northeastern and Eastern Fringe Subareas. The highest concentration detected in these areas in the 2019 WY was detected at 31,000 µg/L in 2S/2E 27P 2, compared to 31,900 µg/L in the 2018 WY.

The source of boron is likely from natural alkali/marine sediments in the east, but this is unconfirmed. It should be noted that the boron detected in the western portion of the Basin primarily occurs along the Arroyo Las Positas and lower Arroyo Mocho. It is believed that this occurrence of elevated boron may be from high-boron groundwater discharging into the Arroyo Las Positas in the eastern portion of the Valley and flowing downstream to the Arroyo Mocho, recharging groundwater along the way. The eastern portion of the Arroyo Las Positas has been a gaining stream and continuously flowing into the Arroyo Mocho since the 1981 WY.

7.2.4.3 Lower Aquifer Zone

Boron was detected above 1,400 µg/L in four Lower Aquifer wells located in two separate municipal supply wellfields in the west, and in one monitoring well located in southeastern Mocho II Subarea in the 2019 WY as follows (*Figure 7-8*):

- Boron was detected above the minimum threshold in two monitoring wells located in the Hopyard Wellfield in the Bernal Basin in the 2019 WY. It was detected at 2,550 µg/L in

3S/1E 17D 4, compared to 2,480 µg/L in the 2018 WY, and 3,050 µg/L in 3S/1E 17D11, compared to 2,720 µg/L in the 2018 WY. However, it has never been detected above 900 µg/L in either of the Hopyard municipal supply wells.

- Boron was detected above the minimum threshold in the Mocho Wellfield in the 2019 WY. It was found at 1,810 µg/L in the municipal supply well Mocho 3 and at 1,420 µg/L in monitoring well 3S/1E 8H 9.
- Boron was also detected in the Lower Aquifer monitoring well 3S/2E 23E 2, in the southeastern portion of the Mocho II Subarea, at 1,780 µg/L in 2019 WY, compared to 2,220 µg/L in the 2018 WY.

7.2.5 Chromium

7.2.5.1 Introduction

Chromium (Cr) is typically found at very low concentrations in groundwater in the Basin. It can be a naturally occurring element or an anthropogenic impact. Prior to August 2017, the Basin Objective and the minimum threshold in the Alternative GSP had been set at the MCL for hexavalent chromium (CrVI), which was 10 µg/L. In August 2017, under orders of the Superior Court, the State Water Resources Control Board (SWRCB) withdrew the CrVI regulation from the California Code of Regulations (CCR). Until the SWRCB establishes a new MCL for CrVI, they have returned to using the more general total Cr MCL of 50 µg/L to ensure public water systems are safe. Since all of the minimum thresholds in the Alternative GSP have been set based on the State's drinking water standards, Zone 7 adjusted the minimum threshold for Cr to match the State's Cr MCL that is in effect; currently 50 µg/L.

7.2.5.2 Upper Aquifer Zone

Cr concentrations exceeded the 50 µg/L threshold in one Upper Aquifer monitoring well during the 2019 WY sampling effort (*Figure 7-9*).

- Cr was detected at 63 µg/L in monitoring well 3S/2E 12C 4, which is located on the Lawrence Livermore National Laboratory (LLNL) site in the East Fringe Subarea. Samples from this well have typically exhibited high Cr values in the past (69 µg/L in the 2018 WY).

7.2.5.3 Lower Aquifer Zone

Cr was not detected above the MCL in any of the monitored Lower Aquifer wells. However, Cr was detected in several monitoring and production wells at greater than the former minimum threshold of 10 µg/L (*Figure 7-10*).

- Because the locations of the slightly elevated Cr concentrations in the Lower Aquifer Zone do not coincide with those in the Upper Aquifer Zone, it is likely that the Cr in the Lower Aquifer Zone is not a result of vertical migration from the Upper Aquifer Zone. It may be the result of localized leaching of naturally occurring chromium-rich minerals in those portions of the Lower Aquifer Zone.

7.2.6 PFAS

7.2.6.1 Introduction

Table 7-3 shows the concentrations of all PFAS compounds detected in groundwater during the 2019 WY. Of those PFAS compounds detected, only PFOS and PFOA have any regulatory limits, and of those two compounds, PFOS had the highest concentrations relative to regulatory limits. Therefore, the two maps generated for this report (discussed below by aquifer) show PFOS concentrations (in ppt).

7.2.6.2 Upper Aquifer Zone

Figure 7-11 shows PFOS concentrations in the upper aquifer.

- While most of the sampled wells had PFOS detections, those concentrations that were above the EPA's 40 ppt screening level and above the DDW's 70 ppt RL appear to be northeast of the mining area in the vicinity of the Jack London Boulevard. The highest concentration detected in the upper aquifer was 450 ppt in well 3S/1E 10A 2, which is just southeast of the airport.

7.2.6.3 Lower Aquifer Zone

Figure 7-12 shows PFOS concentrations in the lower aquifer. For wells that were sampled more than once during the water year, the map shows the range of PFOS concentrations detected. In nested well sets, the map shows the well with the highest PFOS concentration.

- As is the case in the upper aquifer, most of the sampled wells had PFOS detections, however those wells that had concentrations that were above the EPA's 40 ppt screening level lay within an area bounded by the western portion of Jack London Boulevard (northeast of the mining area), to the City of Pleasanton's Well 8 (Pleas 8, south of the mining area), and Zone 7's Mocho Wellfield (west of the mining area).

- There were two areas where PFOS concentrations exceeded the DDW's RL (70 ppt). PFOS was detected above the RL in several wells that extend from the western portion of Jack London Boulevard to Zone 7's Mocho Wellfield. This group of wells included 3S/1E 10B 8 which had the highest concentration detected in the groundwater basin at 1,000 ppt. Zone 7's Mocho 1 municipal well (78 to 90 ppt) was the only municipal well in this area with PFOS concentrations above the RL.

- Pleas 8 had concentrations of PFOS that ranged from 68 to 120 ppt. This area of PFOS above the RL seems to be relatively isolated as evidenced by several wells north (roughly up-gradient) and west (down-gradient) of Pleas 8 with concentrations below the RL.

- Eight of Zone 7's municipal wells have tested above the Notification Level for PFOS (>6.5 ppt) in the 2019 WY, but only one of the municipal wells, Mocho Well No. 1 (i.e., 3S/1E 9M 2), had PFOS concentrations (78 to 90 ppt) that exceeded DDW's recommended Response Level of 70 ppt. Four of Zone 7's wells also tested above the NL for PFOA (>5.1 ppt). Although additional PFAS compounds were also detected in Zone 7's water supplies, at present there are no regulatory guidelines for these contaminants.

Zone 7 continues to monitor and characterize PFAS in the Basin. Continued sampling and the addition of new sampling sites are planned for the 2020 WY.

TABLE 7-1
GROUNDWATER QUALITY PROGRAM
TABLE OF PROGRAM WELLS WITH SAMPLING FREQUENCY
2019 WATER YEAR

SITE INFORMATION				*Sampling Frequency*	*Other Programs*			
State Name	*Well Name*	*Subbasin*	*Aq*		*WR*	*Muni*	*PFAS*	*Other*
2S/1E 32E 1	End of Arnold Rd	None	U	A				
2S/1E 32N 1	Camp Parks	Camp	U	A				
2S/1E 32Q 1	Summer Glen Dr	Camp	U	A				
2S/1E 33L 1	Gleason Dr @ Tassajara	None	U	A				
2S/1E 33P 2	Central Pkwy at Emerald Glen	Camp	U	A				
2S/1E 33R 1	Central Pkwy @ Grafton	None	U	A				
2S/1W 15F 1	BOLLINGER	Bishop	U	A				
2S/1W 26C 2	PINE VALLEY	Dublin	U	A				
2S/1W 36E 3	Kolb Park	Dublin	U	A				
2S/1W 36F 1	Dublin High shallow	Dublin	L	A				
2S/1W 36F 2	Dublin High mid	Dublin	L	A				
2S/2E 27P 2	hartford ave east	Spring	U	A				
2S/2E 28D 2	May School	May	U	A				
2S/2E 28J 2	FCC Well	May	L	A				
2S/2E 28Q 1	hartford ave	May	U	A				
2S/2E 32K 2	jenson's N liv. Ave	Cayetano	U	A				
2S/2E 34E 1	Mud City	May	U	A				
2S/2E 34Q 2	Hollyhock & Crocus	Spring	U	A				
3S/1E 1F 2	Constitution Dr	Camp	U	A				
3S/1E 1H 3	Collier Canyon g1	Camp	U	Q				
3S/1E 1L 1	Kitty Hawk	Camp	U	A				
3S/1E 1P 2	Airport gas g5	Amador	U	A			√	
3S/1E 1P 3	New airport well	Amador	L	Q				
3S/1E 2J 2	Maint. Bldg	Camp	U	A				
3S/1E 2J 3	Doolan Rd East	Camp	U	A			√	
3S/1E 2K 2	Doolan Rd West	Camp	U	A				
3S/1E 2M 3	Friesman Rd North	Camp	U	A				
3S/1E 2N 6	Friesman Rd South	Amador	U	A			√	
3S/1E 2P 3	Crosswinds Church	Camp	L	A			√	
3S/1E 2Q 1	LPGC #1	Amador	U	A			√	
3S/1E 2R 1	Beebs	Amador	U	Q			√	
3S/1E 3G 2	fallon rd	Camp	U	A				
3S/1E 4A 1	SMP-DUB-2	Camp	U	A				
3S/1E 4J 5	Pimlico shallow	Camp	U	A				
3S/1E 4J 6	Pimlico deep	Camp	U	A				
3S/1E 4Q 2	gulfstream	Amador	U	A				
3S/1E 5K 6	Rosewood shallow	Camp	U	A				
3S/1E 5K 7	Rosewood deep	Camp	L	A				
3S/1E 5L 3	Oracle	Camp	U	A				
3S/1E 5P 6	Owens Park	Camp	U	A				
3S/1E 6F 3	Dublin Ct	Dublin	U	A				
3S/1E 6N 2	DSRSD MW-3	Dublin	U	A				
3S/1E 6N 3	DSRSD MW-4	Dublin	U	A				
3S/1E 6N 6	DSRSD NE-76	Dublin	U	A				

Aq = Aquifer: U = Upper; L = Lower; D = Deep   Frequency: Q = Quarterly; SA = SemiAnnually; A = Annually

OTHER: WR = Water Rights; Muni = Municipal wells; PFAS = Sampled for PFAS Compounds.

SITE INFORMATION				*Sampling Frequency*	*Other Programs*			
State Name	*Well Name*	*Subbasin*	*Aq*		*WR*	*Muni*	*PFAS*	*Other*
3S/1E 7B 2	Hopyard rd	Dublin	L	A				
3S/1E 7B12	Hacienda Arch	Dublin	U	A				
3S/1E 7D 1	DSRSD SW-75	Dublin	U	A				
3S/1E 7D 3	DSRSD SE-70	Dublin	U	A				
3S/1E 7G 7	Chabot Well	Dublin	U	A				
3S/1E 7J 5	Thomas Hart School	Dublin	U	A				
3S/1E 8B 1	Lizard Well	Amador	U	A				
3S/1E 8G 4	Apache	Amador	U	A				
3S/1E 8H 9	Mocho 4 Nested Shallow	Amador	L			√	√	
3S/1E 8H10	Mocho 4 Nested Middle	Amador	L			√	√	
3S/1E 8H11	Mocho 4 Nested deep	Amador	D			√	√	
3S/1E 8H13	Mocho 3 mon	Amador	D			√		
3S/1E 8H18	Mocho 4	Amador	L			√		
3S/1E 8K 1	Cockroach well	Amador	U	A				
3S/1E 8N 1	sports park	Bernal	U	A				
3S/1E 9B 1	Stoneridge	Amador	L			√		
3S/1E 9J 7	SW Lake I Shallow	Amador	U	A			√	
3S/1E 9J 8	SW Lake I Middle	Amador	L	A			√	
3S/1E 9J 9	SW Lake I Deep	Amador	L	A			√	
3S/1E 9M 2	Mocho 1	Amador	L			√		
3S/1E 9M 3	Mocho 2	Amador	L			√		
3S/1E 9M 4	Mocho 3	Amador	L			√		
3S/1E 9P 5	Key_AmW_U (Mohr Key)	Amador	U	A			√	
3S/1E 9P 9	Mohr Ave Shallow	Amador	L	A			√	
3S/1E 9P10	Key_AmW_L	Amador	L	A			√	
3S/1E 9P11	Mohr Ave Deep	Amador	L	A			√	
3S/1E 10A 2	El C harro Rd	Amador	U	A			√	
3S/1E 10B 8	Kaiser Rd Shallow	Amador	L	A			√	
3S/1E 10B 9	Kaiser Rd Middle 1	Amador	L	A			√	
3S/1E 10B10	Kaiser Rd Middle 2	Amador	L	A			√	
3S/1E 10B11	Kaiser Rd Deep	Amador	D	A			√	
3S/1E 10B14	COL 5 Monitoring	Amador	L	A				
3S/1E 10B16	COL 5	Amador	L	Q				
3S/1E 10D 2	Stoneridge Shallow	Amador	L	A			√	
3S/1E 10D 3	Stoneridge Middle 1	Amador	L	A			√	
3S/1E 10D 4	Stoneridge Middle 2	Amador	L	A			√	
3S/1E 10D 5	Stoneridge Deep	Amador	D	A			√	
3S/1E 10K 2	COL 1 Monitoring	Amador	L			√		
3S/1E 10K 3	COL 1	Amador	L			√		
3S/1E 11B 1	Airport West	Amador	U	Q				
3S/1E 11C 3	LAVWMA ROW	Amador	U	A			√	
3S/1E 11G 1	Key_AmE_U	Amador	U	A			√	
3S/1E 11G 2	Rancho Charro Middle 1	Amador	L	A			√	
3S/1E 11G 3	Rancho Charro Middle 2	Amador	L	A			√	
3S/1E 11G 4	Rancho Charro Deep	Amador	D	A			√	
3S/1E 11M 2	COL 2 Monitoring	Amador	L			√		
3S/1E 11M 3	COL 2	Amador	L			√		
3S/1E 11P 6	New Jamieson Residence	Amador	L	A				
3S/1E 12A 2	Airport South	Amador	U	Q			√	
3S/1E 12D 2	LWRP G6	Amador	U	Q			√	
3S/1E 12G 1	Oaks Park Shallow	Amador	U	Q			√	

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OTHER: WR = Water Rights; Muni = Municipal wells; PFAS = Sampled for PFAS Compounds.

SITE INFORMATION				***Sampling Frequency***	***Other Programs***			
State Name	***Well Name***	***Subbasin***	***Aq***		***WR***	***Muni***	***PFAS***	***Other***
3S/1E 12H 4	LWRP Shallow	Amador	L	A			√	
3S/1E 12H 5	LWRP Middle 1	Amador	L	A			√	
3S/1E 12H 6	LWRP Middle 2	Amador	L	A			√	
3S/1E 12H 7	LWRP Deep	Amador	D	A			√	
3S/1E 12K 2	Oaks Park Mid	Amador	L	A			√	
3S/1E 12K 3	Key_AmE_L	Amador	L	A			√	
3S/1E 12K 4	Oaks Park Deep	Amador	D	A			√	
3S/1E 13P 5	LGA Grant Nested 1	Amador	U	A				
3S/1E 13P 6	LGA Grant Nested 2	Amador	L	A				
3S/1E 13P 7	LGA Grant Nested 3	Amador	L	A				
3S/1E 13P 8	LGA Grant Nested 4	Amador	L	A				
3S/1E 14B 1	Industrial Asphalt	Amador	L	A				
3S/1E 14D 2	South Cope Lake	Amador	L	A				
3S/1E 15J 3	shadow cliff	Amador	L	A				
3S/1E 15M 3	Bush/Valley South	Amador	L	A				
3S/1E 16A 2	Pleas 8	Amador	L			√		
3S/1E 16A 4	Bush/Valley Mid	Amador	L	A			√	
3S/1E 16B 1	Bush/Valley North	Amador	D	A				
3S/1E 16C 2	Santa Rita Valley Shallow	Amador	L	A				
3S/1E 16C 3	Santa Rita Valley Middle	Amador	L	A				
3S/1E 16C 4	Santa Rita Valley Deep	Amador	L	A				
3S/1E 16E 4	black ave - cultural	Amador	U	A				
3S/1E 16L 5	Pleas 5	Amador	L			√		
3S/1E 16L 7	Pleas 6	Amador	L			√		
3S/1E 16P 5	Vervais Monitor	Amador	U	SA	√			
3S/1E 17B 4	Casterson	Amador	L	A				
3S/1E 17D 3	Hopyard Nested Shallow	Bernal	L			√		
3S/1E 17D 4	Hopyard Nested Middle 1	Bernal	L			√		
3S/1E 17D 5	Hopyard Nested Middle 2	Bernal	L			√		
3S/1E 17D 6	Hopyard Nested Middle 3	Bernal	L			√		
3S/1E 17D 7	Hopyard Nested Deep	Bernal	D			√		
3S/1E 17D11	Hopyard 9 Monitoring Well	Bernal	L			√		
3S/1E 17D12	Hopyard 9	Bernal	L			√		
3S/1E 18A 6	Hopyard 6	Bernal	L			√		
3S/1E 18E 4	Valley Trails II	Bernal	U	A			√	
3S/1E 18J 2	camino segura	Bernal	U	A			√	
3S/1E 19A10	SFWD South (B)	Bernal	L			√		
3S/1E 19A11	SFWD North (A)	Bernal	L			√		
3S/1E 19C 4	del valle & laguna	Bernal	U	A			√	
3S/1E 19K 1	680/bernal	Bernal	U	A				
3S/1E 20B 2	Fairgrounds Potable	Bernal	L	A				
3S/1E 20C 3	Fairgrounds Potable Backup	Bernal	L	A				
3S/1E 20C 7	Key_Bern_U	Bernal	U	SA	√			
3S/1E 20C 8	Key_Bern_L	Bernal	L	A				
3S/1E 20C 9	Fair Nested Deep	Bernal	L	A				
3S/1E 20J 4	civic center	Bernal	U	A				
3S/1E 20M11	S.F "M"LINE	Bernal	U	A				
3S/1E 20Q 2	20Q2	Bernal	U	A				
3S/1E 22D 2	vineyard trailer	Amador	U	A				
3S/1E 23J 1	1627 vineyard trailer	Amador	L	A				
3S/1E 25C 3	Katz Winery Mansion	Amador	U	A				

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SITE INFORMATION				Sampling Frequency	Other Programs			
State Name	Well Name	Subbasin	Aq		WR	Muni	PFAS	Other
3S/1E 29M 4	f.c. channel	Castle	U	A				
3S/1E 29P 2	castlewood dr	Bernal	U	A				
3S/1W 1B 9	DSRSD Shallow	Dublin	L	A				
3S/1W 1B10	DSRSD Middle	Dublin	L	A				
3S/1W 1B11	DSRSD Deep	Dublin	L	A				
3S/1W 1J 1	DSRSD MW-1	Dublin	U	A				
3S/1W 2A 2	McNamara's	Dublin	U	A				
3S/1W 12A 9	DSRSD NW-75	Dublin	U	A				
3S/1W 12B 2	Stoneridge Mall Rd	Dublin	U	A				
3S/1W 12J 1	DSRSD South	Dublin	U	A				
3S/1W 13J 1	muirwood dr	Castle	U	A				
3S/2E 1F 2	Brisa at Circuit City	Spring	U	A				
3S/2E 2B 2	south front rd	Spring	U	A				
3S/2E 3A 1	Bluebell	Spring	U	A				
3S/2E 3K 3	first & S. front rd	Mocho I	U	A				
3S/2E 5N 1	Spider Well	Mocho II	M	A				
3S/2E 7C 2	york way - jaws - G4	Mocho II	U	Q				
3S/2E 7H 2	dakota	Mocho II	U	A				
3S/2E 7N 2	Isabel & Arroyo Mocho	Amador	U	A				
3S/2E 7P 3	CWS 24	Amador	L			√		
3S/2E 7R 3	CWS 31	Upland	L			√		
3S/2E 8F 1	CWS 10	Mocho II	L			√		
3S/2E 8H 2	North k	Mocho II	U	A				
3S/2E 8H 3	Key_Mo2_L	Mocho II	L	A				
3S/2E 8H 4	N Liv Ave Deep	Mocho II	L	A				
3S/2E 8K 2	Key_Mo2_U (Livermore Key)	Mocho II	U	A				
3S/2E 8N 2	CWS 14	Mocho II	L			√		
3S/2E 8Q 9	D-2	Mocho II	L			√		
3S/2E 9Q 1	CWS 9	Mocho II	L			√		
3S/2E 9Q 4	school st	Mocho II	U	A				
3S/2E 10F 3	hexcel	Mocho I	U	A				
3S/2E 10Q 1	almond	Mocho II	U	A				
3S/2E 10Q 2	LLNL W-703	Mocho II	L	A				
3S/2E 11C 1	joan way	Mocho I	U	A				
3S/2E 12C 4	LLNL W-486	Spring	U	A				
3S/2E 12J 3	LLNL W-017A	Spring	L	A				
3S/2E 14A 3	S. vasco @east ave	Mocho I	U	A				
3S/2E 14B 1	5763 east ave	Mocho I	L	A				
3S/2E 15E 2	Retzlaff Winery	Mocho II	L	A				
3S/2E 15L 1	Concannon 2	Mocho II	U	A				
3S/2E 15M 2	Concannon 1	Mocho II	U	A				
3S/2E 15R17	Buena Vista Shallow	Mocho II	U	A				
3S/2E 15R18	Buena Vista Deep	Mocho II	L	A				
3S/2E 16A 3	Memory Gardens	Mocho II	L	A				
3S/2E 16C 1	CWS 15	Mocho II	L			√		
3S/2E 16E 4	pepper tree	Mocho II	U	A				
3S/2E 18B 1	CWS 20	Amador	L			√		
3S/2E 18E 1	E. stanley	Amador	U	A				
3S/2E 19D 7	Isabel Shallow	Amador	U	A				
3S/2E 19D 8	Isabel Middle 1	Amador	L	A				
3S/2E 19D 9	Isabel Middle 2	Amador	L	A				

Aq = Aquifer: U = Upper; L = Lower; D = Deep

Frequency: Q = Quarterly; SA = SemiAnnually; A = Annually

OTHER: WR = Water Rights; Muni = Municipal wells; PFAS = Sampled for PFAS Compounds.

SITE INFORMATION				***Sampling Frequency***	***Other Programs***			
State Name	***Well Name***	***Subbasin***	***Aq***		***WR***	***Muni***	***PFAS***	***Other***
3S/2E 19D10	Isabel Deep	Amador	L	A				
3S/2E 19N 3	Shallow Cemex Nested	Amador	U	A				
3S/2E 19N 4	Deep Cemex Nested	Amador	L	A				
3S/2E 20M 1	Alden Lane	Amador	L	A				
3S/2E 22B 1	grapes	Mocho II	U	A				
3S/2E 23E 1	Mines Nested Shallow	Mocho II	U	A				
3S/2E 23E 2	Mines Nested Deep	Mocho II	L	A				
3S/2E 24A 1	S. greenville	Mocho I	U	A				
3S/2E 26J 2	mines rd	Mocho II	U	A				
3S/2E 29F 4	usgs wetmore	Amador	U	SA	√			
3S/2E 30C 1	Vineyard 30C 1	Amador	L	A				
3S/2E 30D 2	vineyard	Amador	U	A				
3S/2E 33G 1	Crohare	Amador	U	SA	√			
3S/2E 33K 1	VA	Amador	U					
3S/2E 33L 1	VA/CROHARE FENCE	Amador	U					
3S/3E 6Q 3	PPWTP South Monitoring	Altamont	U	A				
3S/3E 6Q 4	PPWTP North Monitoring	Altamont	U	A				
3S/3E 7D 2	7D 2	Spring	U	A				
3S/3E 18N 1	Mohan 18N1	Upland	U					
			Totals:	**179**	**4**	**34**	**44**	**0**

Aq = Aquifer: U = Upper; L = Lower; D = Deep	Frequency: Q = Quarterly; SA = SemiAnnually; A = Annually
OTHER: WR = Water Rights; Muni = Municipal wells; PFAS = Sampled for PFAS Compounds.	

TABLE 7-2
WATER QUALITY RESULTS FOR SELECT METALS AND MINERALS
2019 WATER YEAR

			TEMP	EC		Mineral Constituents (mg/L)									Select Metals (ug/L)				TDS	Hard
SITE ID	DATE	By	°C	umhos/cm	pH	Ca	Mg	Na	K	HCO3	SO4	Cl	NO3N	SiO2	B	As	Fe	Cr	mg/L	mg/L
2S/1E 32E 1	3/13/19	ZONE7	20.1	1527	6.9	167	39	124	1.1	604	33	188	9.92	46	< 100	2	< 100	< 1	939	579
2S/1E 32N 1	3/13/19	ZONE7	21.1	913	7.3	71	17	89	1.3	339	41	111	1.93	29.3	290	1.1	< 100	< 1	535	248
2S/1E 32Q 1	3/13/19	ZONE7	21.4	1883	7	146	61	183	1.5	655	76	266	12.5	36	470	< 1	< 100	< 1	1147	616
2S/1E 33L 1	4/4/19	ZONE7	20	1277	7	110	28	160	2.2	500	43	156	4.36	31.2	400	1.2	< 100	3.5	796	390
2S/1E 33P 2	4/4/19	ZONE7	17.9	2073	6.9	170	70	240	5	678	78	348	6.5	25.5	980	< 2	330	< 4	1299	713
2S/1E 33R 1	4/4/19	ZONE7	20.5	698	7.3	64	14	75	1.1	256	32	77	3.88	28.5	100	1.8	< 100	11	435	218
2S/1W 15F 1	9/15/19	ZONE7	15.7	1491	6.8	181	59	101	1.3	729	38	173	< 0.1	23.5	200	2.3	< 100	< 1	936	693
2S/1W 26C 2	3/28/19	ZONE7	18	1162	6.8	169	31	52	1.1	339	118	135	5.67	31.2	300	1.8	< 100	< 1	729	550
2S/1W 36E 3	3/13/19	ZONE7	19.3	998	7	122	27	54	0.7	417	89	72	4.47	40.7	100	3.6	< 100	< 1	631	416
2S/1W 36F 1	3/13/19	ZONE7	19.2	752	7.5	60	20	75	1	406	16	39	< 0.1	24.2	180	4.5	< 100	< 1	436	232
2S/1W 36F 2	3/13/19	ZONE7	19.5	903	7.7	39	14	129	0.6	414	< 1	101	< 0.1	25.7	480	123	300	< 1	514	156
2S/2E 27P 2	9/4/19	ZONE7	23.2	4735	7.5	80	43	815	2.2	207	< 1	1352	< 0.1	27.8	31000	< 5	< 500	33	2422	377
2S/2E 28D 2	5/8/19	ZONE7	21	1413	7.3	65	36	177	2.7	266	54	209	32.3	33	840	3	< 200	6.4	851	310
2S/2E 28J 2	9/4/19	ZONE7	20.5	976	8.3	4	3	208	0.6	377	61	83	< 0.1	19	1590	< 1	< 100	2.6	570	24
2S/2E 28Q 1	4/9/19	ZONE7	18.9	1150	7.8	41	31	180	1	386	99	142	2.16	34.2	730	9.4	< 100	< 1	729	230
2S/2E 32K 2	5/8/19	ZONE7	20.5	1090	7.5	39	34	145	1.8	351	62	136	3.65	40	500	6.5	< 200	8.6	647	238
2S/2E 34E 1	5/8/19	ZONE7	20.3	1490	7.8	28	23	243	1.4	338	89	234	1.2	24.4	1160	18	< 200	< 2	816	165
2S/2E 34Q 2	5/8/19	ZONE7	23	1851	7.5	67	62	224	1.3	264	145	388	0.96	32.1	3550	< 5	< 500	< 5	1054	423
3S/1E 1F 2	4/4/19	ZONE7	20.5	1406	7.1	120	42	140	1.1	524	32	172	9.49	47.5	270	3.4	< 100	< 1	855	473
3S/1E 1H 3	8/1/19	LWRP	-	1400	-	55	35	200	1	-	49	328	9.8	26	1350.	-	-	-	790	-
3S/1E 1H 3	5/1/19	LWRP	-	1850	-	66	42	250	1.4	-	69	420	14.1	33	1080.	-	-	-	1100	-
3S/1E 1H 3	3/1/19	LWRP	-	1850	-	73	43	270	1.5	-	73	297	16.8	33	980.	-	-	-	1090	-
3S/1E 1H 3	11/6/18	LWRP	-	1840	-	69	44	270	1.6	-	77	306	15.7	34	1260.	-	-	-	1090	-
3S/1E 1L 1	5/8/19	ZONE7	22.5	1658	7.2	76	40	242	1.7	550	53	186	21.9	33	4000	3.2	< 200	4.5	1000	355
3S/1E 1P 2	9/10/19	ZONE7	19.2	1442	7.5	75	44	194	2	419	82	227	0.63	21.4	2890	5.1	< 100	2.5	855	371
3S/1E 1P 2	8/1/19	LWRP	-	1470	-	74	51	190	2.1	-	84	313	0.6	23	3250.	-	-	-	840	-
3S/1E 1P 2	5/1/19	LWRP	-	1450	-	67	46	170	2.2	-	79	283	0.5	23	2930.	-	-	-	850	-
3S/1E 1P 2	3/1/19	LWRP	-	1450	-	73	49	180	2.5	-	80	232	0.5	24	2530.	-	-	-	800	-
3S/1E 1P 2	11/6/18	LWRP	-	1470	-	68	47	180	2.2	-	80	251	0.6	25	3050.	-	-	-	870	-
3S/1E 2J 2	5/7/19	ZONE7	20.2	3011	7.1	155	82	438	2.1	633	232	604	2.18	28.7	5570	< 5	< 500	< 5	1863	726
3S/1E 2J 3	4/9/19	ZONE7	19.2	1312	7.3	63	41	160	5.4	396	25	227	5.65	26.1	530	2.9	< 100	< 1	768	327
3S/1E 2K 2	4/9/19	ZONE7	20.9	1120	7.7	23	18	200	1.8	469	43	109	5.84	21.4	940	4.5	< 100	5.8	674	132
3S/1E 2M 3	5/7/19	ZONE7	21.5	2067	7.3	70	43	373	2.3	867	79	194	4.25	28.2	2900	< 5	< 500	18	1235	352
3S/1E 2N 6	5/7/19	ZONE7	18.8	1661	7.2	75	49	205	1.6	554	90	245	1.09	19	3150	2.3	< 200	< 2	962	390
3S/1E 2P 3	4/11/19	ZONE7	-	774	7.9	44	31	71	2	295	44	68	4.73	24.4	490	1.4	< 100	2.2	453	238
3S/1E 2Q 1	5/14/19	ZONE7	19.8	1625	7.2	70	41	212	6.4	434	94	233	1.95	20.8	2660	4.2	900	< 2	900	344
3S/1E 2R 1	9/10/19	ZONE7	25.2	1772	7.1	86	65	200	1.4	543	99	258	8.42	23.5	2550	4.7	< 100	3.5	1038	483
3S/1E 2R 1	8/1/19	LWRP	-	1810	-	100	78	210	1.9	-	99	340	8.2	28	2840.	-	-	-	1090	-
3S/1E 2R 1	5/1/19	LWRP	-	1780	-	94	70	190	1.9	-	99	318	5.5	27	2850.	-	-	-	1090	-
3S/1E 2R 1	3/1/19	LWRP	-	1780	-	100	75	200	2.5	-	100	280	5.7	26	2830.	-	-	-	1060	-
3S/1E 2R 1	11/6/18	LWRP	-	2100	-	110	85	210	1.7	-	130	365	10.6	29	3400.	-	-	-	1250	-
3S/1E 3G 2	4/4/19	ZONE7	18.2	1011	7.4	47	22	170	2.1	445	25	109	0.18	20.6	940	5.3	< 100	< 1	616	209
3S/1E 4A 1	7/9/19	ZONE7	20.8	1642	7.3	121	35	176	1.4	505	39	283	4.97	21.4	350	2.7	< 100	5.4	948	446
3S/1E 4J 5	7/9/19	ZONE7	19.7	2866	7.8	31	46	642	< 2.5	808	189	503	4.53	18.4	9880	12	< 500	11	1849	268
3S/1E 4J 6	7/9/19	ZONE7	21.5	1858	7.3	103	44	232	2.3	464	95	364	1.75	23.5	1670	3	< 100	5.8	1100	439
3S/1E 4Q 2	8/29/19	ZONE7	23.3	1728	7.4	83	50	193	1.9	409	84	317	0.15	21.4	1650	3.7	< 100	4.8	953	414
3S/1E 5K 6	7/9/19	ZONE7	24.1	2034	7.4	126	59	250	1.5	679	223	233	9.7	21.4	1790	2.9	< 200	4.7	1292	558
3S/1E 5K 7	7/9/19	ZONE7	27.7	1002	7.7	42	29	130	1.4	378	139	73	< 0.1	23.5	900	6.5	< 100	2	625	224
3S/1E 5L 3	7/2/19	ZONE7	21.9	1578	7.4	80	50	200	1.1	540	248	134	< 0.1	20.3	1110	3.9	< 100	1.9	1000	406
3S/1E 5P 6	7/2/19	ZONE7	21.7	3733	7.1	276	194	500	< 2.5	567	1030	558	6.28	27.8	1650	< 5	< 500	7.3	2893	1489

- = Not Analyzed; X = Suspect Result

TABLE 7-2
WATER QUALITY RESULTS FOR SELECT METALS AND MINERALS
2019 WATER YEAR

			TEMP	EC		Mineral Constituents (mg/L)									Select Metals (ug/L)				TDS	Hard
SITE ID	DATE	By	°C	umhos/cm	pH	Ca	Mg	Na	K	HCO3	SO4	Cl	NO3N	SiO2	B	As	Fe	Cr	mg/L	mg/L
3S/1E 6F 3	3/13/19	ZONE7	12.6	4397	7	292	122	512	1.4	600	714	909	< 0.1	24.4	2850	< 10	< 1000	< 10	2870	1233
3S/1E 6M 2	5/23/19	DSRSD	19.9	8628	6.96	-	-	-	-	-	3040	403	< 0.1	-	-	-	-	-	7105	-
3S/1E 6M 2	10/17/18	DSRSD	21.48	8948	6.95	-	-	-	-	-	2960	377	< 0.1	-	-	-	-	-	7075	-
3S/1E 6N 2	5/22/19	DSRSD	21.5	25830	6.6	-	-	-	-	-	1240	9760	< 0.1	-	-	-	-	-	19260	-
3S/1E 6N 2	10/9/18	DSRSD	23.44	26910	7.72	-	-	-	-	-	1180	9460	< 0.1	-	-	-	-	-	19920	-
3S/1E 6N 3	5/29/19	DSRSD	18	10070	6.77	-	-	-	-	-	153	3930	< 0.1	-	-	-	-	-	9240	-
3S/1E 6N 3	10/11/18	DSRSD	23.23	11850	8.91	-	-	-	-	-	180	3830	< 0.1	-	-	-	-	-	7950	-
3S/1E 6N 4	5/22/19	DSRSD	20.1	4049	7.04	-	-	-	-	-	1500	180	2.2	-	-	-	-	-	3194	-
3S/1E 6N 4	10/17/18	DSRSD	16.47	3634	7.25	-	-	-	-	-	1500	176	0.68	-	-	-	-	-	3452	-
3S/1E 6N 5	5/23/19	DSRSD	15.8	26210	6.91	-	-	-	-	-	5540	8540	< 0.1	-	-	-	-	-	23520	-
3S/1E 6N 5	10/15/18	DSRSD	17.78	25420	7.13	-	-	-	-	-	6430	7700	< 0.1	-	-	-	-	-	22820	-
3S/1E 6N 6	5/23/19	DSRSD	16	22560	6.57	-	-	-	-	-	1260	9560	< 0.1	-	-	-	-	-	17600	-
3S/1E 6N 6	10/15/18	DSRSD	17.44	23720	6.94	-	-	-	-	-	1280	9300	< 0.1	-	-	-	-	-	19600	-
3S/1E 7B 2	7/2/19	ZONE7	25.8	707	8.5	8	10	140	1.4	248	27	96	< 0.1	10.3	910	4.1	< 100	1.8	418	61
3S/1E 7B12	3/28/19	ZONE7	19.9	14250	7.2	552	393	2600	5.3	321	1853	4179	< 0.1	23.1	1960	< 20	< 2000	< 20	9764	2999
3S/1E 7D 1	5/30/19	DSRSD	18.8	4200	6.99	-	-	-	-	-	141	1310	< 0.1	-	-	-	-	-	3456	-
3S/1E 7D 1	10/17/18	DSRSD	23.17	4339	7.03	-	-	-	-	-	127	1120	< 0.1	-	-	-	-	-	3017	-
3S/1E 7D 2	5/30/19	DSRSD	22.8	25190	6.88	-	-	-	-	-	11000	4100	< 0.1	-	-	-	-	-	26180	-
3S/1E 7D 2	10/17/18	DSRSD	24.59	25610	6.92	-	-	-	-	-	10900	3420	< 0.1	-	-	-	-	-	23560	-
3S/1E 7D 3	5/28/19	DSRSD	19.2	19070	6.73	-	-	-	-	-	136	8740	< 0.1	-	-	-	-	-	16080	-
3S/1E 7D 3	10/9/18	DSRSD	18.78	19260	7.67	-	-	-	-	-	362	7250	< 0.1	-	-	-	-	-	12590	-
3S/1E 7D 4	5/28/19	DSRSD	26.8	20920	7	-	-	-	-	-	6100	3500	< 0.1	-	-	-	-	-	16240	-
3S/1E 7D 4	10/9/18	DSRSD	21.03	17330	7.88	-	-	-	-	-	6380	5670	< 0.1	-	-	-	-	-	19300	-
3S/1E 7G 7	3/28/19	ZONE7	20	19300	7.1	690	741	2924	10.6	458	2939	5458	< 0.1	24.8	5930	< 20	< 2000	< 20	13013	4774
3S/1E 7J 5	3/28/19	ZONE7	20.6	2793	7.3	140	110	410	2.3	909	495	205	< 0.1	28.5	7160	< 5	< 500	< 5	1839	803
3S/1E 8B 1	7/2/19	ZONE7	21.9	1715	7.4	80	68	200	1.6	587	162	207	0.95	23.5	2560	1.9	360	3.6	1036	480
3S/1E 8G 4	7/2/19	ZONE7	21.7	1957	7.2	67	63	286	2	652	132	278	4.33	27.8	3480	2.9	< 100	18	1196	428
3S/1E 8H 9	6/3/19	ZONE7	19.7	1238	7.3	56	45	160	2.6	420	98	139	1.67	30	1420	1.1	< 100	4.9	746	325
3S/1E 8H10	6/3/19	ZONE7	19.3	1430	7.3	79	56	170	2.8	494	111	159	2.73	32.1	1560	< 1	< 100	6.5	866	429
3S/1E 8H11	6/3/19	ZONE7	22	1332	7.2	90	58	130	3.1	453	111	151	1.92	30	1220	< 1	< 100	5	805	464
3S/1E 8H13	8/29/19	ZONE7	22.8	534	10.6	17	1	75	2.5	14	46	61	0.36	9.2	410	< 1	< 100	2.1	263	46
3S/1E 8H18	7/8/19	ZONE7	19.6	1458	7.4	103	67	115	3.1	517	126	200	3.01	27.8	1380	1.5	< 100	8.7	910	534
3S/1E 8H18	4/9/19	ZONE7	19.7	1501	7.4	120	66	126	3.5	364	129	179	3.14	29.1	1320	< 1	< 100	3.5	846	572
3S/1E 8H18	12/4/18	ZONE7	19.2	1593	7.4	127	79	110	3.6	556	138	184	3.75	29.3	930	< 1	< 100	< 1	962	643
3S/1E 8K 1	7/9/19	ZONE7	23.2	1883	7.2	155	119	119	2.8	726	275	191	2.02	27.8	1530	1.7	< 100	11	1256	878
3S/1E 8N 1	7/9/19	ZONE7	23.8	2236	7	174	132	142	3.1	814	352	213	2.34	30	2310	< 2	< 200	7.4	1457	979
3S/1E 9B 1	7/9/19	ZONE7	19.2	1096	7.5	72	62	68	2.1	397	73	133	3.59	25.7	560	2.1	< 100	8.8	648	435
3S/1E 9B 1	4/9/19	ZONE7	19.6	930	7.6	66	46	61	2.3	318	63	96	3.31	25.9	450	1.1	< 100	5.2	532	355
3S/1E 9B 1	1/8/19	ZONE7	18.1	997	7.6	65	56	54	2.2	375	60	101	5.1	25.3	450	1.2	< 100	3.5	571	393
3S/1E 9B 1	12/4/18	ZONE7	18.8	929	7.6	65	51	53	2.1	342	56	92	3.52	28.9	330	1.1	< 100	3.3	533	372
3S/1E 9B 1	10/8/18	ZONE7	19.8	975	7.7	65	51	52	2.2	359	61	99	3.72	27.2	470	1.1	< 100	5.5	552	372
3S/1E 9J 7	6/3/19	ZONE7	18.5	800	7.3	49	33	71	1.8	241	53	101	< 0.1	15	460	< 1	< 100	< 1	443	258
3S/1E 9J 8	6/3/19	ZONE7	19	928	7.2	95	44	41	2	285	57	129	0.7	21.2	280	< 1	< 100	2.5	533	419
3S/1E 9J 9	6/3/19	ZONE7	22.2	672	7.2	54	48	28	1.7	283	41	57	3.43	27.8	190	< 1	< 100	7.7	412	333
3S/1E 9M 2	7/9/19	ZONE7	17.8	1108	7.3	61	59	95	2	382	65	155	2.22	25.7	1140	1.4	< 100	6.7	661	395
3S/1E 9M 2	4/9/19	ZONE7	17.5	1134	7.5	72	56	100	2.3	390	70	144	2.57	26.7	1110	< 1	< 100	2.7	675	411
3S/1E 9M 3	7/8/19	ZONE7	18	1098	7.4	75	50	90	2.2	385	80	146	1.75	23.5	1160	< 1	< 100	7.7	664	394
3S/1E 9M 3	4/8/19	ZONE7	17.9	1208	7.4	94	50	100	2.5	407	91	144	1.96	24.4	1280	< 1	< 100	3.7	715	441
3S/1E 9M 3	1/8/19	ZONE7	17.4	1225	7.2	89	54	74	2.4	403	91	155	2.03	22.7	900	< 1	< 100	1.4	696	444
3S/1E 9M 3	10/10/18	ZONE7	17.8	1302	7.3	99	54	83	2.7	422	95	177	2.25	23.5	1270	< 1	< 100	3.7	753	470

- = Not Analyzed; X = Suspect Result

TABLE 7-2
WATER QUALITY RESULTS FOR SELECT METALS AND MINERALS
2019 WATER YEAR

			TEMP	EC		Mineral Constituents (mg/L)									Select Metals (ug/L)				TDS	Hard
SITE ID	DATE	By	°C	umhos/cm	pH	Ca	Mg	Na	K	HCO3	SO4	Cl	NO3N	SiO2	B	As	Fe	Cr	mg/L	mg/L
3S/1E 9M 4	8/5/19	ZONE7	18.4	1113	7.5	56	43	138	2.3	377	86	140	1.47	27.8	1510	1.3	< 100	6.8	686	317
3S/1E 9M 4	4/9/19	ZONE7	18.3	1188	7.4	67	43	140	2.6	407	96	139	1.53	27.6	1560	< 1	< 100	4.1	723	345
3S/1E 9M 4	1/7/19	ZONE7	18	1320	7.5	70	53	138	2.7	453	102	156	2.11	26.5	1360	< 1	< 100	2.6	781	393
3S/1E 9M 4	10/8/18	ZONE7	19.1	1396	7.5	75	59	118	2.9	475	103	171	2.32	27.4	1810	< 1	< 100	5	801	432
3S/1E 9P 5	6/3/19	ZONE7	21.1	755	6.9	53	27	66	2.1	205	52	100	0.31	19.3	430	< 1	< 100	1.2	422	243
3S/1E 9P 9	6/3/19	ZONE7	19.4	892	7.2	61	36	84	2.1	268	68	112	0.26	23.5	620	< 1	< 100	1.5	520	300
3S/1E 9P10	6/3/19	ZONE7	23.2	841	7.1	78	37	46	1.8	273	57	101	2.02	21.4	290	< 1	< 100	2	486	347
3S/1E 9P11	6/3/19	ZONE7	28.4	470	7.6	32	15	42	1.5	210	35	21	< 0.1	21.4	420	5.5	< 100	< 1	272	142
3S/1E 10A 2	5/7/19	ZONE7	19.2	1908	7.2	83	84	247	2.6	556	120	292	9.75	31.5	2940	< 5	< 500	< 5	1177	554
3S/1E 10B 8	5/29/19	ZONE7	19.1	1510	7.3	81	82	140	2.4	559	88	181	7.73	30	1920	1.2	< 100	10	914	540
3S/1E 10B 9	5/29/19	ZONE7	31	1086	7.6	65	60	90	2.5	389	63	126	6.05	27.8	950	1.5	< 100	5.7	654	409
3S/1E 10B10	5/29/19	ZONE7	25.3	891	7.5	54	50	67	1.9	346	51	86	4.3	27.8	610	1	< 100	7.7	528	341
3S/1E 10B11	5/29/19	ZONE7	27.3	876	7.4	55	47	68	2.2	328	49	87	5.49	27.8	550	1.4	< 100	5.6	523	332
3S/1E 10B14	5/29/19	ZONE7	19	722	7.6	52	48	35	1.7	301	41	59	3.92	27.8	240	< 1	< 100	7.6	431	328
3S/1E 10B16	7/9/19	ZONE7	18.9	686	7.6	45	44	35	1.5	307	38	50	3.7	25.7	350	1.2	< 100	15	407	293
3S/1E 10B16	4/8/19	ZONE7	18.7	741	7.6	55	42	40	1.9	310	41	60	4.65	27	370	< 1	< 100	6.9	441	311
3S/1E 10B16	1/7/19	ZONE7	18.1	713	7.5	46	43	30	1.6	300	41	54	3.91	25.7	260	< 1	< 100	8.2	407	292
3S/1E 10B16	10/9/18	ZONE7	18.8	693	7.6	47	40	31	1.7	294	38	46	3.81	27.4	320	< 1	< 100	11	394	283
3S/1E 10D 2	7/10/19	ZONE7	28.1	1071	7.7	31	35	144	1.1	451	47	122	0.38	21.4	1490	13	< 100	3	626	222
3S/1E 10D 3	7/10/19	ZONE7	21.3	1186	7.5	66	62	83	2.1	460	64	132	8.6	25.7	1200	2.5	< 100	12	700	420
3S/1E 10D 4	7/10/19	ZONE7	23	783	7.5	45	44	51	1.4	311	42	80	3.75	25.7	400	1.9	< 100	16	459	293
3S/1E 10D 5	7/10/19	ZONE7	21.5	632	7.5	41	37	38	1.8	282	33	45	4.92	27.8	250	1.4	< 100	13	384	254
3S/1E 10K 2	9/3/19	ZONE7	19.5	871	7.3	69	42	55	1.7	305	41	121	0.23	19.9	540	< 1	< 100	3.1	501	345
3S/1E 10K 3	7/9/19	ZONE7	17.2	861	7.4	58	54	40	1.5	329	46	103	2.24	23.5	390	< 1	250	10	499	367
3S/1E 10K 3	4/8/19	ZONE7	18	807	7.3	61	45	39	1.8	290	45	80	2.78	24	350	< 1	< 100	5.6	451	337
3S/1E 10K 3	1/7/19	ZONE7	17.5	817	7.4	58	51	33	1.7	307	47	86	2.93	23.5	280	< 1	< 100	3.8	465	355
3S/1E 10K 3	10/9/18	ZONE7	16.7	842	7.4	59	48	33	1.8	308	48	95	2.95	24.2	360	< 1	< 100	5.7	474	346
3S/1E 11B 1	8/1/19	LWRP	-	1810	-	73	67	250	1.2	-	98	300	11.1	29	4100.	-	-	-	1070	-
3S/1E 11B 1	5/1/19	LWRP	-	1780	-	65	61	220	1.3	-	96	281	10.3	29	3700.	-	-	-	1090	-
3S/1E 11B 1	3/1/19	LWRP	-	1770	-	70	64	230	1.1	-	95	242	11.3	28	2500.	-	-	-	1060	-
3S/1E 11B 1	11/6/18	LWRP	-	1800	-	71	67	250	1.3	-	92	249	10.9	30	4550.	-	-	-	1080	-
3S/1E 11C 3	5/14/19	ZONE7	19	1813	7.2	76	60	228	1.7	572	91	244	3.51	22.9	3190	< 5	< 500	< 5	1021	437
3S/1E 11G 1	5/29/19	ZONE7	22.9	1265	7.1	66	81	97	3	511	68	123	10.8	36.4	770	< 1	< 100	5.6	774	499
3S/1E 11G 2	5/29/19	ZONE7	27.2	1224	7.2	68	82	98	3	503	68	120	10.4	36.4	790	< 1	< 100	5.7	770	508
3S/1E 11G 3	5/29/19	ZONE7	20.6	662	7.5	46	47	33	1.8	298	38	45	3.62	30	190	< 1	< 100	10	404	309
3S/1E 11G 4	5/29/19	ZONE7	19.6	1266	7.3	70	84	100	3	508	68	120	10.4	38.5	850	< 1	< 100	6.2	780	521
3S/1E 11M 2	9/3/19	ZONE7	19.5	813	7.2	48	49	52	1.8	299	46	91	3.54	18	390	< 1	< 100	5.7	469	322
3S/1E 11M 3	7/9/19	ZONE7	18.5	706	7.4	51	42	33	1.4	289	39	64	4.35	23.5	310	< 1	< 100	10	416	301
3S/1E 11M 3	4/8/19	ZONE7	18.5	700	7.4	55	40	32	1.7	284	40	60	4.11	24.4	260	< 1	< 100	5.3	411	303
3S/1E 11M 3	1/7/19	ZONE7	18.4	703	7.4	46	43	27	1.6	277	40	62	4.11	23.8	210	< 1	< 100	4.8	398	292
3S/1E 11M 3	10/9/18	ZONE7	17.9	729	7.5	51	40	30	1.7	285	41	62	4.08	24.6	300	< 1	< 100	6.9	409	293
3S/1E 11P 6	8/29/19	ZONE7	19.2	764	7.3	68	32	43	1.6	245	49	91	1.03	17.8	390	< 1	< 100	4.3	428	302
3S/1E 12A 2	9/10/19	ZONE7	24.4	1193	7.1	69	94	75	2.6	495	75	124	12.1	32.1	510	4.4	< 100	7.9	769	559
3S/1E 12A 2	8/1/19	LWRP	-	1290	-	70	100	66	3.2	-	73	158	12.6	35	630.	-	-	-	770	-
3S/1E 12A 2	5/1/19	LWRP	-	1290	-	68	98	62	3.4	-	70	145	13	33	610.	-	-	-	770	-
3S/1E 12A 2	3/1/19	LWRP	-	1250	-	68	94	60	3.2	-	68	133	14.9	35	500.	-	-	-	730	-
3S/1E 12A 2	11/6/18	LWRP	-	1290	-	69	98	64	3.3	-	69	134	12.6	35	620.	-	-	-	740	-
3S/1E 12D 2	9/10/19	ZONE7	25.6	1520	7.2	89	88	177	2.2	749	72	125	13.1	36.4	2580	3.5	< 100	38	1017	585
3S/1E 12D 2	8/1/19	LWRP	-	1670	-	95	97	170	3.1	-	68	168	14.1	39	3300.	-	-	-	1020	-
3S/1E 12D 2	5/1/19	LWRP	-	1630	-	83	84	160	2.7	-	64	151	13.2	38	3150.	-	-	-	1030	-

- = Not Analyzed; X = Suspect Result

TABLE 7-2
WATER QUALITY RESULTS FOR SELECT METALS AND MINERALS
2019 WATER YEAR

			TEMP	EC		Mineral Constituents (mg/L)									Select Metals (ug/L)				TDS	Hard
SITE ID	DATE	By	°C	umhos/cm	pH	Ca	Mg	Na	K	HCO3	SO4	Cl	NO3N	SiO2	B	As	Fe	Cr	mg/L	mg/L
3S/1E 12D 2	3/1/19	LWRP	-	1600	-	84	84	160	2.5	-	73	120	12.2	30	2350.	-	-	-	960	-
3S/1E 12D 2	11/6/18	LWRP	-	1690	-	90	94	170	3.2	-	78	147	18.2	38	2900.	-	-	-	1030	-
3S/1E 12G 1	9/10/19	ZONE7	26	1043	7	54	71	71	2.3	426	59	107	9.13	30	540	1.5	< 100	11	645	428
3S/1E 12G 1	8/1/19	LWRP	-	1100	-	60	81	72	2.7	-	54	138	9.2	33	750.	-	-	-	650	-
3S/1E 12G 1	5/1/19	LWRP	-	1110	-	56	75	67	2.8	-	52	124	9	33	820.	-	-	-	650	-
3S/1E 12G 1	3/1/19	LWRP	-	1100	-	57	76	69	2.5	-	51	110	10	33	580.	-	-	-	630	-
3S/1E 12G 1	11/6/18	LWRP	-	1160	-	57	78	71	2.5	-	55	120	10.3	35	820.	-	-	-	660	-
3S/1E 12H 4	9/30/19	ZONE7	18.8	702	7.5	49	50	30	1.7	297	41	58	3.79	30	280	1	< 100	11	423	326
3S/1E 12H 4	5/28/19	ZONE7	19.2	847	7.2	57	66	38	2	361	48	70	5.11	30	200	< 1	< 100	7.4	512	414
3S/1E 12H 5	9/30/19	ZONE7	19.1	676	7.6	48	45	34	2	308	41	43	2.94	30	280	1.2	< 100	15	408	307
3S/1E 12H 5	3/12/19	ZONE7	16.8	687	7.4	45	46	28	1.6	324	42	46	3.11	31.7	200	< 1	< 100	7.6	414	302
3S/1E 12H 6	9/30/19	ZONE7	19.3	596	7.8	40	36	43	2.1	295	36	27	2.03	30	230	1.7	< 100	20	369	250
3S/1E 12H 6	3/12/19	ZONE7	19.1	600	7.5	40	39	35	1.8	323	40	28	2.12	31.7	200	< 1	< 100	12	385	261
3S/1E 12H 7	9/30/19	ZONE7	19.2	457	8.3	7	3	101	1	204	16	33	1.21	25.7	450	29	< 100	< 1	294	29
3S/1E 12H 7	3/12/19	ZONE7	18.2	475	7.9	8	4	90	0.7	213	19	33	1.55	25.9	310	21	< 100	< 1	294	36
3S/1E 12K 2	9/30/19	ZONE7	18.7	644	7.5	39	47	33	1.5	244	38	68	1.9	25.7	280	< 1	< 100	5.1	381	292
3S/1E 12K 2	5/28/19	ZONE7	19.8	588	7.2	34	38	31	1.7	241	34	52	1.5	25.7	200	< 1	< 100	3	342	242
3S/1E 12K 3	9/30/19	ZONE7	18.5	652	7.5	44	45	35	1.9	283	37	47	4.15	32.1	240	< 1	< 100	15	400	295
3S/1E 12K 3	5/28/19	ZONE7	20.7	661	7.3	43	46	33	1.8	296	38	46	4.02	32.1	180	< 1	< 100	11	404	298
3S/1E 12K 4	9/30/19	ZONE7	19.5	324	7.8	18	16	30	1.3	146	7.7	22	1.72	21.4	170	< 1	< 100	3.6	196	110
3S/1E 12K 4	5/28/19	ZONE7	21	321	7.7	17	17	29	1.3	152	8	21	1.57	21.4	110	< 1	< 100	2.6	197	112
3S/1E 14B 1	9/3/19	ZONE7	20	774	7.4	92	20	40	1.7	288	45	84	2.7	20.1	380	< 1	< 100	4.4	457	313
3S/1E 14D 2	9/3/19	ZONE7	20	733	7.2	68	34	60	1.5	269	52	112	0.8	18.4	480	< 1	< 100	3.7	482	310
3S/1E 15J 3	8/29/19	ZONE7	20.3	866	6.9	80	39	53	1.9	371	35	78	1.61	16.9	430	< 1	1300	< 1	494	361
3S/1E 15M 3	6/5/19	ZONE7	23.3	734	7.3	53	23	77	1.6	262	38	87	1.62	27.8	230	< 1	< 100	< 1	444	227
3S/1E 16A 2	9/5/19	ZONE7	-	954	7.8	88	41	60	2.2	352	55	116	1.51	18.8	590	< 1	< 100	2.5	563	389
3S/1E 16A 4	6/5/19	ZONE7	22.6	1044	7.3	120	44	46	2	397	63	119	2.86	25.7	300	< 1	< 100	3.3	628	481
3S/1E 16B 1	6/5/19	ZONE7	20.7	585	7.4	62	22	39	1.7	256	34	41	2.41	25.7	180	< 1	< 100	9	363	246
3S/1E 16C 2	6/5/19	ZONE7	20.4	1100	7.2	110	48	66	2.1	429	70	126	2.03	23.5	500	< 1	< 100	2.7	666	473
3S/1E 16C 3	6/5/19	ZONE7	22.4	1145	7.4	110	55	66	2.6	463	69	113	4.76	27.8	450	< 1	< 100	4.4	693	502
3S/1E 16C 4	6/5/19	ZONE7	24.7	1142	7.4	120	52	66	2.5	468	68	114	4.6	27.8	460	< 1	< 100	4.4	702	514
3S/1E 16E 4	8/29/19	ZONE7	20.1	1290	7.1	124	60	74	2.5	524	74	125	5.58	21.2	570	< 1	< 100	6.2	763	557
3S/1E 16L 5	9/5/19	ZONE7	-	945	7.4	89	40	62	2.2	375	58	102	2.61	21.4	540	< 1	< 100	4.3	572	387
3S/1E 16L 7	9/5/19	ZONE7	-	946	7.5	105	52	69	2.4	455	71	124	3.26	23.5	720	< 1	< 100	4.8	687	476
3S/1E 16P 5	9/9/19	ZONE7	21.8	454	6.8	32	19	36	2.1	193	23	39	< 0.1	9.8	260	< 1	< 100	< 1	256	158
3S/1E 16P 5	4/3/19	ZONE7	16.3	389	7	31	18	24	1.9	161	33	25	0.29	11.3	170	< 1	< 100	< 1	225	152
3S/1E 17B 4	8/29/19	ZONE7	18.4	1552	7.1	153	86	74	2.8	645	75	158	7.46	21.4	730	< 1	< 100	5.6	921	736
3S/1E 17D 3	6/27/19	ZONE7	-	1555	7.5	96	105	71	2.8	544	134	167	1.62	16.5	640	< 1	310	2.2	869	673
3S/1E 17D 4	6/27/19	ZONE7	-	1231	8.4	15	6	250	1.2	266	19	251	< 0.1	19.9	2550	8.9	< 100	5.1	699	63
3S/1E 17D 5	6/27/19	ZONE7	-	1164	8.7	14	9	234	1	268	9	246	< 0.1	14.3	2390	69	< 100	5.1	672	72
3S/1E 17D 6	6/27/19	ZONE7	-	1346	8.6	12	5	284	1.5	254	6	306	< 0.1	17.1	1590	6.4	< 100	5.7	766	51
3S/1E 17D 7	6/27/19	ZONE7	-	1399	9	6	5	282	1.8	178	< 1	346	< 0.1	3.6	1730	35	< 100	5.9	749	36
3S/1E 17D11	6/27/19	ZONE7	-	1183	8.2	12	4	244	1	268	1	244	< 0.1	23.5	3050	14	< 100	5	665	46
3S/1E 17D12	7/8/19	ZONE7	17.8	895	7.4	79	53	45	1.8	391	53	78	4.32	23.5	440	1.2	< 100	9.3	546	416
3S/1E 17D12	1/8/19	ZONE7	17.1	955	7.6	83	52	35	1.9	399	58	76	4.67	23.1	290	< 1	< 100	3	547	422
3S/1E 18A 6	7/8/19	ZONE7	17.9	1025	7.3	73	51	73	1.8	419	83	91	3.03	23.5	570	1.9	< 100	7.7	617	392
3S/1E 18A 6	1/7/19	ZONE7	17.6	1014	7.5	79	51	62	1.9	409	81	85	2.93	23.8	400	< 1	< 100	1.5	599	408
3S/1E 18E 4	3/28/19	ZONE7	17.9	737	7.7	61	20	78	0.9	305	68	51	< 0.1	25	460	< 1	200	< 1	454	234
3S/1E 18J 2	3/28/19	ZONE7	18.9	3721	7.2	240	210	410	3.6	751	643	647	< 0.1	26.1	1420	9.3	< 500	< 5	2550	1465
3S/1E 19A10	8/8/19	ZONE7	-	1389	7.4	140	68	65	2.5	497	113	163	2.56	20.5	480	< 1	< 100	4.8	829	630

- = Not Analyzed; X = Suspect Result

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1/16/2020

TABLE 7-2
WATER QUALITY RESULTS FOR SELECT METALS AND MINERALS
2019 WATER YEAR

			TEMP	EC		Mineral Constituents (mg/L)									Select Metals (ug/L)				TDS	Hard
SITE ID	DATE	By	°C	umhos/cm	pH	Ca	Mg	Na	K	HCO3	SO4	Cl	NO3N	SiO2	B	As	Fe	Cr	mg/L	mg/L
3S/1E 19A11	8/8/19	ZONE7	-	1398	7.3	121	60	53	2.1	431	113	187	1.86	19.5	390	< 1	< 100	2.7	777	549
3S/1E 19C 4	3/28/19	ZONE7	18.6	1073	7.2	110	58	36	2.4	396	111	80	2.53	26.1	390	< 1	440	< 1	630	514
3S/1E 19K 1	4/3/19	ZONE7	19.6	1508	7.1	140	88	110	2.2	652	206	104	< 0.1	15.8	640	1.6	< 100	< 1	987	713
3S/1E 20B 2	9/24/19	ZONE7	-	928	7.1	83	44	58	1.8	353	56	86	3.52	25.7	370	< 1	< 100	2.4	544	389
3S/1E 20C 7	9/9/19	ZONE7	20.4	656	7.1	53	28	57	2.1	273	44	66	1.1	16.9	340	< 1	< 100	2.2	406	247
3S/1E 20C 7	5/28/19	ZONE7	21.5	682	7.1	53	28	55	2.1	272	44	65	0.96	17.1	270	< 1	< 100	1.8	402	247
3S/1E 20C 8	5/28/19	ZONE7	19.6	1002	7.4	100	53	33	2.3	312	53	85	5.37	23.5	190	< 1	< 100	3.5	527	468
3S/1E 20C 9	5/28/19	ZONE7	22.9	949	7.4	89	50	51	3.1	409	62	86	2.23	25.7	310	< 1	< 100	3	579	428
3S/1E 20J 4	4/3/19	ZONE7	19.9	1079	6.8	61	38	130	1.2	418	62	103	4.97	32.5	570	< 1	< 100	< 1	655	309
3S/1E 20M11	4/3/19	ZONE7	19.5	884	7.1	81	39	56	2.1	355	62	82	2.54	23.1	370	< 1	< 100	< 1	531	363
3S/1E 20Q 2	8/29/19	ZONE7	21.7	1405	7.3	70	77	127	1.3	596	20	162	< 0.1	19.5	580	< 1	5700	3.2	771	492
3S/1E 22D 2	4/3/19	ZONE7	21	994	7.2	46	38	110	1	317	55	114	10.5	42.8	< 100	< 1	< 100	1.1	609	272
3S/1E 23J 1	5/14/19	ZONE7	18.6	390	8.4	22	13	38	1.7	119	25	41	0.19	10.2	100	< 1	< 100	< 1	211	109
3S/1E 25C 3	9/9/19	ZONE7	21.8	775	7.1	50	28	70	1.4	248	29	109	4.05	23.5	310	< 1	< 100	2	451	240
3S/1E 29M 4	4/3/19	ZONE7	18	1196	7.4	110	55	89	2.9	661	9	96	< 0.1	30.4	1040	19	2100	< 1	718	502
3S/1E 29P 2	4/3/19	ZONE7	18.1	1400	7.3	84	62	160	2.4	670	41	147	< 0.1	21.2	1780	< 1	< 200	< 1	848	465
3S/1W 1B 9	6/27/19	ZONE7	-	1179	7.5	68	34	150	1.7	400	100	120	8.91	23.5	600	7	< 100	1.6	735	310
3S/1W 1B10	6/27/19	ZONE7	-	787	7.4	42	18	120	0.8	371	< 1	89	< 0.1	25.7	500	155	250	1.1	479	179
3S/1W 1B11	6/27/19	ZONE7	-	922	7.6	26	12	150	1.2	260	< 1	158	< 0.1	23.5	600	23	< 100	2.6	500	114
3S/1W 1J 1	5/20/19	DSRSD	18.3	2805	7.01	-	-	-	-	-	565	218	< 0.1	-	-	-	-	-	2054	-
3S/1W 1J 1	10/15/18	DSRSD	26.29	3577	6.98	-	-	-	-	-	565	212	< 0.1	-	-	-	-	-	2078	-
3S/1W 1J 2	5/20/19	DSRSD	20.9	2503	7.13	-	-	-	-	-	552	103	12.5	-	-	-	-	-	1768	-
3S/1W 1J 2	10/15/18	DSRSD	28.76	3195	7.24	-	-	-	-	-	600	114	14.3	-	-	-	-	-	1956	-
3S/1W 2A 2	3/13/19	ZONE7	20.8	1443	6.7	166	29	109	0.5	279	71	157	3.32	25.9	280	< 1	< 100	< 1	710	533
3S/1W 12A 9	5/28/19	DSRSD	18.1	6242	6.98	-	-	-	-	-	113	2780	< 0.1	-	-	-	-	-	5312	-
3S/1W 12A 9	10/11/18	DSRSD	19.5	6630	9	-	-	-	-	-	110	2200	< 0.1	-	-	-	-	-	4934	-
3S/1W 12A10	5/28/19	DSRSD	23.4	2524	7.37	-	-	-	-	-	850	45.9	3.3	-	-	-	-	-	1942	-
3S/1W 12A10	10/11/18	DSRSD	24.31	2708	9.21	-	-	-	-	-	567	137	2.15	-	-	-	-	-	1574	-
3S/1W 12B 2	3/28/19	ZONE7	21.1	1079	6.5	117	37	66	0.5	331	109	102	5.36	38.7	190	< 1	< 100	< 1	657	444
3S/1W 12J 1	3/28/19	ZONE7	21.2	1572	7.4	108	34	225	1.1	437	226	170	0.77	28.7	790	1.6	< 100	< 1	1012	410
3S/1W 13J 1	4/3/19	ZONE7	19.3	964	6.6	100	41	54	0.5	287	94	109	5.27	26.5	190	< 1	< 100	< 1	590	419
3S/2E 1F 2	1/10/19	ZONE7	18.7	2849	7.5	104	50	351	2	222	182	669	4.88	46.2	5020	< 1	< 100	2.1	1535	466
3S/2E 2B 2	1/10/19	ZONE7	21	1982	7.4	116	42	196	1.5	260	96	420	6.54	36.8	1340	< 1	< 100	5.4	1065	463
3S/2E 3A 1	5/8/19	ZONE7	20.6	1152	7.5	60	34	128	1.3	292	69	165	6.06	37.7	1460	2.3	< 200	16	666	290
3S/2E 3K 3	1/24/19	ZONE7	19.9	965	7.6	48	39	96	2	306	64	121	9.15	26.3	1040	< 1	< 100	7.1	588	281
3S/2E 5N 1	9/10/19	ZONE7	20.9	858	7.4	53	57	49	1.8	312	42	82	10.2	27.8	540	< 1	< 100	8.6	512	367
3S/2E 7C 2	8/1/19	LWRP	-	1280	-	67	110	65	4	-	70	156	12.2	37	680.	-	-	-	760	-
3S/2E 7C 2	5/1/19	LWRP	-	1230	-	59	96	58	3.7	-	69	143	11.3	46	5880.	-	-	-	730	-
3S/2E 7C 2	3/1/19	LWRP	-	1210	-	58	91	56	3.5	-	67	131	12.1	39	500.	-	-	-	700	-
3S/2E 7C 2	11/6/18	CWS	-	1260	-	60	97	59	3.8	-	70	133	12.7	39	610.	-	-	-	750	-
3S/2E 7H 2	5/9/19	ZONE7	23.1	1300	7	56	70	118	3.1	443	158	94	12.9	31.7	690	< 1	< 100	< 1	806	428
3S/2E 7N 2	5/28/19	ZONE7	18.5	536	7.3	34	38	22	1.6	190	36	58	1.25	27.8	200	< 1	< 100	1.8	317	242
3S/2E 8F 1	9/10/19	CWS	-	-	-	-	-	-	-	-	-	-	-	-	520	-	-	< 50	-	-
3S/2E 8G 1	4/4/19	CWS	21.5	1100	7.86	65	79	40	< 1	370	70	120	11	29	470	< 10	290	13	590	490
3S/2E 8H 2	9/4/19	ZONE7	29.3	1416	6.9	49	106	96	1.1	446	108	190	10.1	34.2	360	1.1	< 100	7	849	559
3S/2E 8H 3	9/4/19	ZONE7	21.4	1277	7.2	80	85	64	1.4	443	76	128	9.49	30	460	< 1	< 100	8	725	550
3S/2E 8H 4	9/4/19	ZONE7	22.4	1133	7.6	48	51	117	2	352	28	182	4.13	23.5	510	3	< 100	12	644	330
3S/2E 8K 2	5/7/19	ZONE7	21	1081	7.4	53	78	50	2	382	66	120	9.89	29.5	400	< 5	< 200	3.4	631	453
3S/2E 8N 2	9/10/19	CWS	-	-	-	-	-	-	-	-	-	-	-	-	380	-	-	< 50	-	-
3S/2E 8Q 9	4/9/19	ZONE7	20.7	881	7.5	51	57	43	2.2	353	55	92	5.29	24	360	< 1	< 100	1.8	522	363

- = Not Analyzed; X = Suspect Result

TABLE 7-2
WATER QUALITY RESULTS FOR SELECT METALS AND MINERALS
2019 WATER YEAR

			TEMP	EC		Mineral Constituents (mg/L)									Select Metals (ug/L)				TDS	Hard
SITE ID	DATE	By	^oC	umhos/cm	pH	Ca	Mg	Na	K	HCO3	SO4	Cl	NO3N	SiO2	B	As	Fe	Cr	mg/L	mg/L
3S/2E 9Q 1	9/10/19	CWS	-	-	-	-	-	-	-	-	-	-	-	-	460	-	-	< 50	-	-
3S/2E 9Q 4	5/9/19	ZONE7	20.7	1215	7.2	46	86	69	1.5	393	83	139	10.2	35.3	720	< 1	< 100	3.4	698	469
3S/2E 10C 6	8/27/19	ZONE7	30.7	979	7.3	56	45	118	1.4	506	78	16	10.4	27.8	800	1.7	< 100	< 1	638	325
3S/2E 10C11	8/27/19	ZONE7	27.7	929	7.5	41	37	139	7.5	515	55	38	0.19	36.4	650	5.5	< 100	1.3	610	254
3S/2E 10C12	8/27/19	ZONE7	29.3	441	7.3	30	19	28	2.6	113	6	76	1.87	10.9	190	2	< 100	9	237	152
3S/2E 10D 2	8/27/19	ZONE7	23.2	1426	7.3	91	78	117	3.6	477	14	254	4.97	34.2	350	2	< 100	3.2	849	549
3S/2E 10F 3	1/28/19	ZONE7	-	1657	7.1	80	112	88	1.2	579	106	217	11	32.1	880	< 1	< 100	< 1	971	661
3S/2E 10Q 1	1/24/19	ZONE7	21.2	1687	7.1	73	122	89	1.4	519	120	247	16.6	32.7	1090	< 1	< 100	< 1	1014	685
3S/2E 10Q 2	3/19/19	ZONE7	-	780	7.6	50	32	54	1.9	194	83	91	6.06	26.5	600	< 1	< 100	9	461	257
3S/2E 11C 1	5/9/19	ZONE7	20.1	735	7.4	48	20	80	2	239	34	98	1.83	31.7	390	< 1	< 100	4	440	202
3S/2E 12C 4	3/19/19	ZONE7	-	1308	7.6	51	10	167	1.8	322	93	205	2.19	34.9	2840	1.6	< 100	63	732	169
3S/2E 12J 3	3/19/19	ZONE7	-	709	7.8	41	15	68	2.9	63	64	148	0.3	24.8	330	< 1	< 100	< 1	396	164
3S/2E 14A 3	9/4/19	ZONE7	27.5	1171	7.1	98	42	78	2.5	494	31	101	12	27.8	640	< 1	< 100	9.5	677	418
3S/2E 14B 1	9/4/19	ZONE7	21	1007	7.3	69	38	74	2	334	45	121	9.39	25.7	650	1	< 100	14	581	329
3S/2E 15E 2	9/9/19	ZONE7	19.1	1140	7.6	51	86	50	1.6	414	84	114	10	25.7	520	< 1	< 100	2.9	661	482
3S/2E 15L 1	1/24/19	ZONE7	21.1	1216	7.5	39	90	68	1.5	401	101	131	12.4	28.7	370	< 1	< 100	< 1	712	469
3S/2E 15R 3	2/20/19	ZONE7	-	1241	7.8	62	91	74	1.8	380	102	149	10.5	41.5	480	< 1	< 100	< 1	757	530
3S/2E 15R 5	2/20/19	ZONE7	-	1176	7.6	41	89	82	1.4	323	101	168	11.9	44.3	480	< 1	< 100	< 1	740	469
3S/2E 15R17	1/24/19	ZONE7	20.3	983	7.5	40	82	32	1.5	354	65	99	12.47	27.2	390	< 1	< 100	4.6	577	438
3S/2E 15R18	1/24/19	ZONE7	21.5	717	7.6	45	41	33	1.4	329	44	45	1.45	26.5	160	< 1	< 100	< 1	405	281
3S/2E 16A 3	9/4/19	ZONE7	20.8	1122	7.4	49	89	51	1.6	377	80	106	8.67	30	450	< 1	< 100	5.6	631	488
3S/2E 16E 4	1/28/19	ZONE7	-	663	7.1	26	40	50	2.3	236	42	72	1.93	18	220	< 1	< 100	< 1	375	230
3S/2E 18E 1	9/9/19	ZONE7	24.8	554	7.6	40	34	23	1.6	189	37	65	1.59	23.5	210	< 1	< 100	2.2	324	240
3S/2E 19D 7	9/3/19	ZONE7	20.1	1056	7.2	89	61	38	2	327	27	168	5.57	25.7	< 100	< 1	< 100	8.9	596	473
3S/2E 19D 8	9/3/19	ZONE7	24.5	1035	7.3	94	49	41	2	322	27	165	5.57	25.7	< 100	< 1	< 100	8.3	587	436
3S/2E 19D 9	9/3/19	ZONE7	19.5	758	7.2	58	31	45	1.4	227	30	98	8.86	25.7	100	< 1	< 100	2.5	440	273
3S/2E 19D10	9/3/19	ZONE7	22.2	767	7.3	62	33	49	1.6	219	30	99	8.9	27.8	110	< 1	< 100	2.7	450	291
3S/2E 19N 3	9/4/19	ZONE7	29.6	560	7.5	35	20	51	1.5	265	26	40	0.62	23.5	230	3.2	< 100	< 1	331	169
3S/2E 19N 4	9/4/19	ZONE7	28.4	860	7.7	26	14	132	2.5	288	52	107	< 0.1	14.3	360	26	< 100	2.5	491	123
3S/2E 20M 1	5/14/19	ZONE7	19.2	1032	7	64	42	66	1.9	343	53	117	4.92	23.3	230	< 2	< 200	< 2	558	333
3S/2E 22B 1	1/24/19	ZONE7	20.8	1270	7.3	52	98	64	1.4	399	161	127	7.73	29.7	320	< 1	< 100	< 1	764	534
3S/2E 23E 1	1/24/19	ZONE7	21.5	827	7.7	35	53	49	1.9	352	42	69	5.14	21.4	350	1	< 100	2.5	468	306
3S/2E 23E 2	1/24/19	ZONE7	18.5	1082	7.6	41	60	109	2.4	393	51	166	0.49	29.3	1780	< 1	< 100	< 1	655	349
3S/2E 24A 1	1/10/19	ZONE7	19.5	1631	7	120	59	136	1.9	541	80	193	25.4	28.7	710	< 1	< 100	< 1	998	543
3S/2E 25H 1	2/20/19	ZONE7	-	1156	7.9	33	62	130	1.6	402	87	130	2.15	32.1	1010	< 1	< 100	< 1	686	337
3S/2E 26J 2	1/28/19	ZONE7	-	1091	7.4	50	98	44	2.8	518	81	68	3.67	14.1	560	< 1	< 100	< 1	630	529
3S/2E 29F 4	9/9/19	ZONE7	26.6	669	7.6	65	27	41	1.6	302	58	40	< 0.1	19.9	300	4.1	< 100	< 1	402	273
3S/2E 29F 4	1/28/19	ZONE7	-	610	7.5	50	23	41	1.6	258	48	47	0.16	17.3	230	3.8	< 100	< 1	356	220
3S/2E 30D 2	5/9/19	ZONE7	24.3	605	7.2	41	22	47	2	238	42	50	1.32	16	230	< 1	< 100	< 1	343	193
3S/2E 33G 1	9/9/19	ZONE7	26.1	321	7.3	29	15	24	2.1	160	27	17	< 0.1	12.6	180	1.2	< 100	< 1	206	134
3S/2E 33G 1	5/14/19	ZONE7	19.5	369	7.2	26	14	26	1.9	141	34	22	0.17	12.3	220	1.2	< 100	< 1	206	123
3S/2E 33K 1	9/24/19	VA	26.5	1890	7.7	-	-	-	-	-	-	280	3.1	-	-	-	-	-	1080	-
3S/2E 33K 1	6/5/19	VA	24.5	2090	7.7	-	-	-	-	-	-	320	4.6	-	-	-	-	-	1050	-
3S/2E 33K 1	3/12/19	VA	16	721	7.5	-	-	-	-	-	-	60	3.2	-	-	-	-	-	400	-
3S/2E 33K 1	12/28/18	VA	17.1	1160	7.5	-	-	-	-	-	-	120	4.5	-	-	-	-	-	631	-
3S/2E 33L 1	9/24/19	VA	28.1	1410	7.2	-	-	-	-	-	-	200	0.79	-	-	-	-	-	738	-
3S/2E 33L 1	6/5/19	VA	23	1170	7.2	-	-	-	-	-	-	150	1.4	-	-	-	-	-	727	-
3S/2E 33L 1	3/12/19	VA	16.5	789	7.1	-	-	-	-	-	-	69	3.2	-	-	-	-	-	401	-
3S/2E 33L 1	12/28/18	VA	15.8	1320	7.1	-	-	-	-	-	-	140	3.9	-	-	-	-	-	906	-
3S/3E 6Q 3	1/10/19	ZONE7	21.3	2340	7.2	112	42	304	3.2	351	446	282	7.02	49.9	3880	< 1	< 100	1.2	1443	453

- = Not Analyzed; X = Suspect Result

TABLE 7-2
WATER QUALITY RESULTS FOR SELECT METALS AND MINERALS
2019 WATER YEAR

			TEMP	EC		Mineral Constituents (mg/L)									Select Metals (ug/L)				TDS	Hard
SITE ID	**DATE**	**By**	^{o}C	umhos/cm	**pH**	**Ca**	**Mg**	**Na**	**K**	**HCO3**	**SO4**	**Cl**	**NO3N**	**SiO2**	**B**	**As**	**Fe**	**Cr**	**mg/L**	**mg/L**
3S/3E 6Q 4	1/10/19	ZONE7	20.2	1676	7.1	93	33	235	2.1	441	286	183	1.52	51.4	4040	< 1	< 100	< 1	1108	368
3S/3E 18N 1	12/20/18	ZONE7	-	1457	7.7	21	55	184	1.8	449	170	143	0.33	18.7	5370	< 1	< 100	< 1	818	279

- = Not Analyzed; X = Suspect Result

TABLE 7-3
WATER QUALITY RESULTS FOR PFAS
2019 WATER YEAR

Well	Well Name	Sample Date	PFBS	PFHpA	PFHxA	PFHxS	PFNA	PFOA	PFOS
3S/1E 1P 2	Airport gas g5	9/16/19	8.4	< 2	< 2	13	< 2	< 2	26
3S/1E 2J 3	Doolan Rd East	9/16/19	< 2	8.6	30	3.6	< 2	8	9.3
3S/1E 2N 6	Friesman Rd South	9/16/19	10	< 2	< 2	16	3.3	7.3	47
3S/1E 2P 3	Crosswinds Church	9/16/19	< 2	< 2	< 2	< 2	< 2	< 2	< 2
3S/1E 2Q 1	LPGC #1	10/15/19	13	< 2	2	22	< 2	4.7	37
3S/1E 2R 1	Beebs	9/16/19	15	2.8	7.6	10	4.1	17	55
3S/1E 8H 9	Mocho 4 Nested Shallow	6/3/19	6.3	2.1	5.2	21	< 2	5.1	20
3S/1E 8H10	Mocho 4 Nested Middle	6/3/19	7.6	2	5	19	< 2	3.5	13
3S/1E 8H11	Mocho 4 Nested deep	6/3/19	7.4	2.5	6.1	24	< 2	4.7	20
3S/1E 8H18	**Mocho 4**	12/4/18	5.7	< 2	4	18	< 2	3	9.1
3S/1E 8H18	**Mocho 4**	4/9/19	5.7	< 2	4.4	17	< 2	3.3	4.4
3S/1E 9B 1	**Stoneridge**	12/4/18	3.1	< 2	< 2	13	< 2	< 2	8.9
3S/1E 9B 1	**Stoneridge**	4/9/19	2.8	< 2	< 2	9.8	< 2	< 2	4.8
3S/1E 9B 1	**Stoneridge**	7/9/19	3.6	< 2.0	2.4	13	< 2.0	2	12
3S/1E 9J 7	SW Lake I Shallow	6/3/19	5.5	< 2	3	18	< 2	4.4	26
3S/1E 9J 8	SW Lake I Middle	6/3/19	12	2.9	9.7	54	< 2	6.8	60
3S/1E 9J 9	SW Lake I Deep	6/3/19	< 2	< 2	4.9	< 2	< 2	< 2	7
3S/1E 9M 2	**Mocho 1**	1/2/19	11	3.3	11	67	< 2	7.6	78
3S/1E 9M 2	**Mocho 1**	1/22/19	-	-	-	-	-	7.9	86
3S/1E 9M 2	**Mocho 1**	4/9/19	16	4.3	14	90	< 2	9.8	90
3S/1E 9M 3	**Mocho 2**	11/28/18	< 2	< 2	< 2	< 2	< 2	< 2	< 2
3S/1E 9M 3	**Mocho 2**	4/8/19	8.6	2.3	7.4	42	< 2	5.6	46
3S/1E 9M 3	**Mocho 2**	4/17/19	7.7	2	7.2	47	< 2	6.1	50
3S/1E 9M 4	**Mocho 3**	1/2/19	6.7	2.3	5.4	29	< 2	6	30
3S/1E 9M 4	**Mocho 3**	1/22/19	-	-	-	-	-	5.2	26
3S/1E 9M 4	**Mocho 3**	4/9/19	7.2	2.7	6.9	30	< 2	5.8	32
3S/1E 9M 4	**Mocho 3**	8/5/19	6.4	2.4	5.6	28	< 2.0	5.6	35
3S/1E 9P 5	Key_AmW_U (Mohr Key)	6/3/19	5.7	< 2	4.8	17	< 2	3.9	29
3S/1E 9P 9	Mohr Ave Shallow	6/3/19	7.1	< 2	5.2	28	< 2	4.6	46
3S/1E 9P11	Mohr Ave Deep	6/3/19	< 2	< 2	< 2	< 2	< 2	< 2	3.1
3S/1E 10A 2	El C harro Rd	10/1/19	25	4.1	18	120	< 2	13	450
3S/1E 10B 9	Kaiser Rd Middle 1	9/17/19	15	4.5	19	120	< 2	7.4	120
3S/1E 10B10	Kaiser Rd Middle 2	9/17/19	< 2	< 2	< 2	9.3	< 2	< 2	16
3S/1E 10B11	Kaiser Rd Deep	9/17/19	4.2	< 2	5	35	< 2	2.5	32
3S/1E 10B16	**COL 5**	1/22/19	-	-	-	-	-	< 2	35
3S/1E 10B16	**COL 5**	7/9/19	2.8	< 2.0	2.6	24	< 2.0	2.2	42
3S/1E 10D 2	Stoneridge Shallow	9/17/19	< 2	< 2	< 2	< 2	< 2	< 2	< 2
3S/1E 10D 3	Stoneridge Middle 1	9/17/19	15	4.5	17	110	< 2	7.7	150
3S/1E 10D 4	Stoneridge Middle 2	9/17/19	< 2	< 2	< 2	< 2	< 2	< 2	2.3
3S/1E 10D 5	Stoneridge Deep	9/17/19	< 2	< 2	< 2	< 2	< 2	< 2	< 2
3S/1E 10K 3	**COL 1**	11/28/18	5.3	2	5.4	29	< 2	4.7	32
3S/1E 10K 3	**COL 1**	4/8/19	4.5	< 2	4	23	< 2	3.7	29

Municipal Wells are Bold

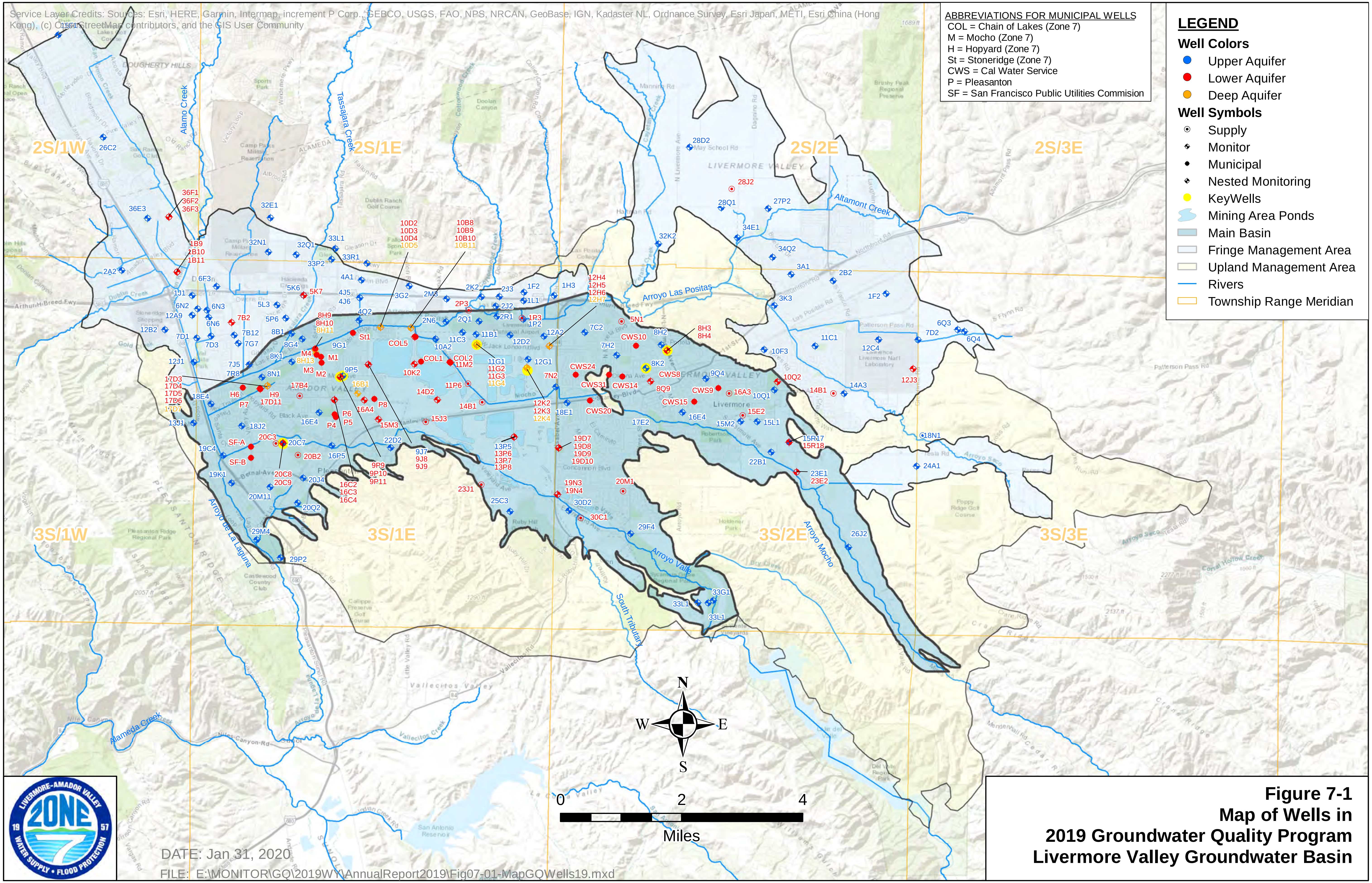
Only PFAS Compounds with detected concentrations shown.

- = Not Analyzed

TABLE 7-3
WATER QUALITY RESULTS FOR PFAS
2019 WATER YEAR

Well	Well Name	Sample Date	PFBS	PFHpA	PFHxA	PFHxS	PFNA	PFOA	PFOS
3S/1E 10K 3	**COL 1**	7/9/19	6.5	2.2	6.6	34	< 2.0	6.2	44
3S/1E 11C 3	LAVWMA ROW	10/15/19	30	7.4	28	130	2.8	19	360
3S/1E 11G 1	Key_AmE_U	10/1/19	25	8.3	24	87	< 2	16	210
3S/1E 11G 2	Rancho Charro Middle 1	10/1/19	26	7.7	23	98	< 2	14	160
3S/1E 11G 3	Rancho Charro Middle 2	10/1/19	< 2	< 2	< 2	2.6	< 2	< 2	26
3S/1E 11G 4	Rancho Charro Deep	10/1/19	25	7.5	23	93	< 2	14	170
3S/1E 11M 3	**COL 2**	1/2/19	2.8	< 2	2.5	12	< 2	2.4	12
3S/1E 11M 3	**COL 2**	1/22/19	-	-	-	-	-	3	16
3S/1E 11M 3	**COL 2**	4/8/19	2.5	< 2	2.2	11	< 2	< 2	12
3S/1E 11M 3	**COL 2**	7/9/19	3.2	< 2.0	2.8	14	< 2.0	2.9	15
3S/1E 12A 2	Airport South	10/15/19	15	11	20	52	< 2	19	100
3S/1E 12D 2	LWRP G6	10/15/19	8.5	14	36	76	< 2	12	100
3S/1E 12G 1	Oaks Park Shallow	10/1/19	7.1	4.7	10	12	2	15	68
3S/1E 12H 4	LWRP Shallow	9/30/19	< 2	< 2	< 2	3.1	< 2	< 2	5.3
3S/1E 12H 5	LWRP Middle 1	9/30/19	< 2	< 2	< 2	< 2	< 2	< 2	8.4
3S/1E 12H 6	LWRP Middle 2	9/30/19	< 2	< 2	< 2	< 2	< 2	< 2	< 2
3S/1E 12H 7	LWRP Deep	9/30/19	< 2	< 2	< 2	< 2	< 2	< 2	< 2
3S/1E 12K 2	Oaks Park Mid	9/30/19	2.6	< 2	2	3.1	< 2	3.3	6.9
3S/1E 12K 3	Key_AmE_L	9/30/19	< 2	< 2	< 2	< 2	< 2	< 2	< 2
3S/1E 12K 4	Oaks Park Deep	9/30/19	< 2	< 2	< 2	< 2	< 2	< 2	< 2
3S/1E 16A 2	**Pleas 8**	5/22/19	-	-	-	-	-	9.2	120
3S/1E 16A 2	**Pleas 8**	6/18/19	-	-	-	-	-	8.3	110
3S/1E 16A 2	**Pleas 8**	12/3/19	7.5	8.1	12	60	4	7.5	69
3S/1E 16A 4	Bush/Valley Mid	10/2/19	6.6	2.9	6.7	34	< 2	3.3	37
3S/1E 16L 5	**Pleas 5**	5/22/19	-	-	-	-	-	4.2	31
3S/1E 16L 5	**Pleas 5**	6/18/19	-	-	-	-	-	4.1	31
3S/1E 16L 5	**Pleas 5**	12/3/19	4.7	2.2	3.9	19	< 1.8	3.3	21
3S/1E 16L 7	**Pleas 6**	5/22/19	-	-	-	-	-	4.1	30
3S/1E 16L 7	**Pleas 6**	6/18/19	-	-	-	-	-	3.5	22
3S/1E 16L 7	**Pleas 6**	12/3/19	5	2.5	4.5	23	< 1.8	3.6	22
3S/1E 17D12	**Hopyard 9**	1/2/19	< 2	< 2	< 2	< 2	< 2	< 2	< 2
3S/1E 17D12	**Hopyard 9**	7/8/19	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
3S/1E 18A 6	**Hopyard 6**	11/28/18	< 2	< 2	< 2	< 2	< 2	< 2	< 2
3S/1E 18A 6	**Hopyard 6**	7/8/19	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
3S/1E 18E 4	Valley Trails II	10/2/19	< 2	< 2	< 2	< 2	< 2	< 2	< 2
3S/1E 18J 2	camino segura	10/2/19	< 2	< 2	< 2	< 2	< 2	< 2	3.4
3S/1E 19C 4	del valle & laguna	10/2/19	2.2	< 2	< 2	2.7	< 2	< 2	6.9
MA-K 28	Lake H	5/22/19	8.2	2.8	8.9	30	< 2	7.8	44
MA-K 30	Cope Lake	5/22/19	4	< 2	3.5	8.8	< 2	4.7	26
MA-K 37	Lake I	5/22/19	4.5	< 2	4.9	16	< 2	5.2	46

Municipal Wells are Bold
Only PFAS Compounds with detected concentrations shown.
- = Not Analyzed



ABBREVIATIONS FOR MUNICIPAL WELLS
COL = Chain of Lakes (Zone 7)
M = Mocho (Zone 7)
H = Hopyard (Zone 7)
St = Stoneridge (Zone 7)
CWS = Cal Water Service
P = Pleasanton
SF = San Francisco Public Utilities Commision

LEGEND

Well Colors
- ● Upper Aquifer
- ● Lower Aquifer
- ● Deep Aquifer

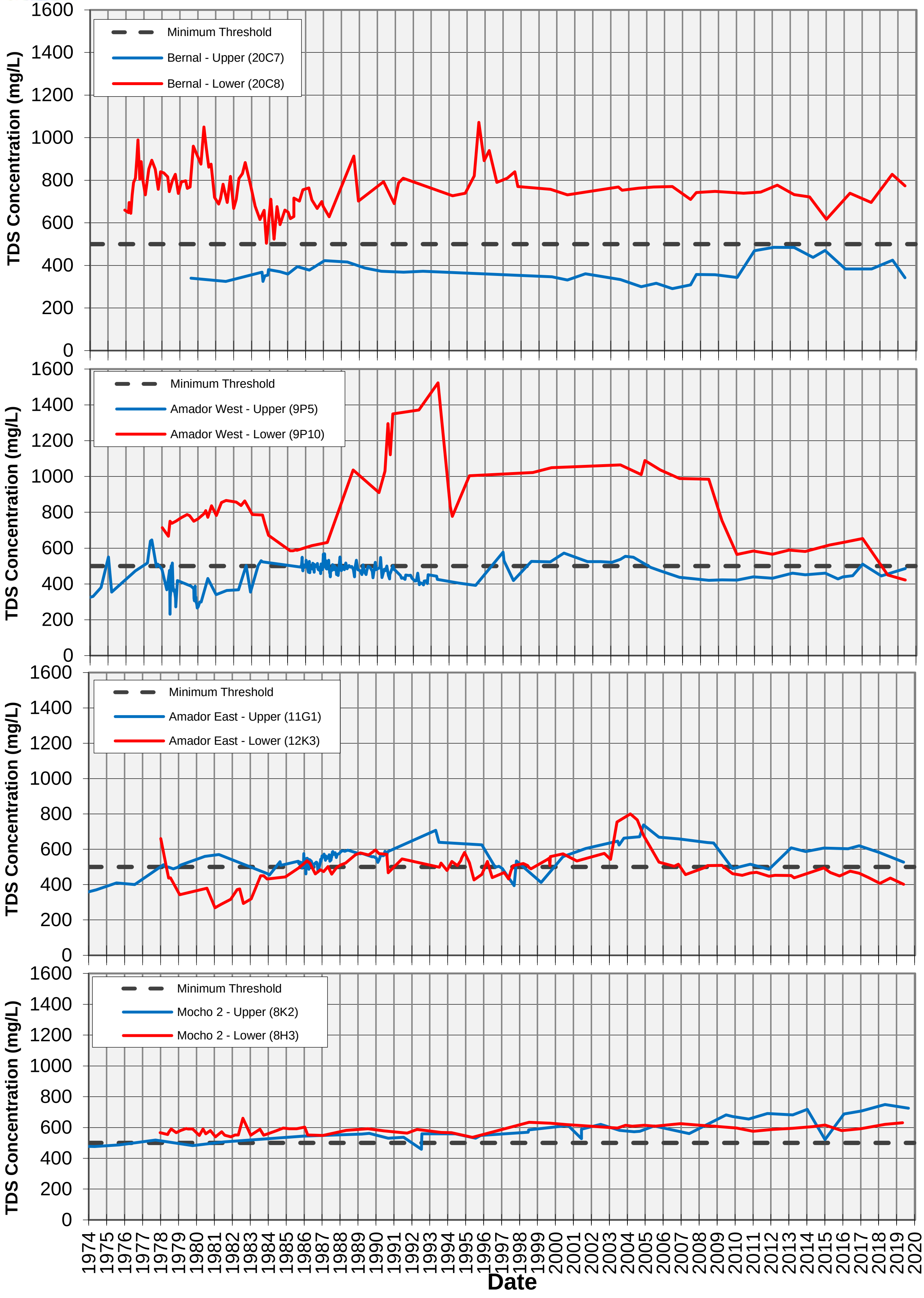
Well Symbols
- ⊙ Supply
- ◈ Monitor
- • Municipal
- ◈ Nested Monitoring
- ● KeyWells
- ▨ Mining Area Ponds
- ▨ Main Basin
- ▭ Fringe Management Area
- ▭ Upland Management Area
- — Rivers
- ▭ Township Range Meridian

DATE: Jan 31, 2020

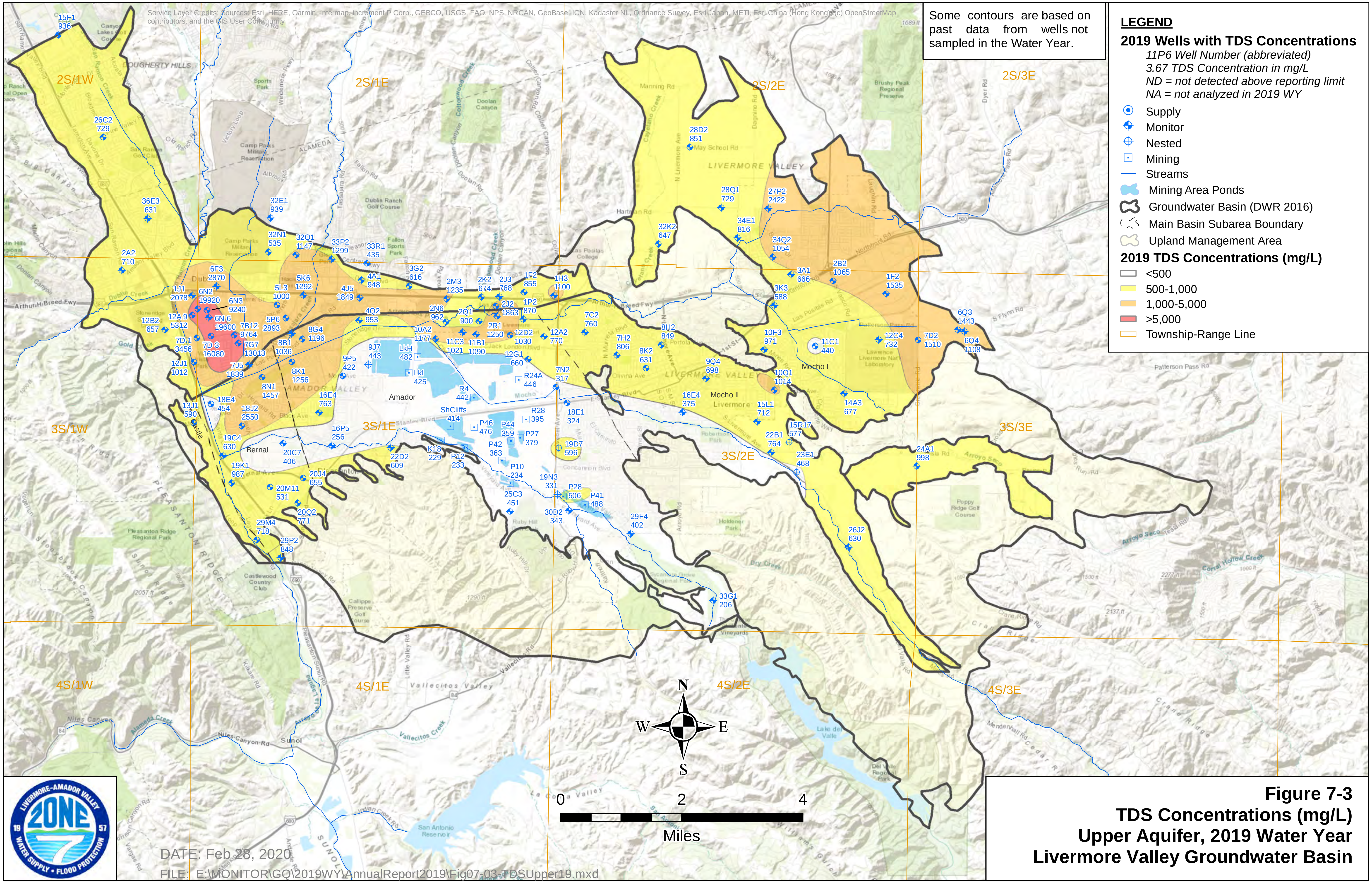
FILE: E:\MONITOR\GQ\2019WY\AnnualReport2019\Fig07-01-MapGQWells19.mxd

Figure 7-1
Map of Wells in
2019 Groundwater Quality Program
Livermore Valley Groundwater Basin

FIGURE 7-2
TDS CONCENTRATIONS IN KEY WELLS
1974 TO 2019 WATER YEARS



E:\MONITOR\GQ\2019WY\AnnualReport2019\Fig07-02-KeyWellTDS19.xls
2/27/2020

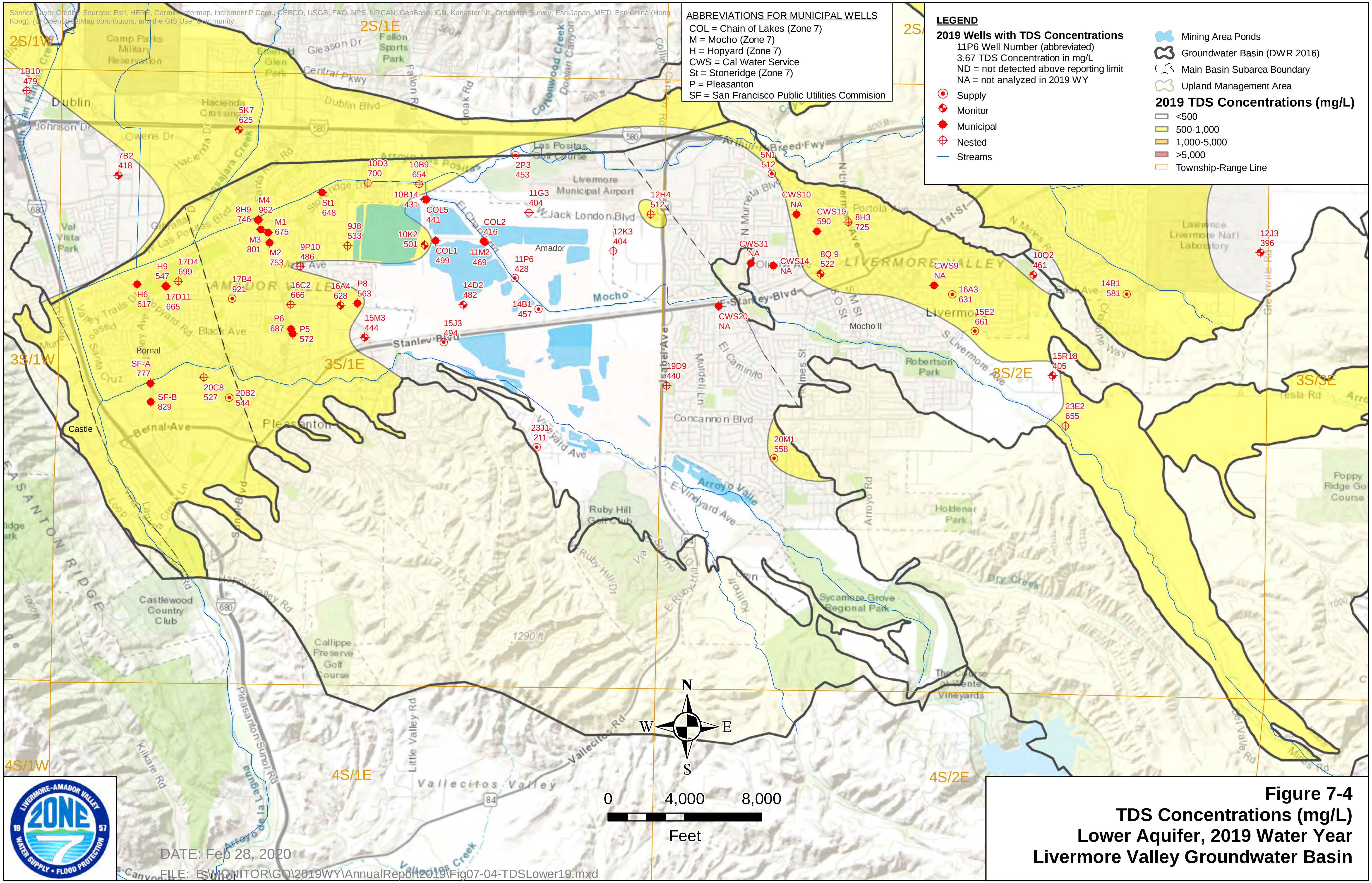


Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Some contours are based on past data from wells not sampled in the Water Year.

Figure 7-3
TDS Concentrations (mg/L)
Upper Aquifer, 2019 Water Year
Livermore Valley Groundwater Basin

DATE: Feb 28, 2020
FILE: E:\MONITOR\GQ\2019WY\AnnualReport2019\Fig07-03-TDSUpper19.mxd



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P = Pleasanton
SF = San Francisco Public Utilities Commision

LEGEND

2019 Wells with TDS Concentrations
11P6 Well Number (abbreviated)
3.67 TDS Concentration in mg/L
ND = not detected above reporting limit
NA = not analyzed in 2019 WY

- ⊙ Supply
- ⊕ Monitor
- ● Municipal
- ⊕ Nested
- — Streams
- Mining Area Ponds
- Groundwater Basin (DWR 2016)
- Main Basin Subarea Boundary
- Upland Management Area

2019 TDS Concentrations (mg/L)
- ▭ <500
- 🟨 500-1,000
- 🟧 1,000-5,000
- 🟥 >5,000
- ▭ Township-Range Line

DATE: Feb 28, 2020
FILE: E:\MONITOR\GQ\2019WY\AnnualReport2019\Fig07-04-TDSLower19.mxd

Figure 7-4
TDS Concentrations (mg/L)
Lower Aquifer, 2019 Water Year
Livermore Valley Groundwater Basin

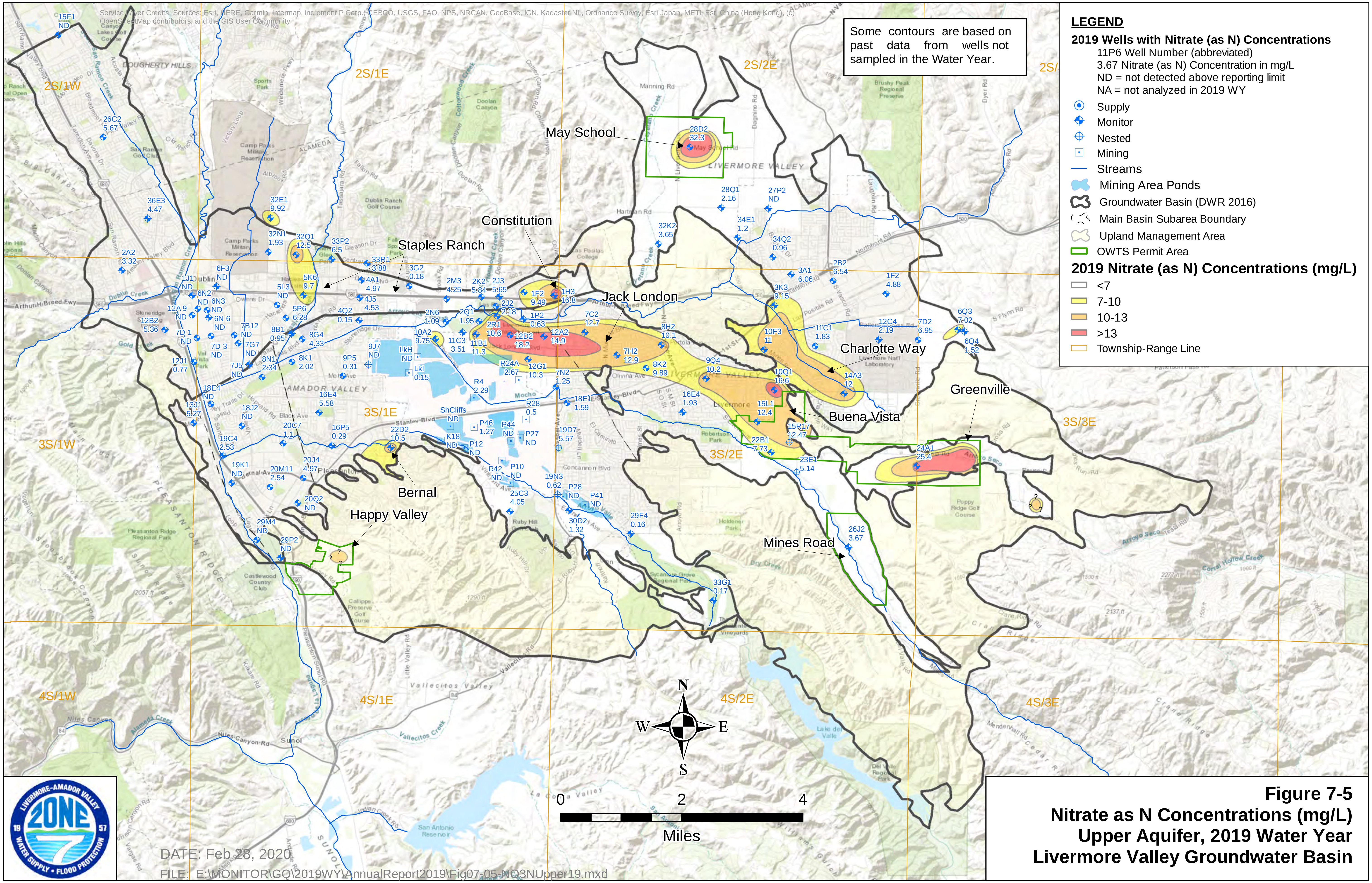
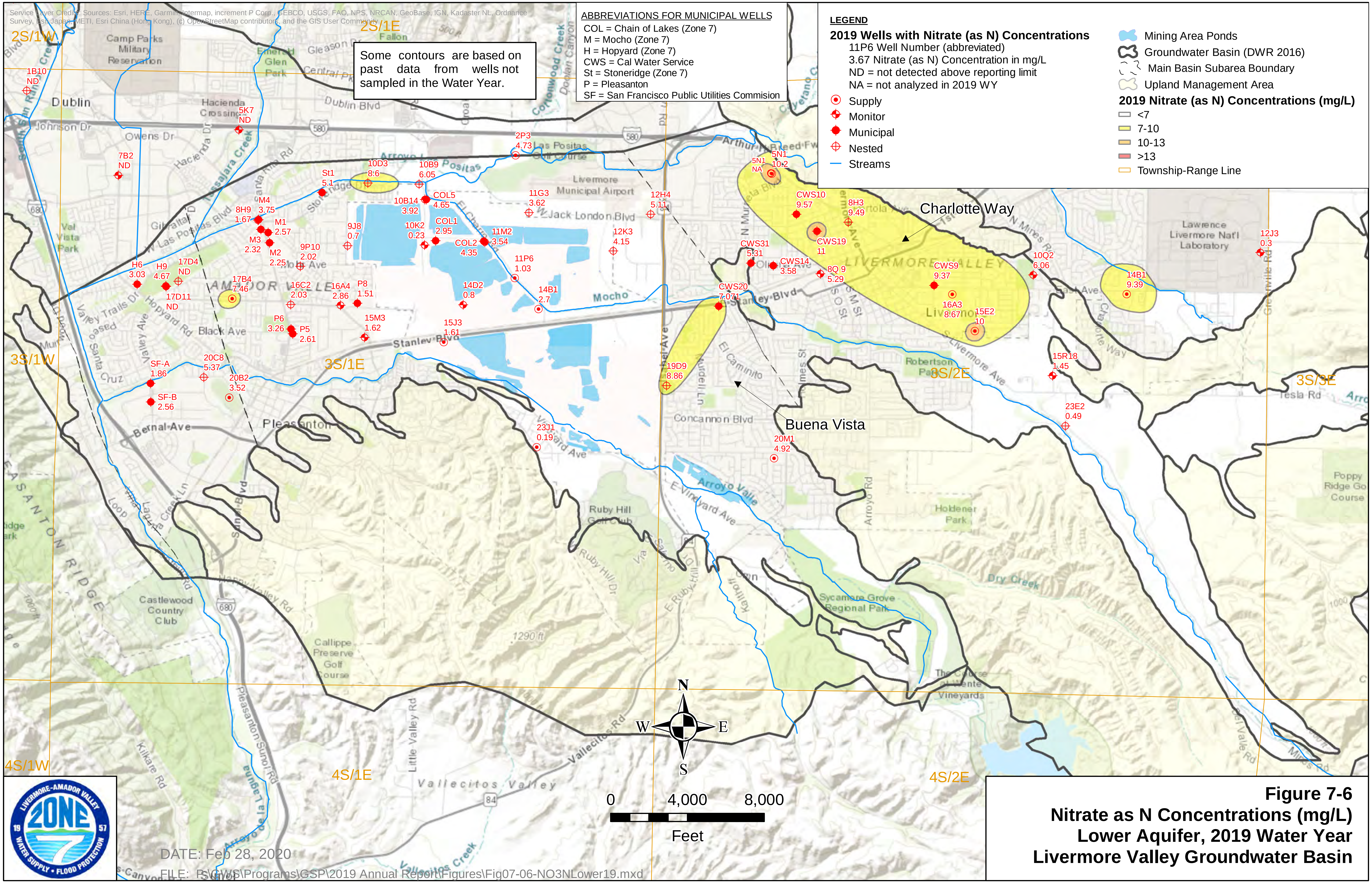


Figure 7-5
Nitrate as N Concentrations (mg/L)
Upper Aquifer, 2019 Water Year
Livermore Valley Groundwater Basin

DATE: Feb 28, 2020

FILE: E:\MONITOR\GQ\2019WY\AnnualReport2019\Fig07-05-NO3NUpper19.mxd



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Some contours are based on past data from wells not sampled in the Water Year.

ABBREVIATIONS FOR MUNICIPAL WELLS

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P = Pleasanton
SF = San Francisco Public Utilities Commision

LEGEND

2019 Wells with Nitrate (as N) Concentrations
11P6 Well Number (abbreviated)
3.67 Nitrate (as N) Concentration in mg/L
ND = not detected above reporting limit
NA = not analyzed in 2019 WY

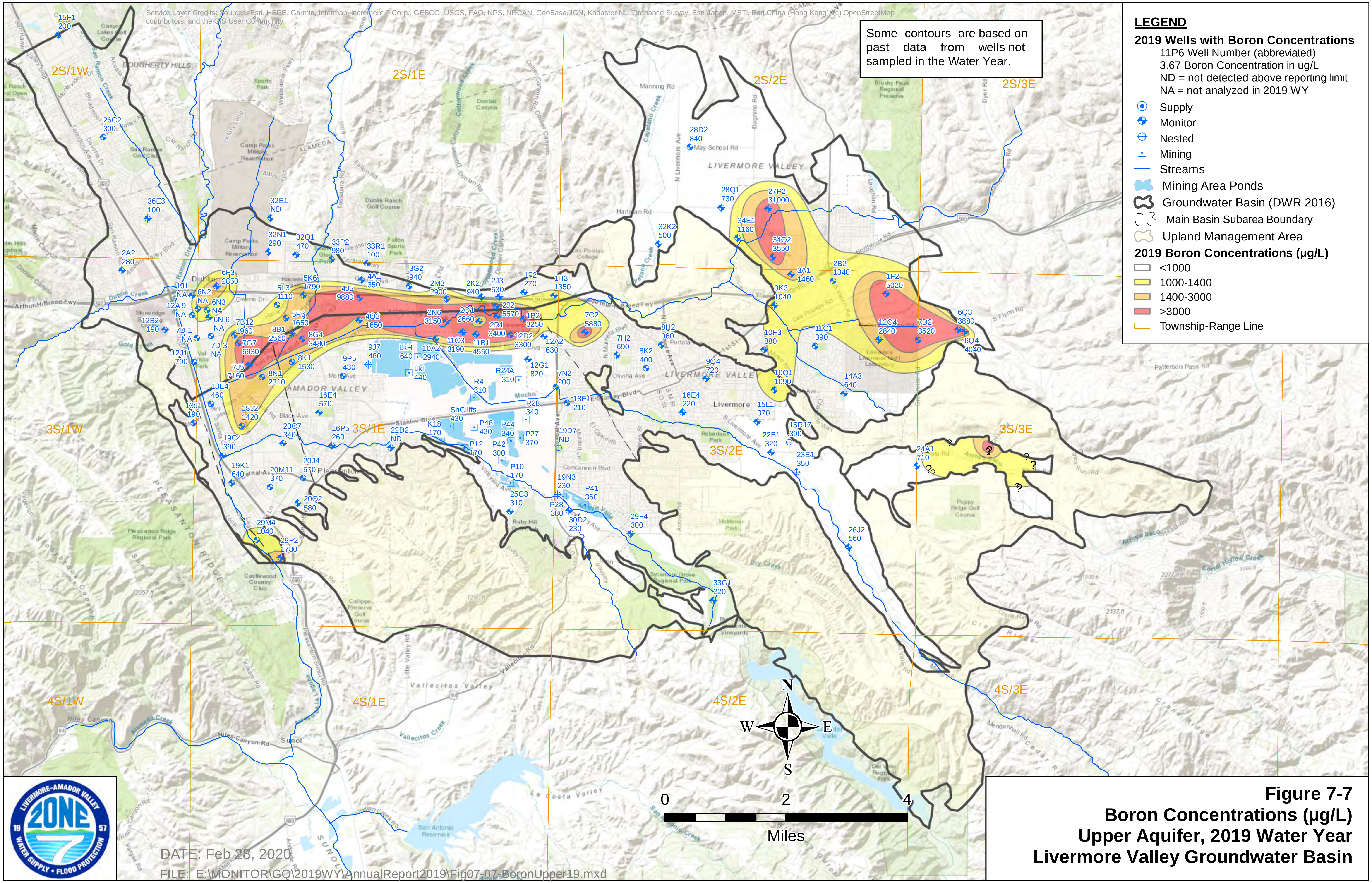
◉ Supply
⊕ Monitor
● Municipal
⊕ Nested
— Streams

Mining Area Ponds
Groundwater Basin (DWR 2016)
Main Basin Subarea Boundary
Upland Management Area

2019 Nitrate (as N) Concentrations (mg/L)
▭ <7
🟨 7-10
🟧 10-13
🟥 >13
▭ Township-Range Line

Figure 7-6
Nitrate as N Concentrations (mg/L)
Lower Aquifer, 2019 Water Year
Livermore Valley Groundwater Basin

DATE: Feb 28, 2020
FILE: P:\GWS\Programs\GSP\2019 Annual Report\Figures\Fig07-06-NO3NLower19.mxd

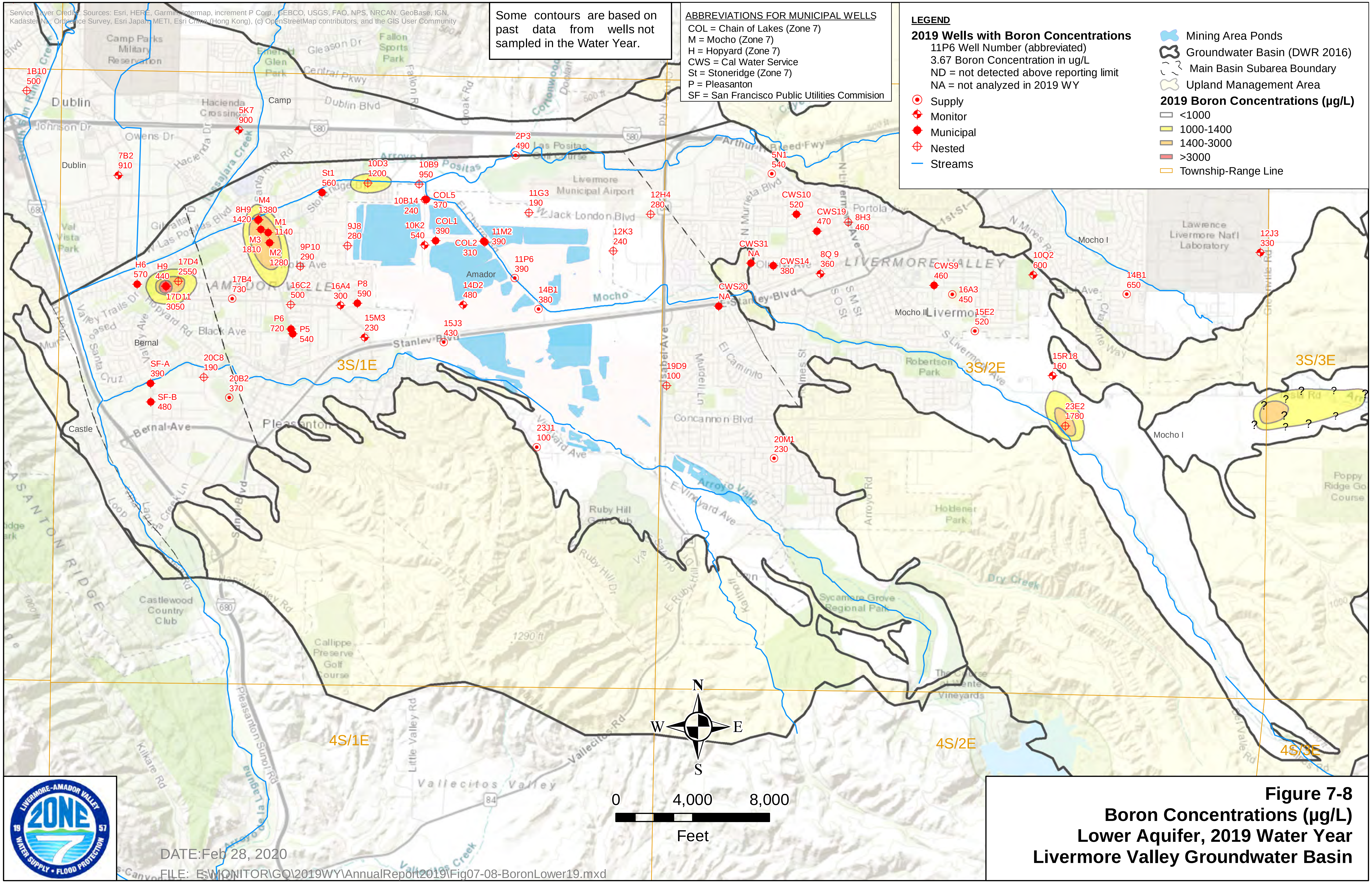


Some contours are based on past data from wells not sampled in the Water Year.

DATE: Feb 28, 2020

FILE: E:\MONITOR\GQ\2019WY\AnnualReport2019\Fig07-07-BoronUpper19.mxd

Figure 7-7
Boron Concentrations (µg/L)
Upper Aquifer, 2019 Water Year
Livermore Valley Groundwater Basin



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Some contours are based on past data from wells not sampled in the Water Year.

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LEGEND

2019 Wells with Boron Concentrations

11P6 Well Number (abbreviated)
3.67 Boron Concentration in ug/L
ND = not detected above reporting limit
NA = not analyzed in 2019 WY

⊙ Supply
✚ Monitor
● Municipal
⊕ Nested
— Streams

Mining Area Ponds
Groundwater Basin (DWR 2016)
Main Basin Subarea Boundary
Upland Management Area

2019 Boron Concentrations (µg/L)

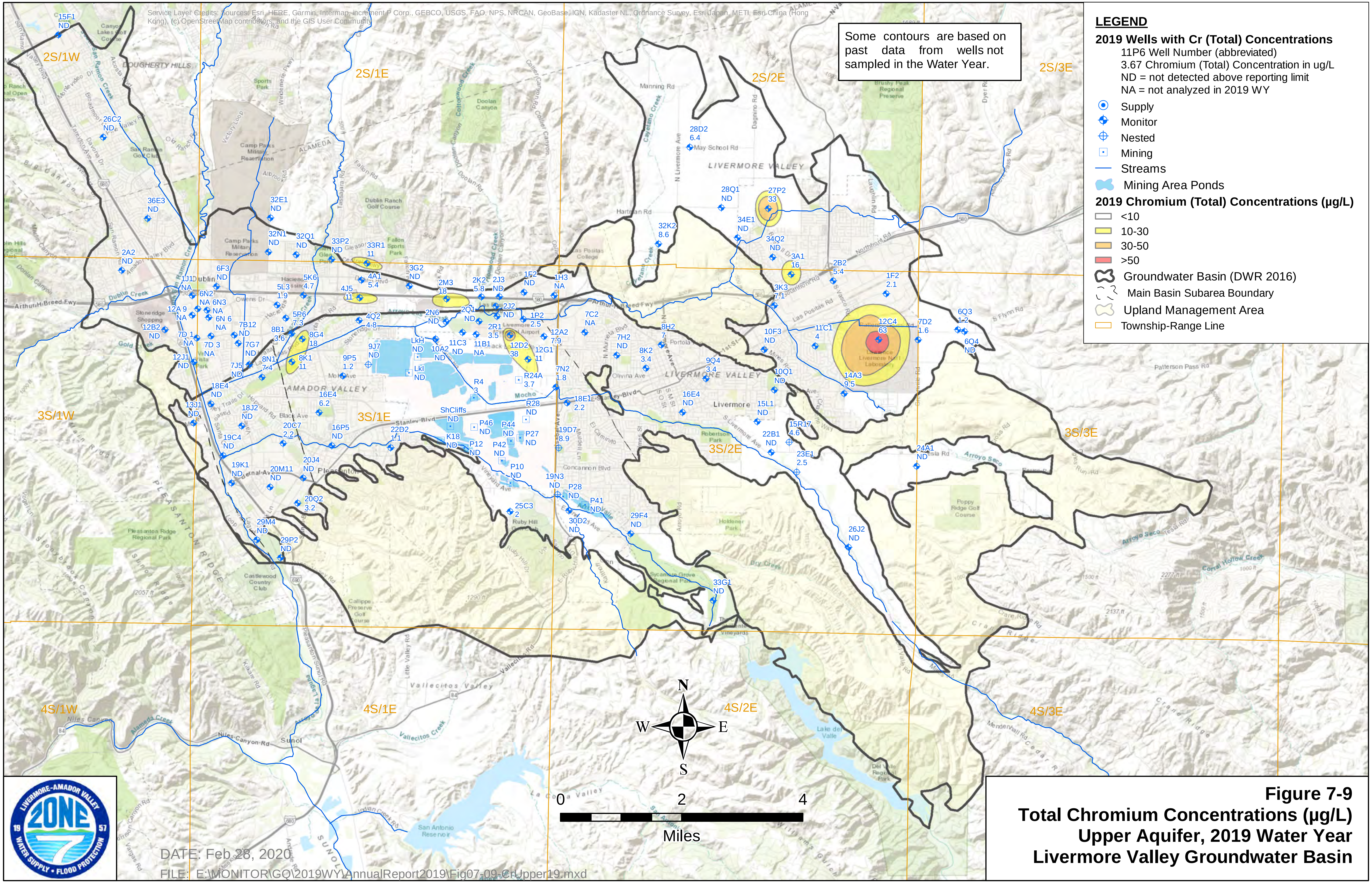
▭ <1000
🟨 1000-1400
🟧 1400-3000
🟥 >3000
▭ Township-Range Line

ZONE 7 LIVERMORE-AMADOR VALLEY 1957 WATER SUPPLY • FLOOD PROTECTION

DATE:Feb 28, 2020

FILE: E:\MONITOR\GQ\2019WY\AnnualReport2019\Fig07-08-BoronLower19.mxd

Figure 7-8
Boron Concentrations (µg/L)
Lower Aquifer, 2019 Water Year
Livermore Valley Groundwater Basin



Some contours are based on past data from wells not sampled in the Water Year.

LEGEND

2019 Wells with Cr (Total) Concentrations

11P6 Well Number (abbreviated)
3.67 Chromium (Total) Concentration in ug/L
ND = not detected above reporting limit
NA = not analyzed in 2019 WY

- ◉ Supply
- ⌖ Monitor
- ⊕ Nested
- ▫ Mining
- — Streams
- ▨ Mining Area Ponds

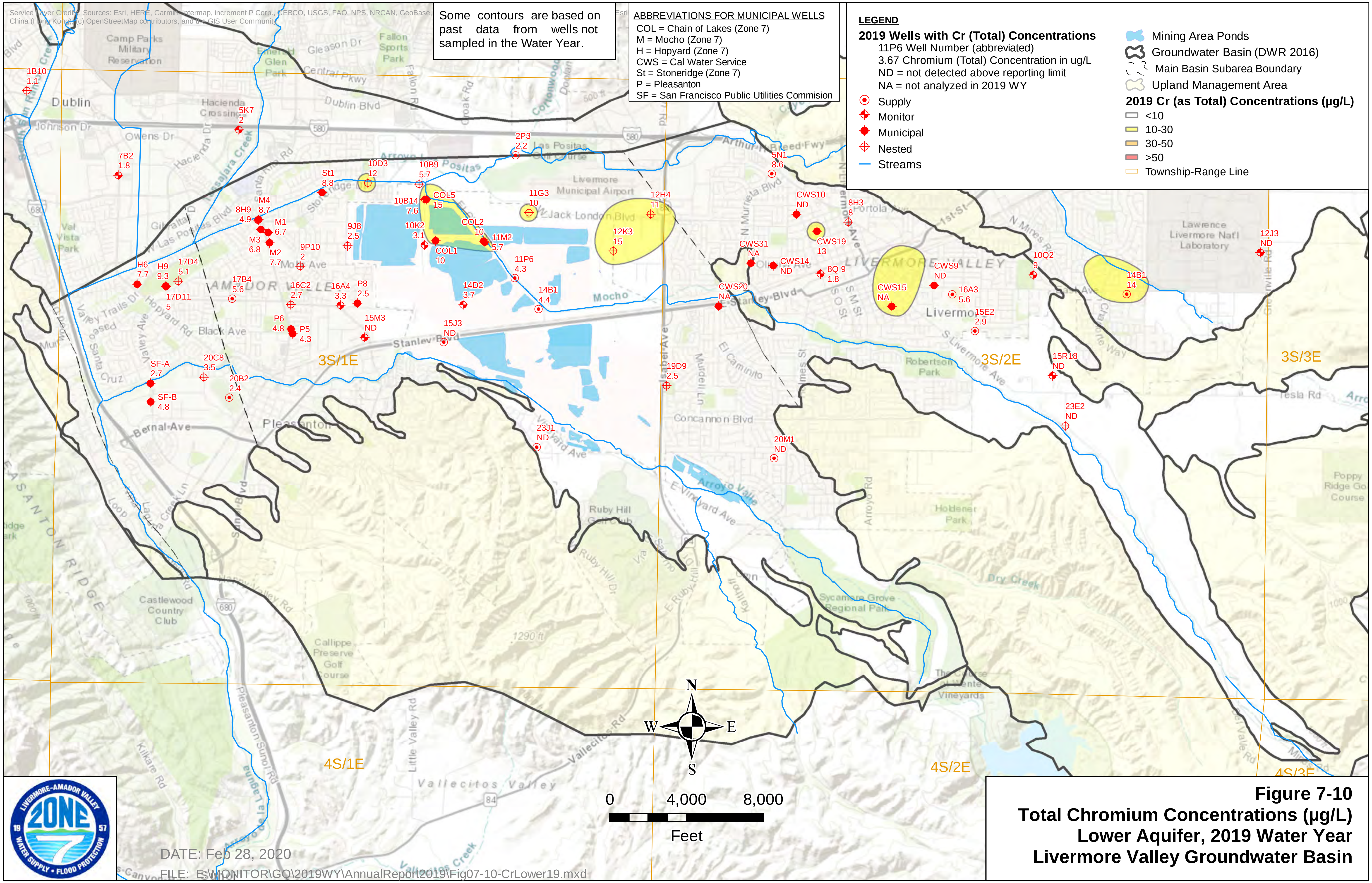
2019 Chromium (Total) Concentrations (µg/L)

- ☐ <10
- 🟨 10-30
- 🟧 30-50
- 🟥 >50
- Groundwater Basin (DWR 2016)
- Main Basin Subarea Boundary
- Upland Management Area
- Township-Range Line

DATE: Feb 28, 2020

FILE: E:\MONITOR\GQ\2019WY\AnnualReport2019\Fig07-09-CrUpper19.mxd

Figure 7-9
Total Chromium Concentrations (µg/L)
Upper Aquifer, 2019 Water Year
Livermore Valley Groundwater Basin



Some contours are based on past data from wells not sampled in the Water Year.

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P = Pleasanton
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LEGEND

2019 Wells with Cr (Total) Concentrations
11P6 Well Number (abbreviated)
3.67 Chromium (Total) Concentration in ug/L
ND = not detected above reporting limit
NA = not analyzed in 2019 WY

⊙ Supply
✚ Monitor
● Municipal
⊕ Nested
— Streams

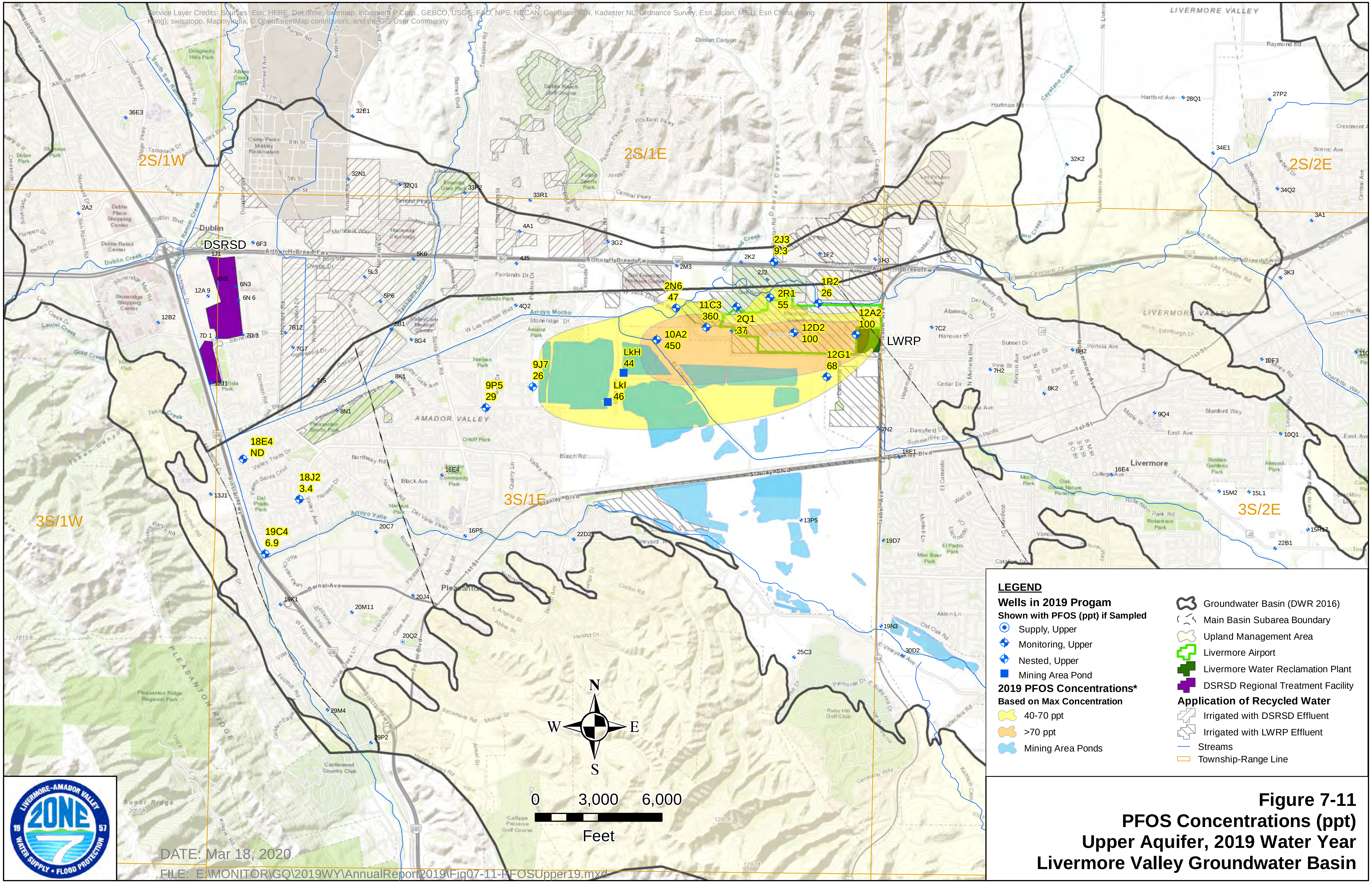
🟦 Mining Area Ponds
Groundwater Basin (DWR 2016)
Main Basin Subarea Boundary
Upland Management Area

2019 Cr (as Total) Concentrations (µg/L)
▭ <10
🟨 10-30
🟧 30-50
🟥 >50
▭ Township-Range Line

Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, Esri
China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Figure 7-10
Total Chromium Concentrations (µg/L)
Lower Aquifer, 2019 Water Year
Livermore Valley Groundwater Basin

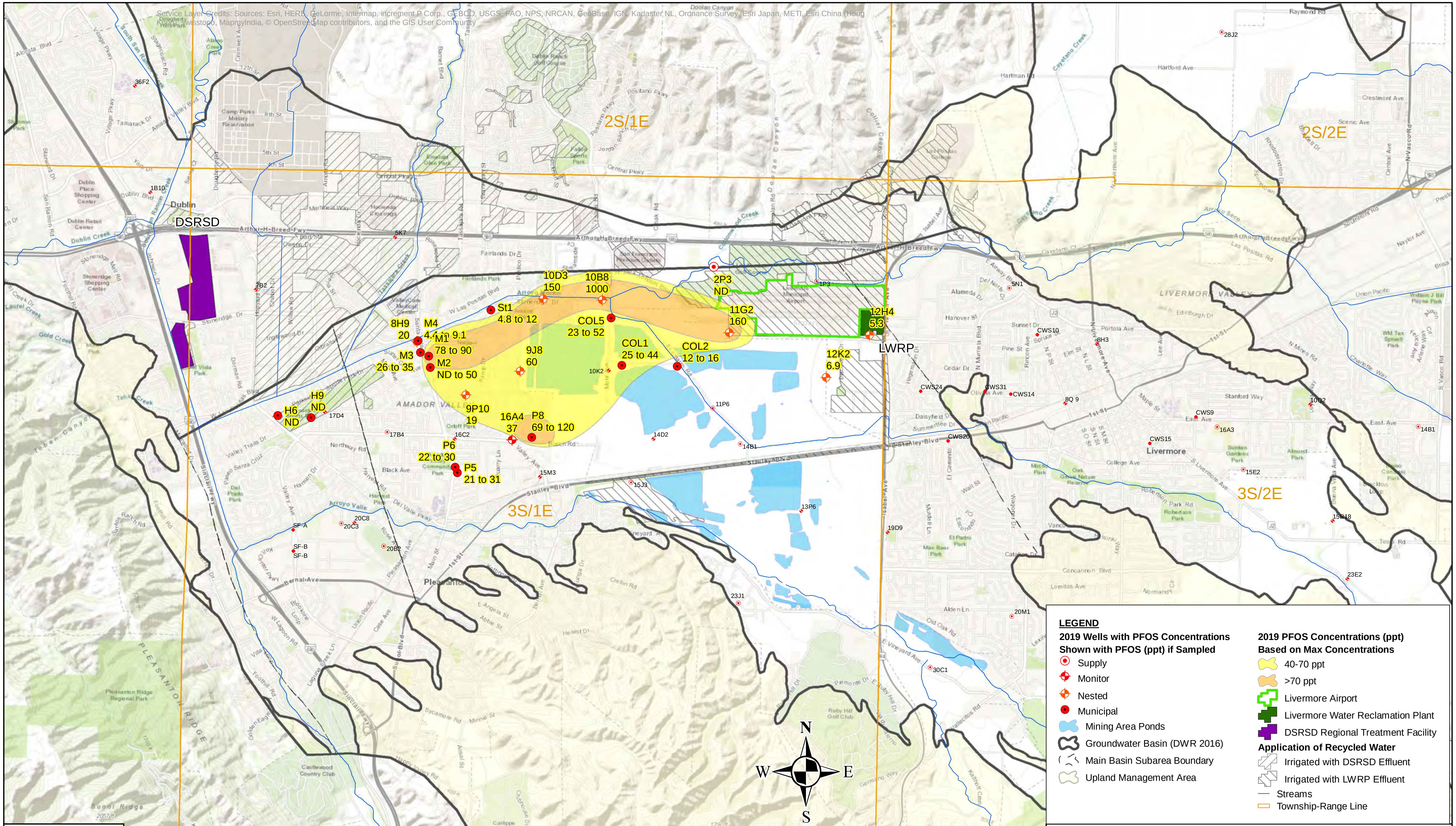
DATE: Feb 28, 2020
FILE: E:\MONITOR\GQ\2019WY\AnnualReport2019\Fig07-10-CrLower19.mxd



DATE: Mar 18, 2020

FILE: E:\MONITOR\GQ\2019WY\AnnualReport2019\Fig07-11-PFOSUpper19.mxd

Figure 7-11
PFOS Concentrations (ppt)
Upper Aquifer, 2019 Water Year
Livermore Valley Groundwater Basin



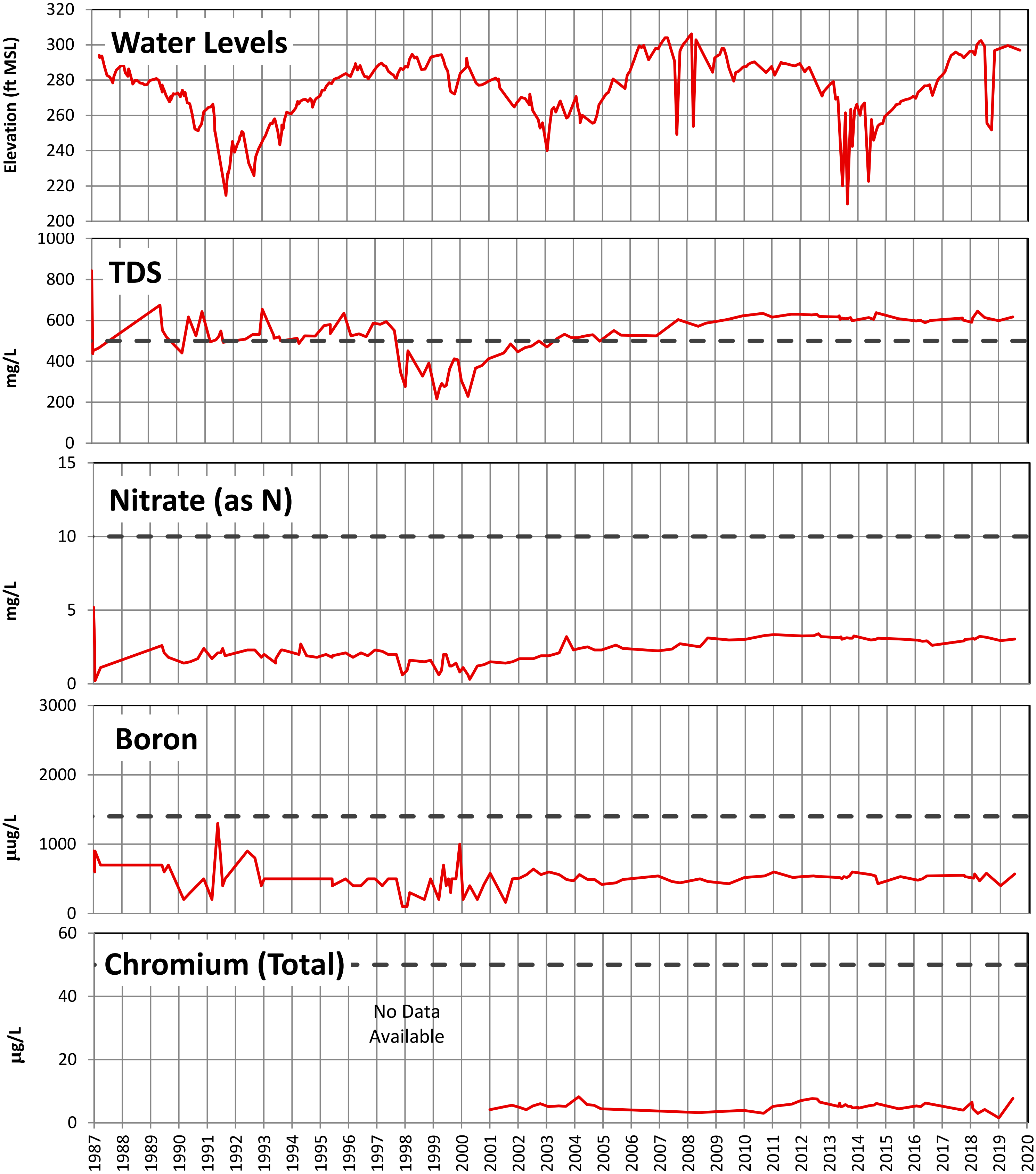
Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

DATE: Mar 17, 2020

FILE: E:\MONITOR\GQ\2019WY\AnnualReport2019\Fig07-12-PFOSLower19.mxd

Figure 7-12
PFOS Concentrations (ppt)
Lower Aquifer, 2019 Water Year
Livermore Valley Groundwater Basin

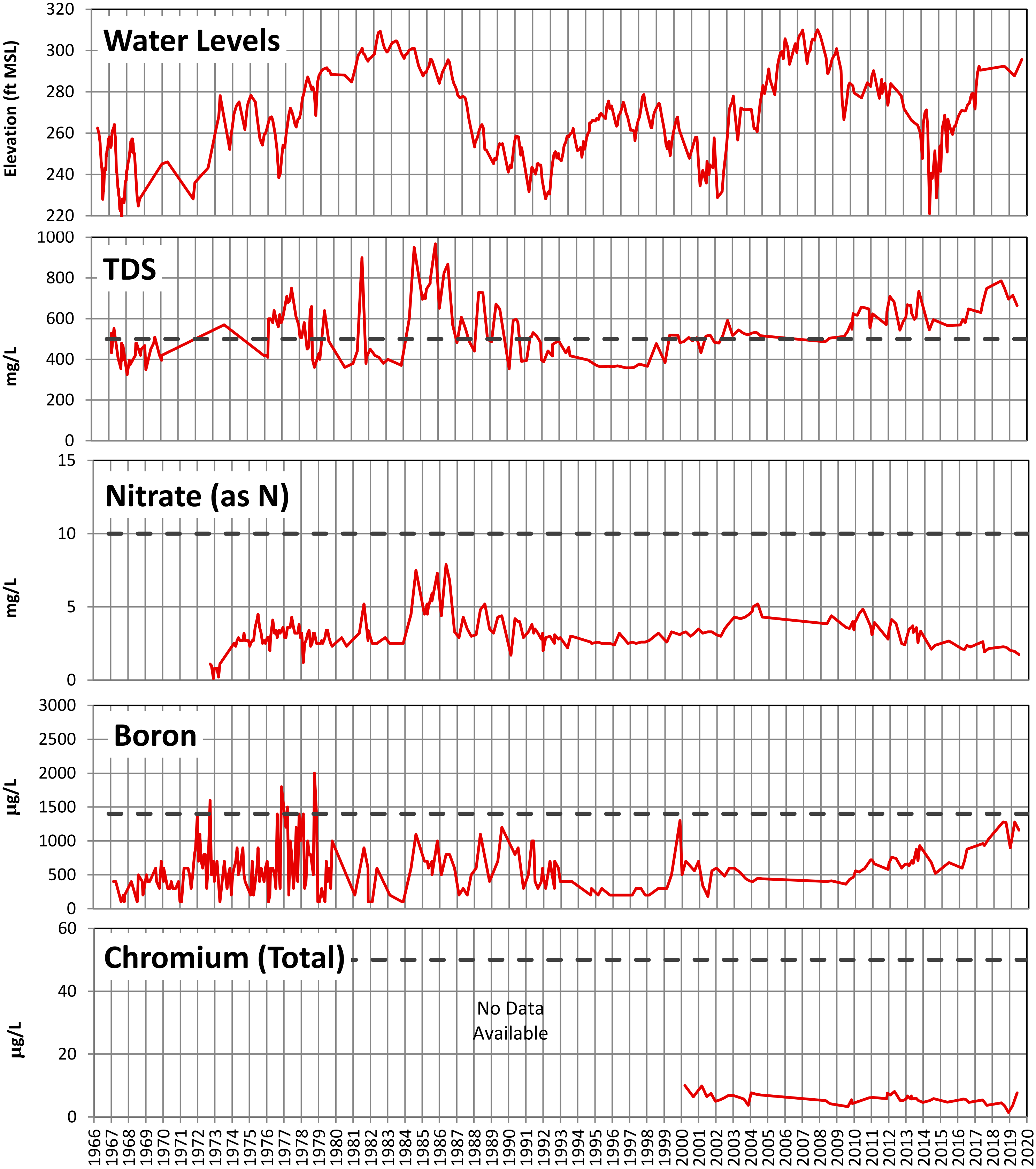
FIGURE 7-13
HYDRO-CHEMO GRAPH FOR 3S/1E 18A 6 (HOPYARD 6)
1987 to 2019 WATER YEARS
BERNAL SUBAREA - LOWER AQUIFER



Well Depth = 500'; Wellhead Elevation = 327'; Well Screen Depth: 215 to 490' bgs. Minimum Threshold = ━ ━ ━ ━ ━

E:\MONITOR\GQ\2019WY\AnnualReport2019\Fig07-13to16-HydroChemoGraphs19.xlsx\F7-13Grph

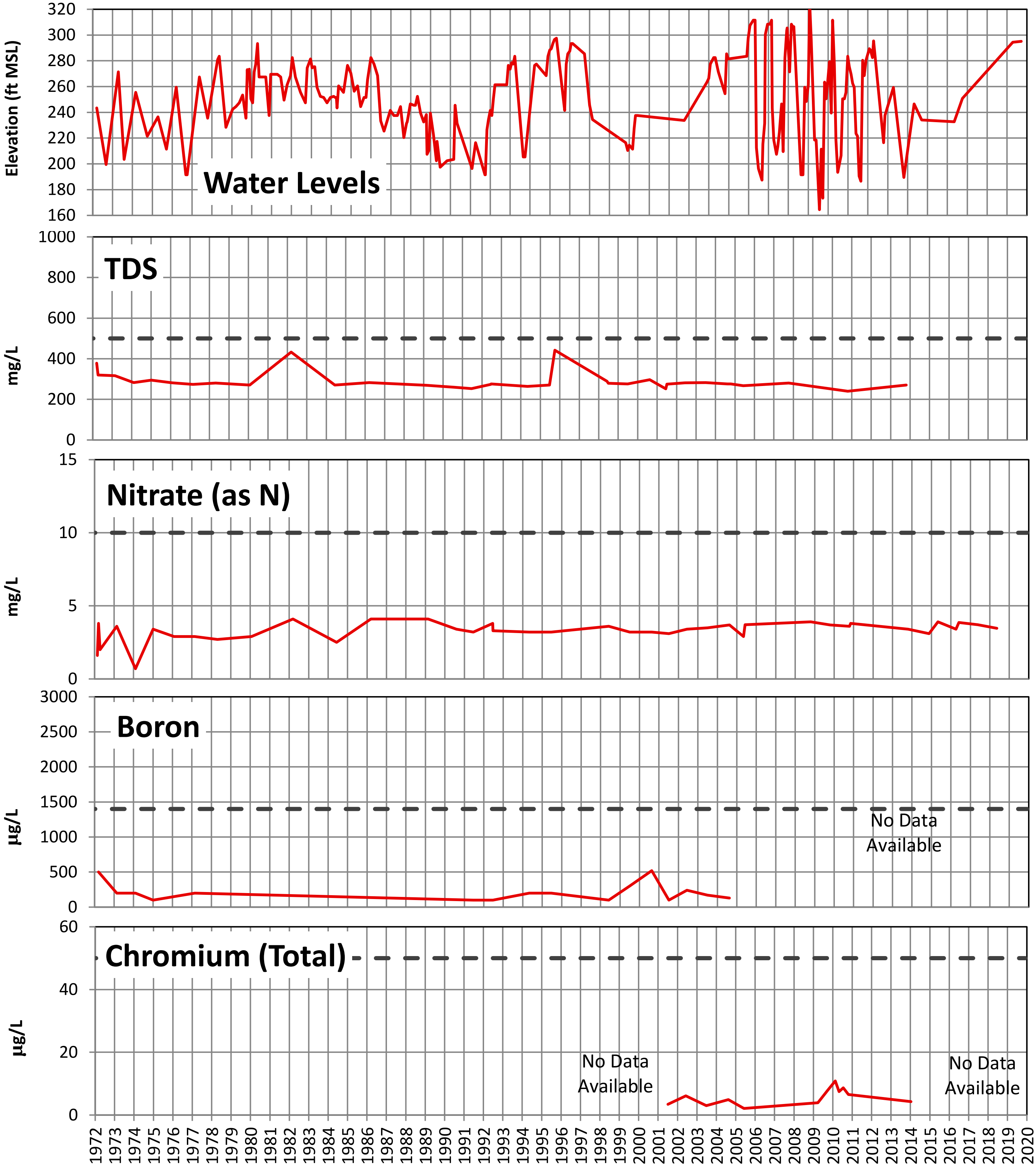
FIGURE 7-14
HYDRO-CHEMO GRAPH FOR 3S/1E 9M 3 (Mocho 2)
1967 to 2019 WATER YEARS
AMADOR SUBAREA WEST - LOWER AQUIFER



Well Depth = 575'; Wellhead Elevation = 344'; Well Screen Depth: 250 to 570' bgs. Minimum Threshold = ----

E:\MONITOR\GQ\2019WY\AnnualReport2019\Fig07-13to16-HydroChemoGraphs19.xlsx\F7-14Grph

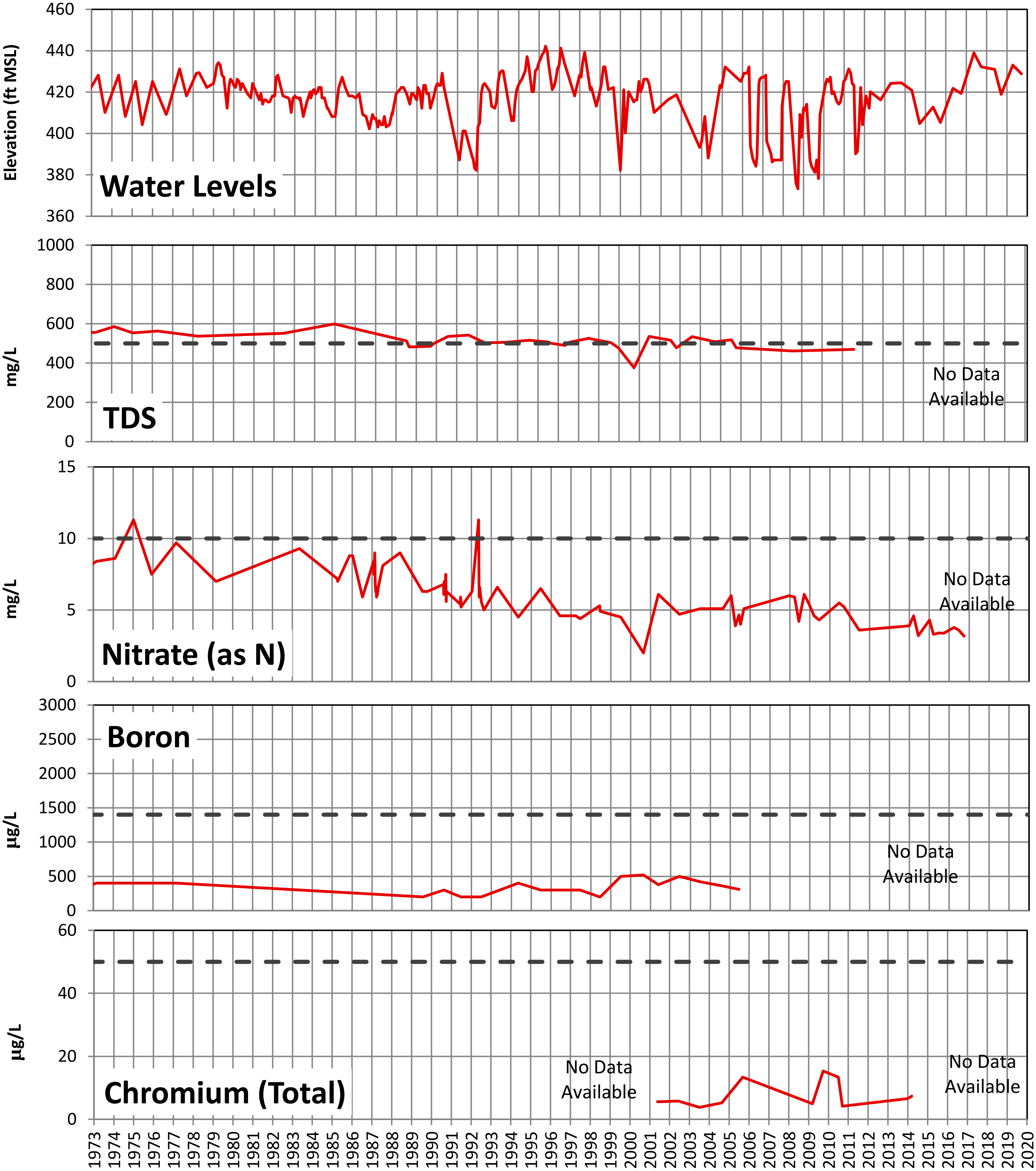
FIGURE 7-15
HYDRO-CHEMO GRAPH FOR 3S/2E 7P 3 (CWS 24)
1973 to 2019 WATER YEARS
AMADOR SUBAREA EAST - LOWER AQUIFER



Well Depth = 510'; Wellhead Elevation = 429'; Well Screen Depth: 300 to 490' bgs.

E:\MONITOR\GQ\2019WY\AnnualReport2019\Fig07-13to16-HydroChemoGraphs19.xlsx\F7-15Grph

FIGURE 7-16
HYDRO-CHEMO GRAPH FOR 3S/2E 8P 1 (CWS 8)
1974 to 2019 WATER YEARS
MOCHO II SUBAREA - LOWER AQUIFER



Well Depth = 273'; Wellhead Elevation = 466'; Well Screen Depth: 122 to 263' bgs. Minimum Threshold = ━ ━ ━ ━

E:\MONITOR\GQ\2019WY\AnnualReport2019\Fig07-13to16-HydroChemoGraphs19.xlsx\F7-16Grph

8 Land Surface Elevation

8.1 Program Description

8.1.1 Monitoring Network

This section describes the details of Zone 7's ongoing Land Surface Elevation Monitoring Program for subsidence and the results for the 2019 WY. Up until the 2018 WY, Zone 7 contracted with a licensed land surveyor to measure land surface elevations within the Main Basin boundary twice per year. The program included a network of approximately 40 elevation benchmarks encompassing Zone 7's production wellfields and spanning the Bernal and Amador Subareas within the Main Basin. The program also included reference benchmarks located in bedrock outside of the alluvial basin. Background information regarding Zone 7's land surface elevation monitoring was provided in *Section 2.3.9, Land Subsidence,* of the Alternative GSP.

In the 2016 WY, Zone 7 contracted with TRE Altamira (TRE) to evaluate Interferometric Synthetic Aperture Radar (InSAR) as an alternative to land surveying for subsidence monitoring. TRE analyzed InSAR data from three different satellites over a 24-year period (from 1992 to 2016) which included approximately 120 satellite images with between 415 and 1,202 measuring points per square mile. Each measuring point contains a deformation time series, including cumulative displacement, average deformation rate, acceleration, and seasonal amplitude. The study results correlated well with topographic surface measurements taken by land surveys within the same time period. An added benefit of the InSAR dataset was that it included a larger area (i.e., the entire Main Basin) than the land surveying. The resulting TRE 2016 report was included in Zone 7's Alternative GSP (Attachment I).

8.1.2 Program Changes for the 2019 Water Year

Starting in the 2019 WY, instead of continuing the land surveying program, Zone 7 is using InSAR for monitoring land subsidence. For the 2019 WY, Zone 7 contracted again with TRE to perform an analysis of satellite data for the Livermore Valley collected since the 2016 WY. For this study, TRE included all of the Livermore Valley Groundwater Basin area, including the entire Main Basin, the Fridge Subareas, and the Upland Areas. The results of TRE's study are presented in the resulting report (see *Appendix 8-1*) and discussed below.

8.2 Results for the 2019 Water Year

Table 8-1 shows the annual and semiannual change in land surface elevation for selected InSAR points located near previous land survey benchmarks. *Figure 8-1* shows the extent of the InSAR study performed this year, the locations of the selected InSAR points, and the land surface deformation from the 2018 to 2019 WY. The TRE report (*Appendix 8-1*) includes the following additional figures and tables:

- *Figures 10 to 12* (pages 14 and 15) show that ground surface elevation changes for three InSAR points compare closely with three nearby land survey benchmarks.

- *Figures 14 and 15* (page 18) show graphs of ground surface elevation and groundwater elevation.

In general, observed land surface elevation changes between September 2018 to September 2019 near Zone 7's municipal wells were within the range Zone 7 considers to be "elastic deformation" (i.e., rebound to their original location when groundwater levels return to previous levels). The following items summarize the findings from the InSAR analysis for the entire groundwater basin for the period September 2018 to September 2019 (*Figure 8-1*):

- In the western portion of the Main Basin, where the previous land surveying network was located, the majority of the InSAR points show that ground surface elevations fluctuated less than +/- 0.07 ft seasonally, and less than +/- 0.03 ft annually; i.e., fall 2018 to fall 2019 (*Table 8-1*).

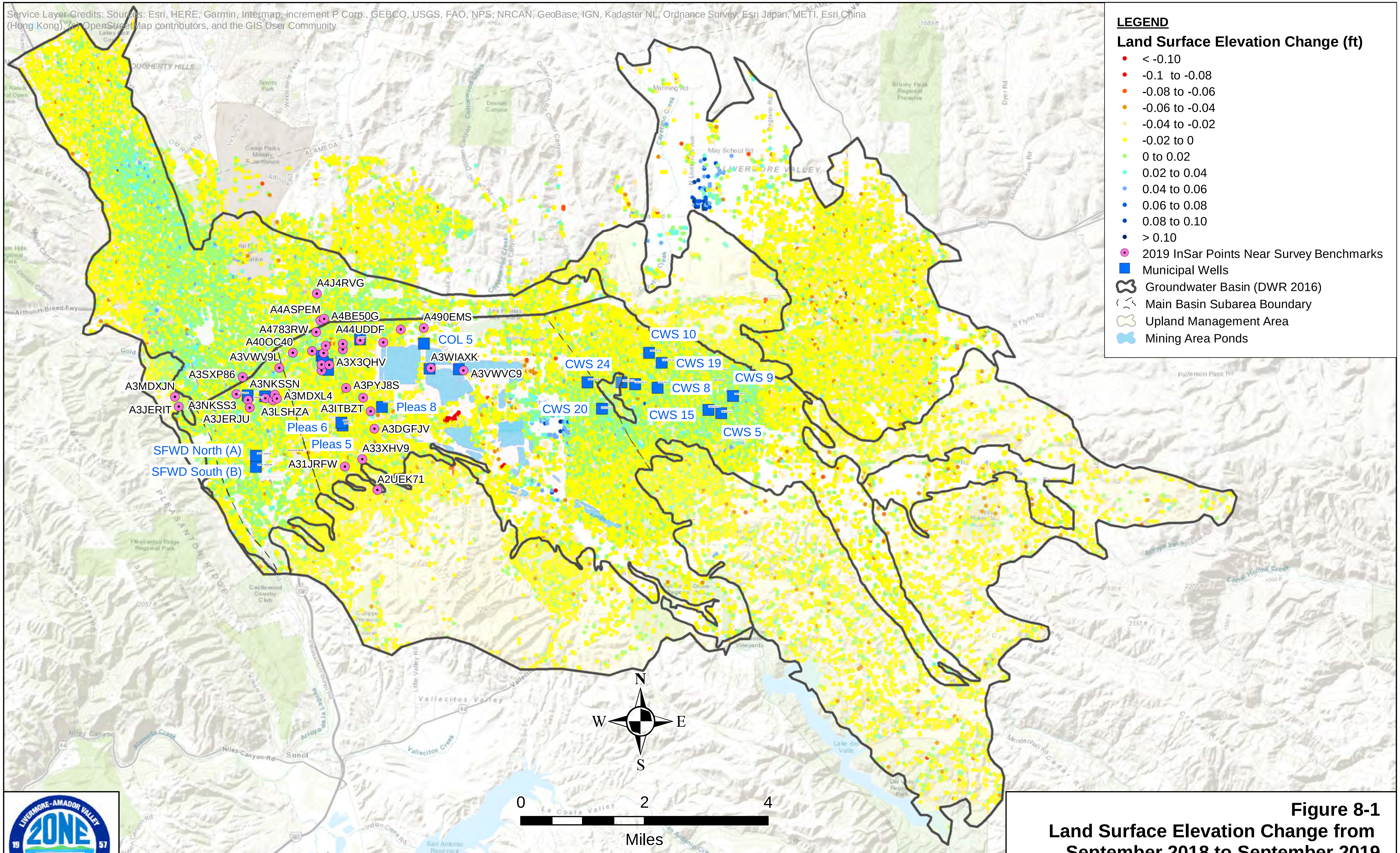
- In the other portions of the Main Basin, Fringe Subareas, and Upland Areas, land surface elevations generally rose or dropped within +/- 0.02 feet, except for the two areas described below.

- Some points in the mining area appear to have dropped as much as 0.17 feet (indicated by several red dots in *Figure 8-1*). These are likely due to changes in excavation and additional grading activities, and not from land subsidence.

- In an area east of Livermore Avenue in the Northeastern Fringe Subarea, land surface elevations rose by as much as 0.1 feet (indicated by several blue dots in *Figure 8-1*). The reason for this localized uplift is unknown, but Zone 7 will continue to monitor this area.

TABLE 8-1
CHANGE IN GROUND SURFACE ELEVATION FOR SELECTED SITES NEAR PREVIOUS LAND SURVEY BENCHMARKS, 2019 WATER YEAR

Site	Nearby Benchmark ID	Change in Elevation (ft)		
		Fall 2018 to Spring 2019	Spring 2019 to Fall 2019	Fall 2018 to Fall 2019
A3MDXJN	A1- 1.0	-0.032	0.029	-0.003
A3JERIT	A1- 2.0	-0.043	0.058	0.014
A3NKSS3	A1- 3.0	-0.038	0.035	-0.002
A3SXP86	A1- 4.0	-0.024	0.029	0.005
A3VWV9L	A1- 6.0	-0.032	0.033	0.001
A40OC40	A1- 6.05	-0.029	0.037	0.007
A419RQ2	A1- 6.1	-0.035	0.028	-0.007
A40OC4G	A1- 7.0	-0.039	0.042	0.003
A3X3QHV	A1-10.0	-0.030	0.031	0.001
A3PYJ8S	A1-12.0	-0.034	0.033	-0.002
A3MZD85	A1-13.1	-0.038	0.030	-0.008
A3ITBZT	A1-14.1	-0.031	0.026	-0.005
A3DGFJV	A1-15.0	-0.041	0.020	-0.021
A33XHV9	A1-15.1	-0.041	0.028	-0.013
A31JRFW	A1-16.0	-0.058	0.048	-0.009
A2UEK71	A1-17.0	-0.040	0.027	-0.013
A4322JL	B1- 5.1	-0.027	0.030	0.003
A3X3QHR	B1-13.0	-0.046	0.045	-0.001
A3X3QHV	B1-14.1	-0.030	0.031	0.001
A3VBFOF	B1-16.2	-0.015	0.020	0.005
A3LSHYX	B3- 1.0	-0.028	0.028	0.001
A3JERJU	B3- 2.0	-0.034	0.018	-0.017
A3MDXKY	B3- 3.0	-0.025	0.032	0.007
A3LSHZA	B3- 4.0	-0.031	0.029	-0.002
A3MDXL4	B3- 5.0	-0.015	0.022	0.007
A43NI5M	B4- 1.0 N	-0.019	0.020	0.001
A41V7CA	B4- 1.0 S	-0.028	0.029	0.002
A44UDDF	B4- 2.0	-0.044	0.041	-0.003
A448XRZ	B4- 3.0	-0.043	0.038	-0.005
A48EZ0O	B4- 4.0	-0.034	0.034	0.000
A490EMS	B4- 5.0	-0.038	0.027	-0.012
A3VWVC9	B4- 6.0	-0.068	0.061	-0.007
A3WIAXK	B4- 7.0	-0.035	0.022	-0.013
A4783RW	B5- 1.0	-0.032	0.033	0.001
A4ASPEM	B5- 2.0	-0.015	0.027	0.012
A4BE50G	B5- 3.0	-0.033	0.034	0.001
A4J4RVG	B5- 4.0	-0.032	0.038	0.006
A3NKSSN	H7-C	-0.034	0.021	-0.013

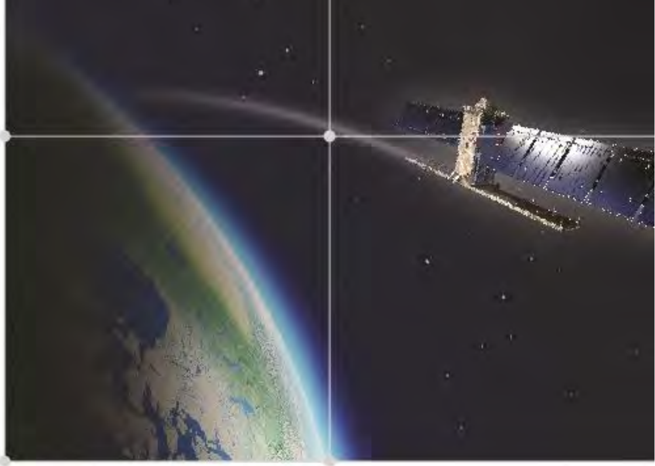


DATE: Mar 5, 2020

FILE: E:\MONITOR\Em\2019WY\AnnualReport2019\Fig08-01-LandSurfaceDeformation18to19.mxd

Figure 8-1
Land Surface Elevation Change from September 2018 to September 2019 Livermore Valley Groundwater Basin

APPENDIX 8-1



InSAR Analysis of Ground Deformation over Livermore

2014 December - 2019 September

Technical Report

February 2020

TRE
ALTAMIRA
A CLS Group Company

Report Specifications

Client:	**Zone 7 Water Agency**
Attention:	Tom Rooze
Address:	100 N. Canyons Parkway Livermore, CA 94551-9486

Reference:	
Title:	InSAR Analysis of Ground Deformation over Livermore
TRE ALTAMIRA Delivery Reference:	JO19-936-CA REP 1.0
Client Reference (PO):	

Prepared by:	**TRE ALTAMIRA Inc.**
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Verified by:	Giacomo Falorni
Approved by:	Giacomo Falorni
Date:	20 February 2020
Version:	1.0

Executive Summary

This report describes the results of the InSAR ground deformation analysis over Livermore covering the period 13 March 2015 to 24 September 2019. TRE Altamira used its SqueeSAR® algorithm to process Sentinel satellite imagery and produce 2-D ground deformation measurements that were calibrated using GNSS stations in the area. The following points summarize the key findings:

- Generalized westward movement is present throughout the AOI
- Uplift is observed in the NW of the AOI
    - An interpolated map of annual (September to September) ground deformation shows over 0.5 inches of uplift from 2015 to 2016 as well as from 2017 to 2018 in the NW
- A comparison between InSAR ground deformation readings and topographic survey benchmarks indicates a good correlation between the measurements.
- There is good agreement between variations in groundwater levels and ground deformation. 0.6 to 0.9 inches of subsidence were observed during the drought in the first half of 2017 at the four key well locations.

Confidentiality disclaimer

This document contains confidential proprietary information and is intended solely for the recipient. The contents of this document, including information related to TRE ALTAMIRA methodology and know-how, may not be disclosed in whole or in part to any third party by any means or used for any other purpose without the express written permission of TRE ALTAMIRA.

Table of Contents

Acronyms and Abbreviations

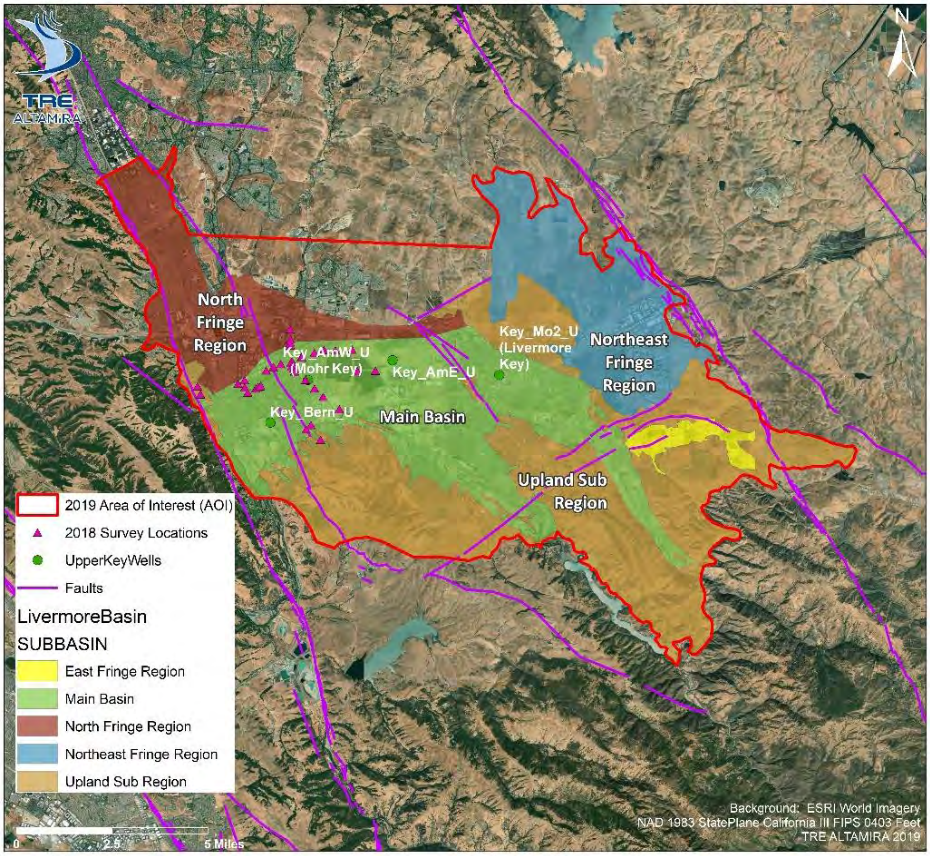
AOI	Area of Interest
ATS	Average Time Series
CS	Cross-Section
cRTS	Common Time Series of Residuals
DEM	Digital Elevation Model
DInSAR	Differential Interferometric SAR
DS	Distributed Scatterer(s)
ENVISAT	ENVISAT Satellite
ERS	European Remote Sensing Satellite
GIS	Geographic Information System
GNSS	Global Navigation Satellite System
InSAR	Interferometric Synthetic Aperture Radar
LOS	Line of Sight
LTS	LOS Time Series
MP	Measurement Point
PS	Permanent Scatterer(s)
SAR	Synthetic Aperture Radar
SNT	Sentinel Satellite
SqueeSAR®	The most recent InSAR algorithm patented by TRE
TS	Time Series
UNAVCO	UNAVCO Data Center

1. Introduction

TRE ALTAMIRA Inc. (TRE) has been contracted by the Zone 7 Water Agency (Zone 7) to provide a 2-D SqueeSAR ground deformation update over the Livermore and Pleasanton areas. TRE had previously performed a historical study using ERS, Envisat and Sentinel satellite imagery covering the periods 1992 – 2000, 2003 – 2010, and 2015 – 2016, respectively, over the same area. The current study is based on Sentinel satellite imagery that extends the analysis delivered in 2016 to September 2019.

1.1. Area of Interest

The AOI for Livermore comprises urban as well as very dry, sparsely vegetated areas and covers approximately 121 square miles (Figure 1). The terrain is flat with moderate hills and presents conditions suitable for the application of InSAR.



Livermore, California

Figure 1: Livermore Area of Interest (AOI).

2. Radar Data

Radar images were acquired over Livermore by the Sentinel (SNT) satellite from a descending orbit (satellite travelling from north to south and imaging to the west) and an ascending orbit (satellite travelling from south to north and imaging to the east) with a 12-day revisit frequency. A total of 130 images from the descending orbit, covering four year and nine months (31 December 2014 - 30 September 2019), and 121 from the ascending orbit, spanning 13 March 2015 to 24 September 2019, were processed (Table 1). The temporal distribution of the radar imagery is shown in Figure 2. Appendix 2 provides additional information on the satellite acquisition date.

Table 1: Satellite acquisition parameters and image acquisition information.

Satellite	Pixel Resolution	Orbit	LOS Angle (Θ)	Revisit Frequency	# of Images	Date Range
Sentinel	65 ft x 15 ft	Descending	42.08°	12-day (6-day since Aug 2019)	130	31 Dec 2014 – 30 Sep 2019
		Ascending	41.74°	12-day (6-day since Jan 2019)	121	13 Mar 2015 – 24 Sep 2019

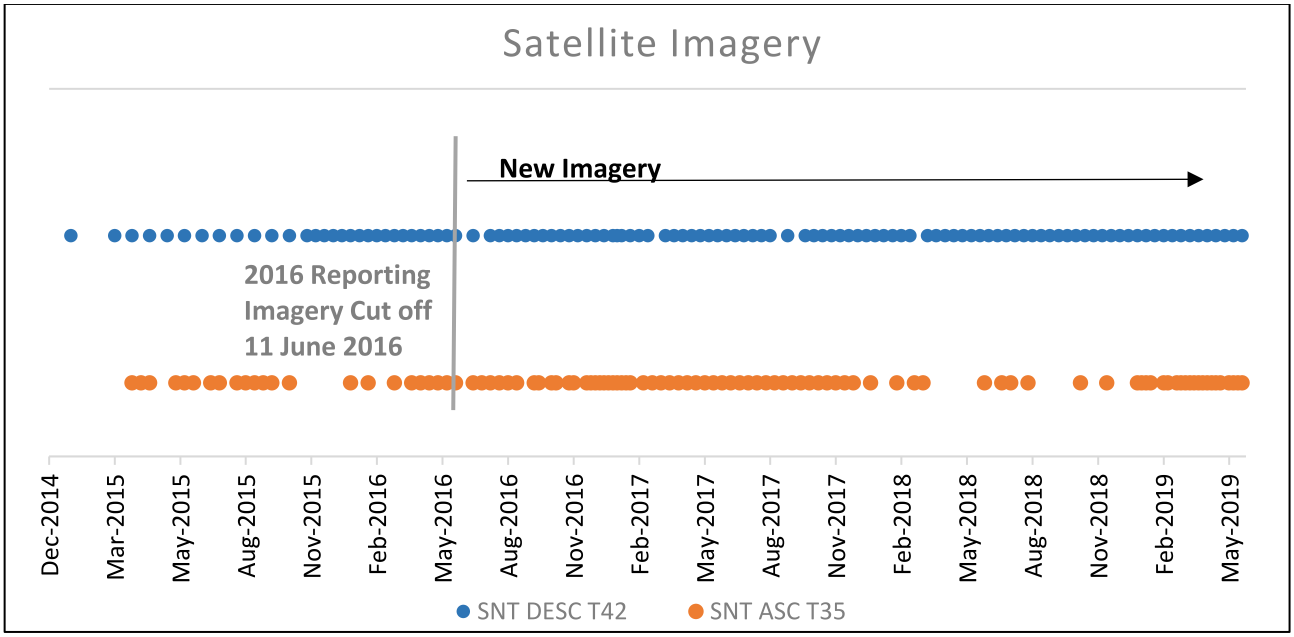


Figure 2: Temporal distribution of Sentinel ascending and descending radar images processed over Livermore.

3. Overview of Results

This section provides a summary of the techniques used and a general overview of the results, while Section 4 further describes areas of deformation in more detail. Refer to the Handbook for further details the technology and techniques used.

3.1. SqueeSAR Analysis

SqueeSAR identifies measurement points (MPs) from objects on the ground that display a stable return to the satellite in every image of an image archive. The MPs belong to two different families (Figure 3):

- Permanent Scatterers (PS): point-wise radar targets characterized by highly stable radar signal return (e.g. buildings, rocky outcrops, linear infrastructures, etc.)
- Distributed Scatterers (DS): patches of ground exhibiting a lower but homogenous radar signal return (e.g. rangeland, debris fields, arid areas, etc.). DS therefore refer to small areas covering several pixels rather than to a single target or object on the ground. For clarity of presentation and ease of interpretation, DS are represented as individual points.

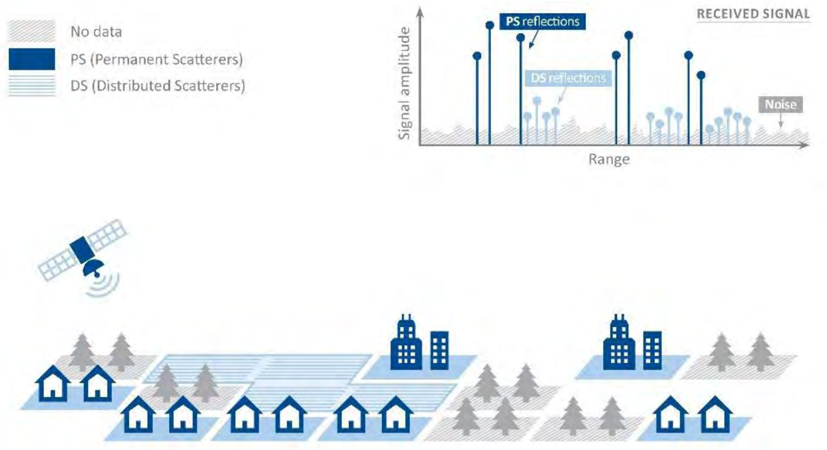


Figure 3: Schematic of PS and DS radar targets.

In InSAR analyses, all measurements are 1-D readings along the sensor's line-of-sight (LOS) as the true vector of deformation is projected onto the LOS. The same deformation will produce different readings when viewed from different angles (Figure 4). The LOS deformation rates are calculated from a linear regression of the ground movement measured over the entire period covered by the satellite images. Each measurement point corresponds to a Permanent Scatterer (PS) or a distributed scatterer (DS), and is color-coded according to its annual rate of movement and direction:

- In a descending LOS analysis, negative values (red) indicate surface deformation away from the satellite (i.e. subsidence and/or westward movement), while positive values (blue) indicate surface deformation towards the satellite (i.e. uplift and/or eastward movement).
- In an ascending LOS analysis, negative values (red) indicate movement away from the satellite (i.e. subsidence and/or eastward movement) while positive values (blue) indicate movement towards the satellite (i.e. uplift and/or westward movement).

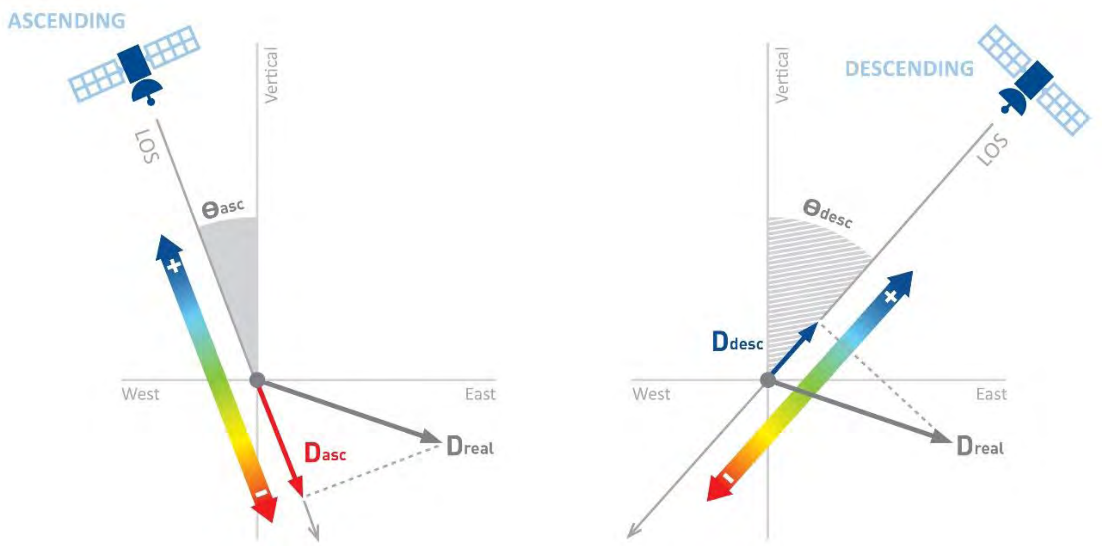


Figure 4: SqueeSAR measures the projection of real movement (D_{real}) along the LOS. The same real movement (D_{real}) will produce a different value from a different LOS (different inclination or different acquisition geometry).

Deformation measurements obtained by the SqueeSAR algorithm are differential in space and time. Measurements are spatially related to the reference point, and temporally to the date of the first available satellite image. The reference point is assumed to be motionless and selected for its radar properties and motion behavior.

The trigonometric combination of SqueeSAR results obtained from different orbits (i.e. ascending and descending), over the same area and overlapping period, produces 2-D (vertical and east-west) measurements of ground movement (Figure 5) in a gridded format, as different measurement points are identified from the two orbits. MPs contained within a same cell are averaged and a new unique, derived time series of deformation is obtained for each grid cell.

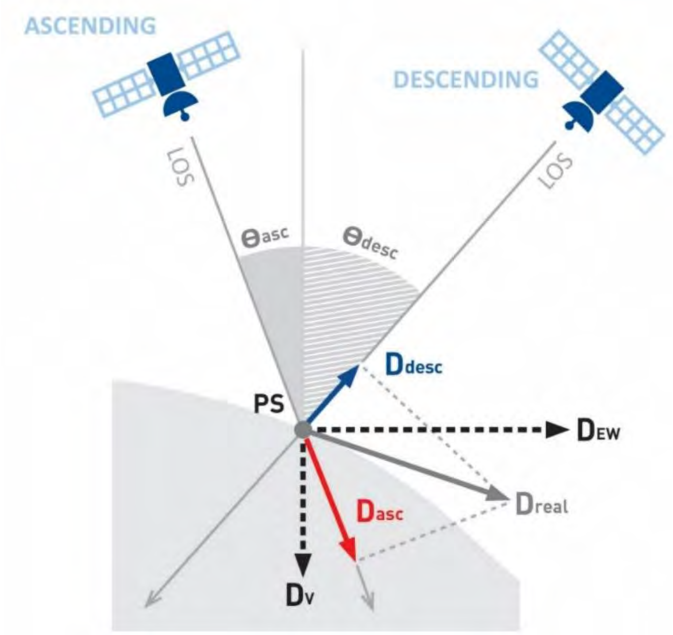


Figure 5: Example of motion decomposition combining ascending and descending acquisitions geometry.

As in the LOS analysis, average annual deformation rates in a 2-D analysis are calculated from a linear regression of the ground movement measured over the entire time interval covered by the analysis and all measurements are relative to a chosen reference point. Each point is color-coded according to the magnitude of movement:

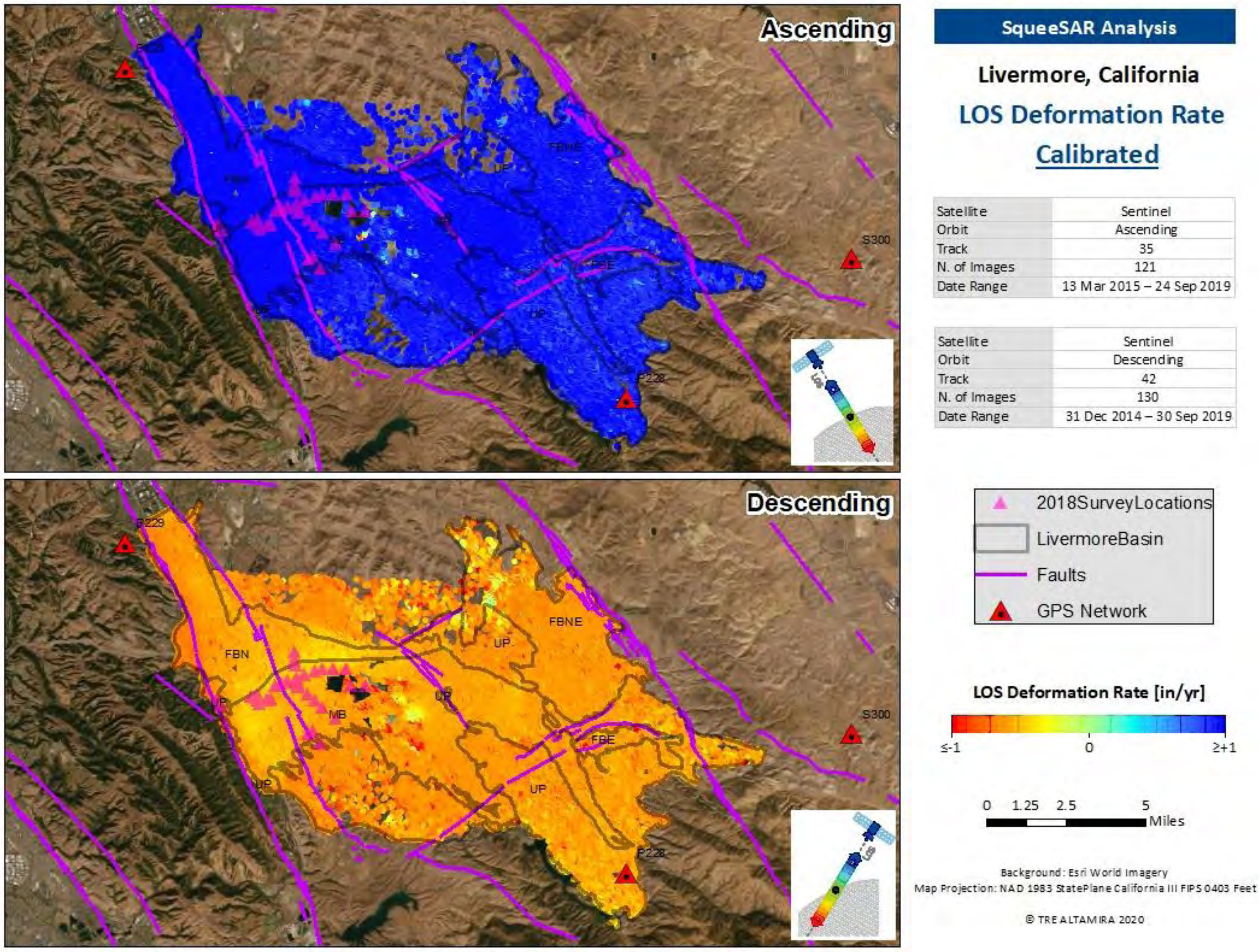
- In a vertical data set, negative values (red) indicate downward surface deformation (i.e. subsidence), while positive values (blue) indicate upward surface deformation (i.e. uplift).
- In an east-west data set, negative values (red) indicate westward motion, while positive values (blue) indicate eastward motion.

Calibration methodology is applied to the SqueeSAR results using GNSS (Global Navigation Satellite System) stations P228 and P229 from UNAVCO. Appendix 3 provides additional information on the details for the calibration methodology.

3.2. Calibrated 2-D and Line-of-Sight Results

The LOS deformation rates, measured in inches per year, were computed from the ascending archive (13 March 2015 to 24 September 2019) and the descending archive (31 December 2014 to 30 September 2019). These LOS results were calibrated using GPS stations located within the area of interest to account for regional ground deformation trends (Figure 6). The calibrated LOS (Ascending and Descending) results were then used to produce calibrated 2-D (East-West and Vertical) measurements (Figure 7). The calibrated 2-D output highlights an area of uplift in the western portion of the AOI and generalized westward movement throughout the AOI. Further observations are described in Section 4.

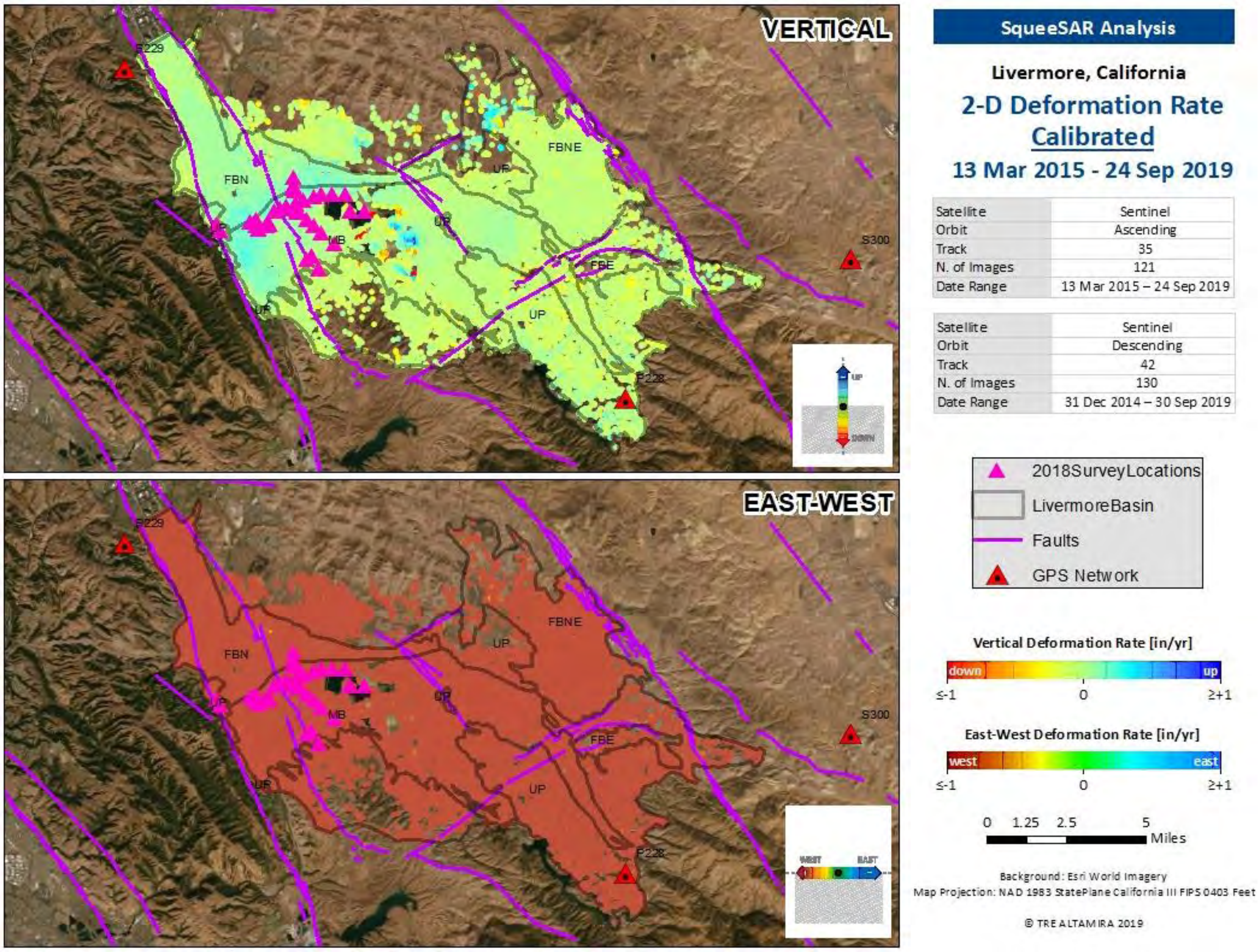
Various parameters of the analysis, including measurement point density and precision, are indicated in Table 2.



Satellite	Sentinel
Orbit	Ascending
Track	35
N. of Images	121
Date Range	13 Mar 2015 – 24 Sep 2019

Satellite	Sentinel
Orbit	Descending
Track	42
N. of Images	130
Date Range	31 Dec 2014 – 30 Sep 2019

Figure 6: Ascending and Descending calibrated deformation rates over the AOI for the entire study period.



Satellite	Sentinel
Orbit	Ascending
Track	35
N. of Images	121
Date Range	13 Mar 2015 – 24 Sep 2019

Satellite	Sentinel
Orbit	Descending
Track	42
N. of Images	130
Date Range	31 Dec 2014 – 30 Sep 2019

Figure 7: East-West and Vertical calibrated deformation rates over the AOI for the entire study period.

Table 2: Properties of the SqueeSAR analyses.

Attribute	Ascending	Descending	Vertical	East-West
Date Range	13 Mar 2015 – 24 Sep 2019	31 Dec 2014 – 30 Sep 2019	13 Mar 2015– 24 Sep 2019	13 Mar 2015 – 24 Sep 2019
N. of Images	121	130	185	185
Total points (PS + DS) **Number of PS** **Number of DS**	110,994 77,492 33,502	107,662 69,381 38,281	36,862 / /	36,862 / /
Average Point Density (pts/mi^2)	917.9	890.34	304.82	304.82
Average Deformation Rate Standard Deviation (in/yr)	±0.02	±0.02	±0.02	±0.02
Average Time Series Error Bar (in)	0.24	0.14	/	/

4. Observations

All data analyses in this section use calibrated vertical data, which is simply referred to as vertical data in the following.

4.1. Annual Ground Deformation

Figure 8 outlines annual (from September to September) cumulative displacement within the AOI. Uplift is observed within the North Fringe Region sub-basin (FBN) and the northwest Main Basin (MB) in all four annual periods. The maximum amount of uplift (>5 inches) is observed between September 2015 and September 2016, when it also has the largest areal extension.

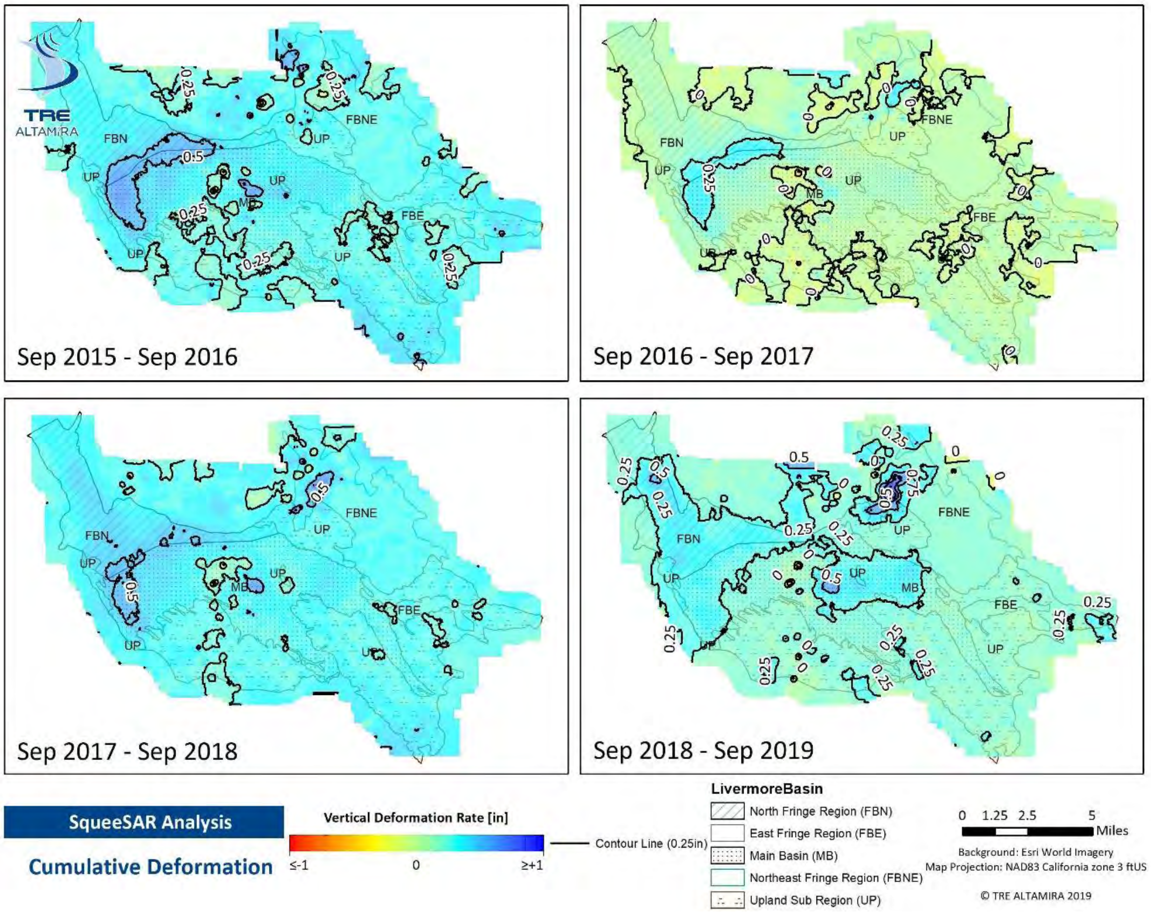


Figure 8: The interpolated map showing annual ground deformation from September to September and the contour lines with a 0.25-inch interval.

4.2. Comparison with Topographic Data

A comparison between 3 topographic benchmarks[1] and InSAR measurements was performed. To allow a direct comparison, the topographic measurements closest to 13 March 2015, corresponding to the first date of the InSAR vertical data, is set to zero. Benchmarks A1-3.0, B1 - 5.1, and B4-4.0 and their closest vertical measurement points are shown in Figure 9. The results indicate substantial correlation between the InSAR and topographic survey measurements (Figure 10 to Figure 12).

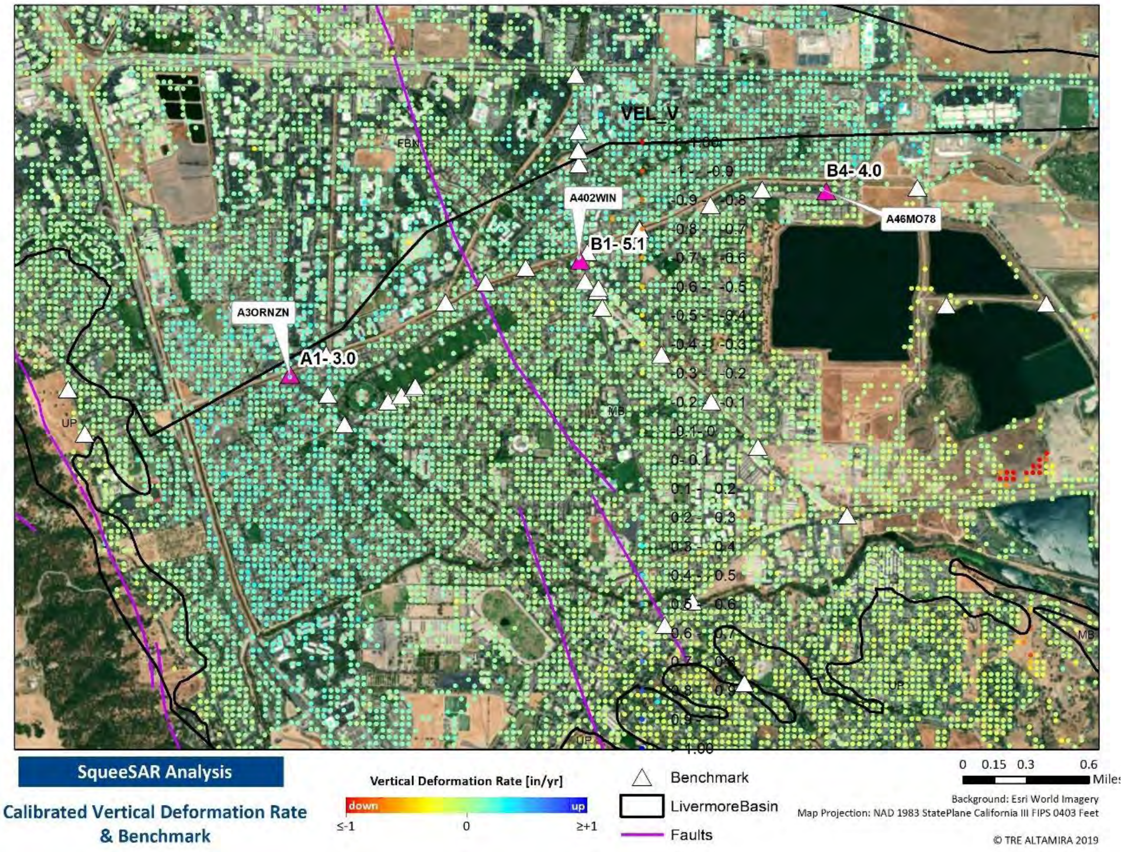


Figure 9:Three topographic benchmarks (A1-3.0, B1 - 5.1, and B4-4.0) and their closest vertical measurement points.

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[1] Topographic data is provided by Zone 7 Water Agency.

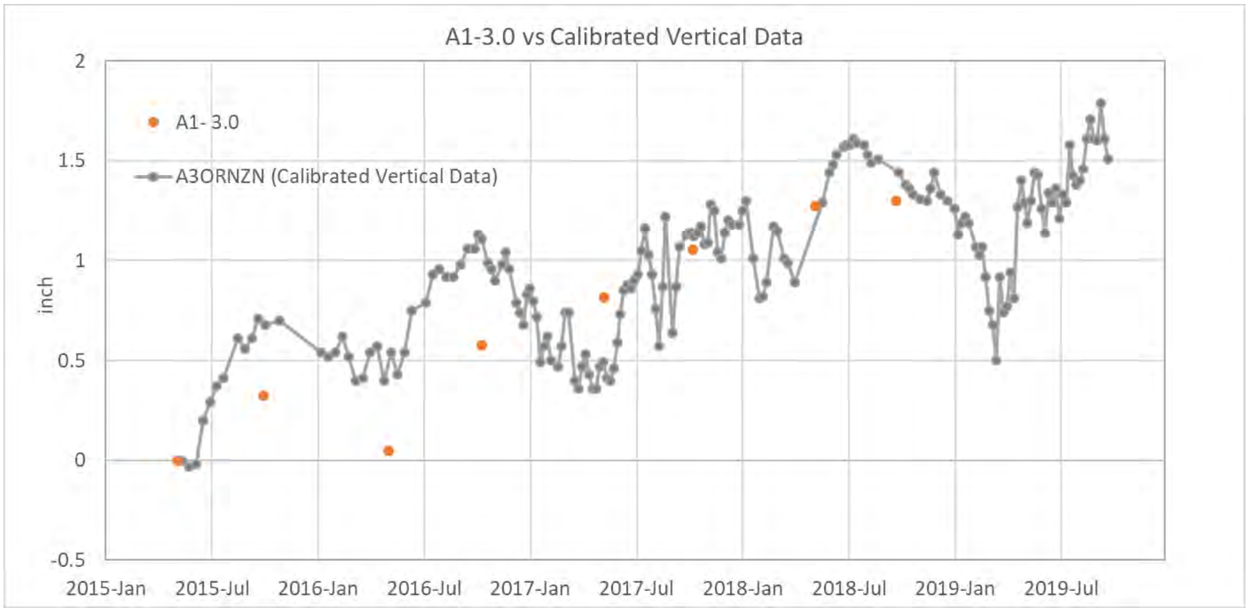

Figure 10: Topographic measurement vs SqueeSAR at benchmark A1-3.0.

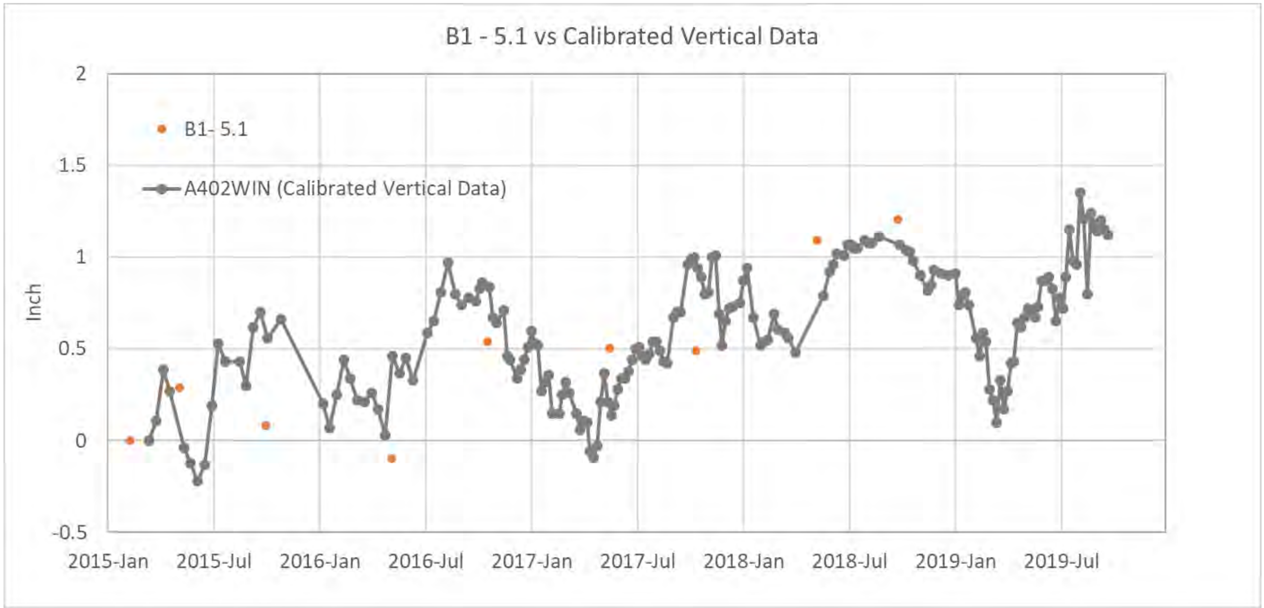

Figure 11: Topographic measurement vs SqueeSAR at benchmark B1-5.1.

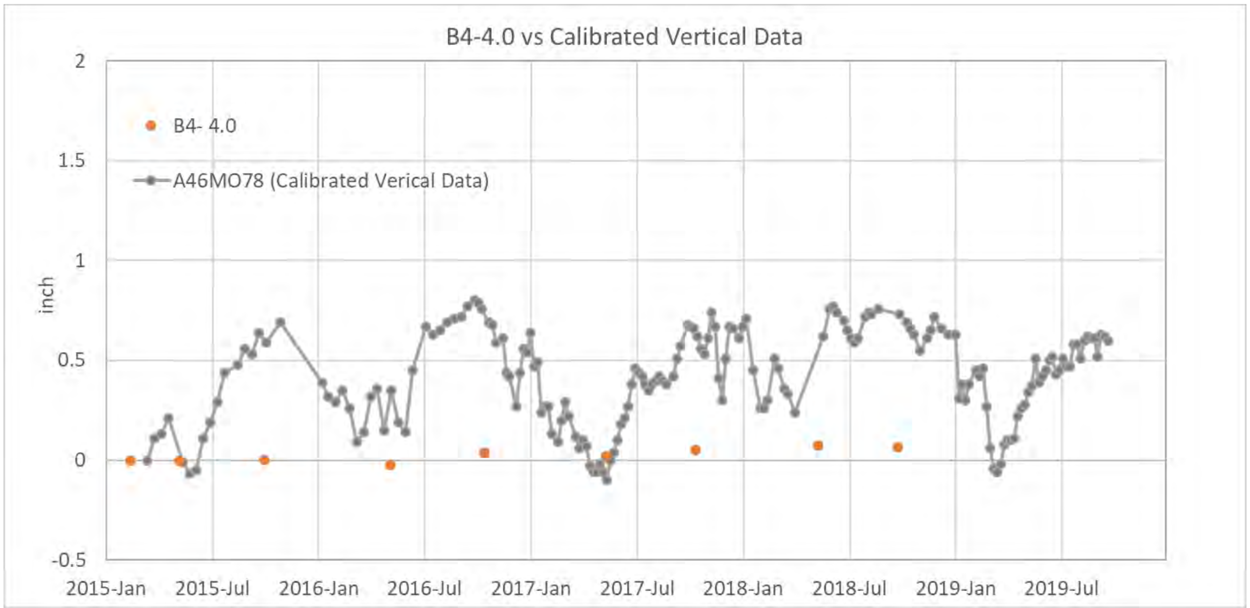

Figure 12: Topographic measurement vs SqueeSAR at benchmark B4-4.0.

4.3. Comparison with Groundwater Levels

The relationship between groundwater levels and ground deformation was investigated by comparing vertical measurements within a 500 foot buffer from four key wells with groundwater levels[2] (Figure 13). The results show a good correlation between variations in groundwater elevation and vertical ground deformation trends, including subsidence (-0.5 inches) during the first half of 2017 (Figure 14 and Figure 15).

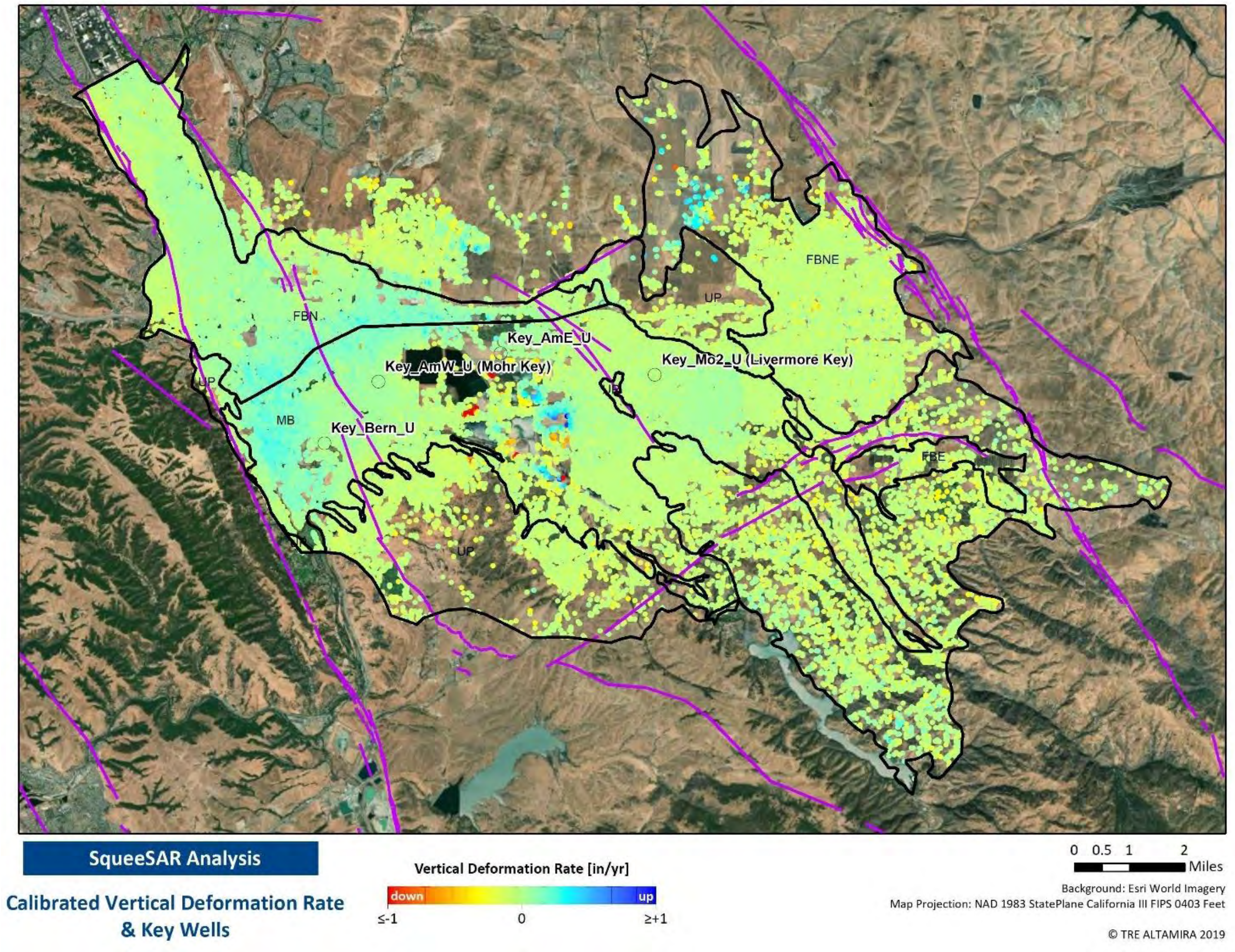

Figure 13: Key wells over Livermore.

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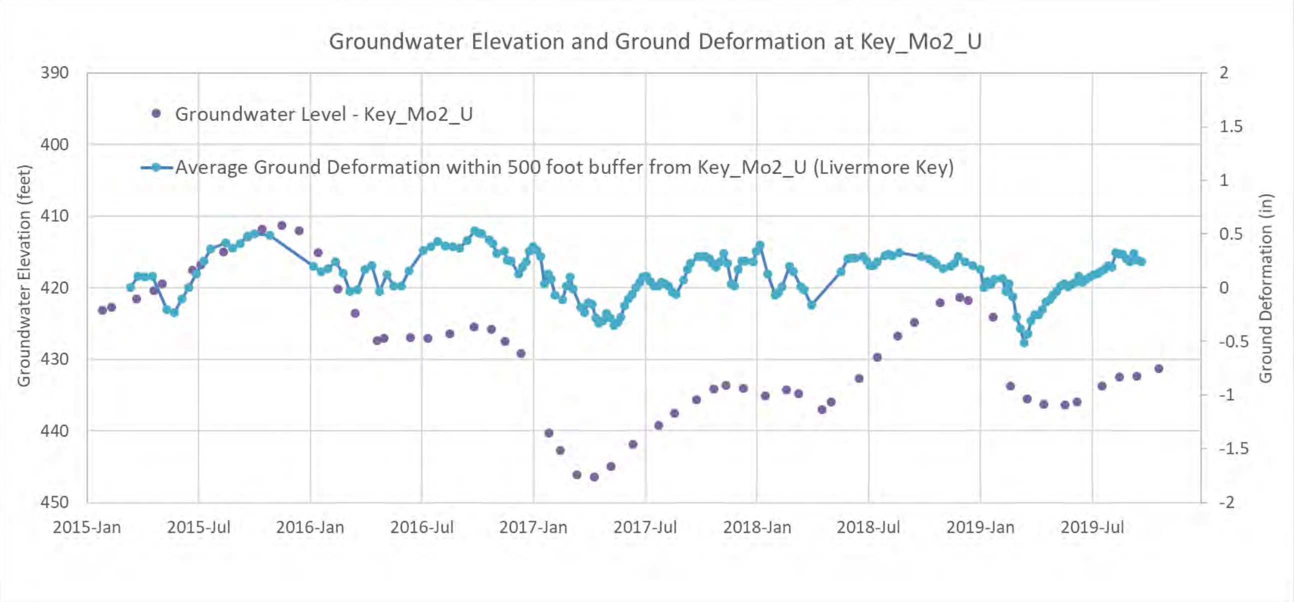
[2] Groundwater level data is provided from Zone 7 Water Agency.



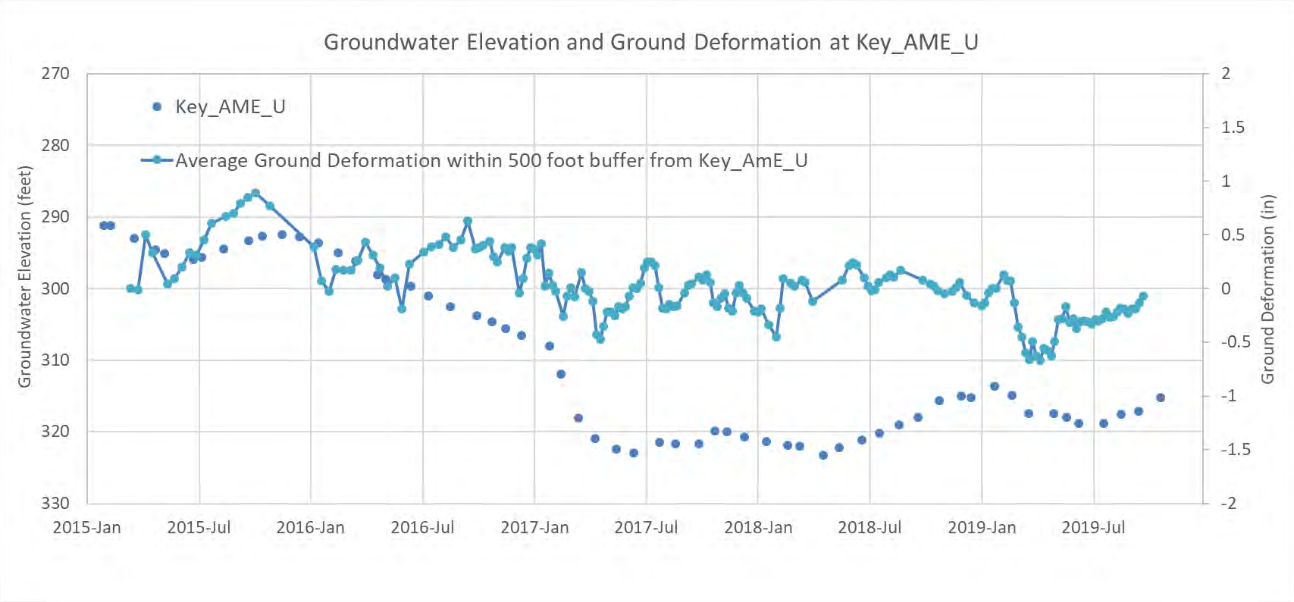
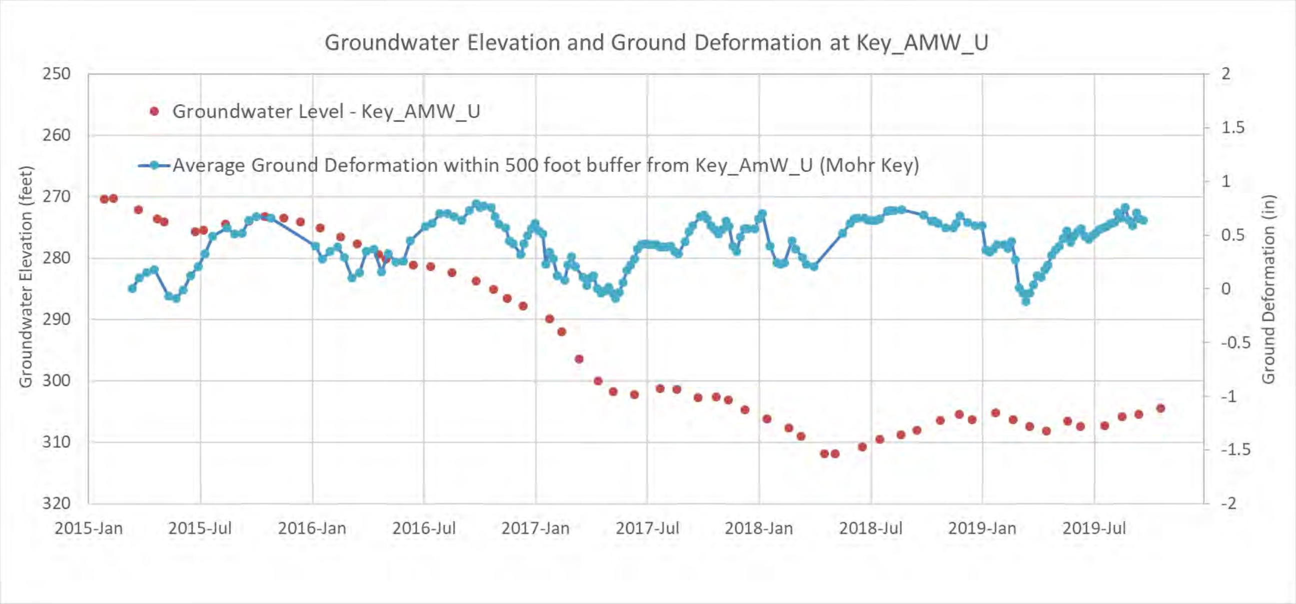


Figure 14: Groundwater elevation vs. ground deformation at Key_Mo2_U (top) and Key_AME_U (bottom).



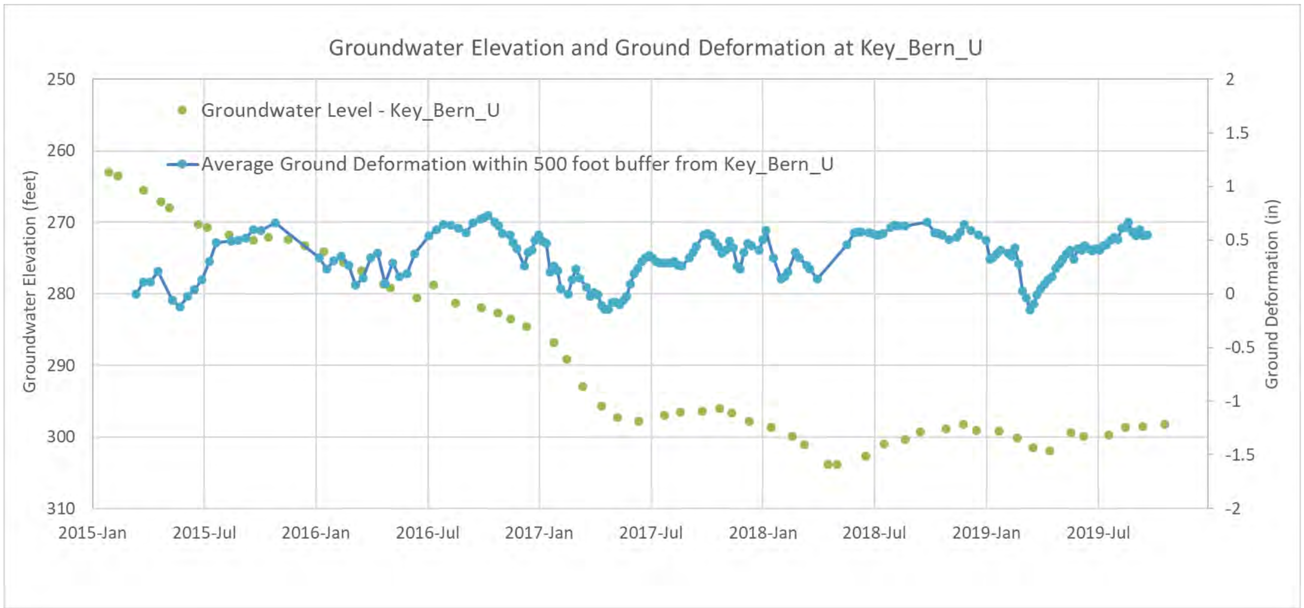


Figure 15: Groundwater elevation vs. ground deformation at Key_AMW_U (top) and Key_Bern_U (bottom).

5. Summary and Recommendations

TRE Altamira used its SqueeSAR® algorithm to process Sentinel images coupled with a calibration procedure using GNSS data to carry out 2-D analysis of ground deformation over Livermore spanning 13 March 2015 to 24 September 2019. Uplift is observed within the sub-basins of the North Fringe Region and Main Basin, with rates ranging from 0.2 to 0.4 in/year, and a generalized westward trend is present in the entire area. Comparisons with topographic benchmarks and ground water levels indicate substantial correlation between the InSAR measurements and these independent parameters.

For future monitoring TRE recommends continuing with the calibrated 2-D approach using the ongoing Sentinel acquisitions to characterize regional movement trends. However, if the main interest is to understand local ground movement trends a 1-D LOS approach using an uncalibrated local reference point will allow localized differential movement in the area to be highlighted.

Appendix 1: Delivered Files

List of Deliverables

Table 3 list the deliverables including the present report, the InSAR data files and an updated version of the TRE toolbar, a software tool for assisting with the loading, viewing and interrogation of the data in ESRI ArcGIS 10.x software (For set-up procedure and functionalities, see the attached manual *TREToolbarSetup_5.0.pdf*).

Table 3: List of deliverables.

Description	File name
SqueeSAR Data	**LOS Calibrated & Uncalibrated:** Ascending: LIVERMORE_SNT_T35_A_SEP2019_NAD83_IMPERIAL_CA2109A1S.shp Descending: LIVERMORE_SNT_T42_D_SEP2019_NAD83_IMPERIAL_CA1798A2S.shp **2-D Calibrated & Uncalibrated:** Vertical: LIVERMORE_SNT_VERT_SEP2019_NAD83_IMPERIAL_CA2109A2V.shp East-West: LIVERMORE_SNT_EAST_SEP2019_NAD83_IMPERIAL_CA2109A3E.shp
MXD project file containing all the data (ESRI ArcGIS version 10.0 and 10.6)	Livermore_2019InSAR_Historical_Analysis.mxd
Technical Report	Livermore Historical SqueeSAR_2019.pdf
TRE Toolbar (ESRI® ArcGIS 10.x)	TREToolbar_5.0 TREToolbarSetup_5.0.pdf

Database Structure

The SqueeSAR vector data are delivered in a shapefile format and projected to NAD_1983_StatePlane_California_III_FIPS_0403_Feet (EPSG:2227) coordinates. The shapefile of each elaboration contains details about the measurement points identified, including deformation rate, elevation, cumulative deformation and quality index. The information associated within the database files (dbf) are described in Table 4.

Table 4: Description of the fields contained in the database of the vector data. *Field is only present in LOS data sets.

Field	Description
CODE	Measurement Point (MP) identification code.
HEIGHT*	Topographic Elevation referred to WGS84 ellipsoid of the measurement point [ft].
H_STDEV*	Height standard deviation of the measurement point [ft].
VEL	MP deformation rate [in/yr]. **Ascending LOS:** Positive values correspond to motion toward the satellite (i.e. uplift and/or westward movement); negative values correspond to motion away from the satellite (i.e. downward and/or eastward movement). **Descending LOS:** Positive values correspond to motion toward the satellite (i.e. uplift and/or eastward movement); negative values correspond to motion away from the satellite (i.e. downward and/or westward movement). **Vertical (VEL_V):** Positive values indicate uplift; negative values indicate downward movement. **E-W Horizontal (VEL_E):** Positive values indicate eastward movement; negative values westward movement.
V_STDEV	Deformation rate standard deviation [in/yr].
ACC*	Acceleration rate [in/yr^2].
A_STDEV*	Standard deviation of the acceleration value [in/yr^2].
SEASPM_AMP*	Average seasonal amplitude [in]
S_AMP_STD*	Average seasonal amplitude standard deviation [in]
SEASON_PHS*	Average seasonal phase [day]
S_PHS_STD*	SEASON_PHS standard deviation [day]

COHERENCE*	Quality measure between 0 and 1.
STD_DEF*	Deformation time series error bar [in]
EFF_AREA*	This parameter represents the effective extension of the area [ft^2] covered by Distributed Scatterers (DS). For permanent scatterers (PS), its value is set to 0.
Dyyyymmdd	Series of columns that contain the deformation values of successive acquisitions relative to the first acquisition available [in].

TREmaps

TREmaps® is our proprietary online GIS platform to view and interrogate the InSAR datasets. TREmaps has been completely revamped to include features and functionality previously available only within the TRE ArcGIS toolbar. Little or no training is required and no specialized GIS software is necessary. With internet access, the platform allows data to be overlaid on an optical image and to perform various operations on the data.

Functionalities include:

- Time-Series tool to view the history of deformation for each measurement point
- Average Time-Series tool to view the average history of deformation for a group of selected points.
- Cross-section tool to view the evolution of the ground surface over time
- Data download and data export (of subsets of data) to common formats (SHP, KML, GeoDB, CSV)
- Dynamic filtering tool to filter a subset of the results by a specified time period
- Client data integration.

TREmaps is hosted by Microsoft Azure, with all the advantages of data security and the cloud-based environment, with minimal downtime and robust internet connectivity. TREmaps runs directly on most Internet browsers and is accessed through a secure client login.

To log in, please go to:

https://tremaps5.tre-altamira.com/treaviewer

For assistance on any of the functions, please click the Help icon on the viewer or go to:

https://site.tre-altamira.com/tremaps-getting-started/

Appendix 2: Additional Radar Data Details

InSAR-based approaches measure surface deformation on a one-dimensional plane, along the satellite line-of-sight (LOS). The LOS angle varies depending on the satellite and on the acquisition parameters while another important angle, between the orbit direction and the geographic North, is nearly constant.

An ascending orbit denotes a satellite travelling from south to north and imaging to the east, while a descending orbit indicates a satellite travelling from north to south and imaging to the west. Table 5 lists the values of the angles for this study, while Figure 16 and Figure 17 show the geometry of the image acquisitions over the site for the ascending and descending orbits, respectively. The symbol Θ (theta) represents the angle the LOS forms with the vertical and δ (delta) the angle formed with the geographic north.

Table 5: Satellite viewing angles for the study.

Satellite	Wavelength	Orbit	Beam Mode/ Track	Symbol	Angle
Sentinel	C-Band 5.55 cm	Ascending	35	θ	41.74^{o}
				δ	10.49^{o}
		Descending	42	θ	42.08^{o}
				δ	8.94^{o}

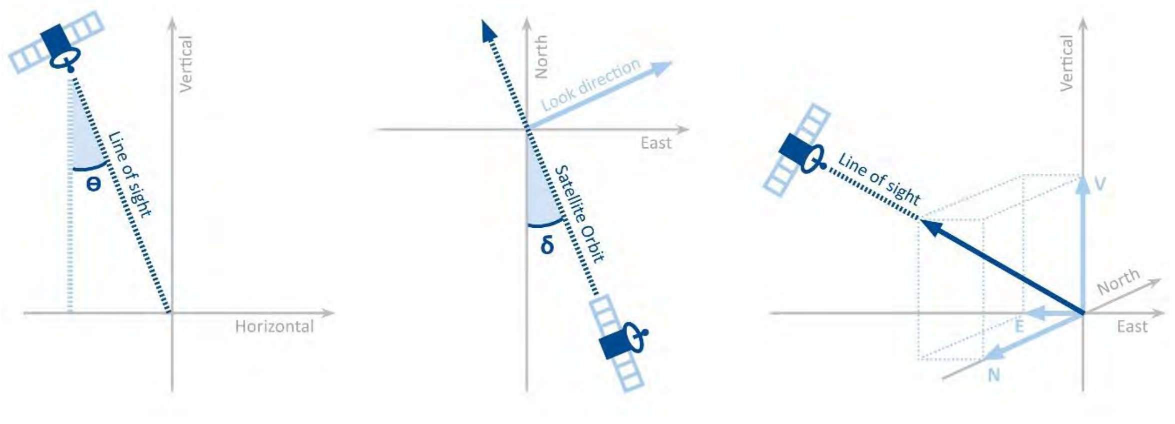


Figure 16: Geometry of the image acquisitions along the ascending orbit.

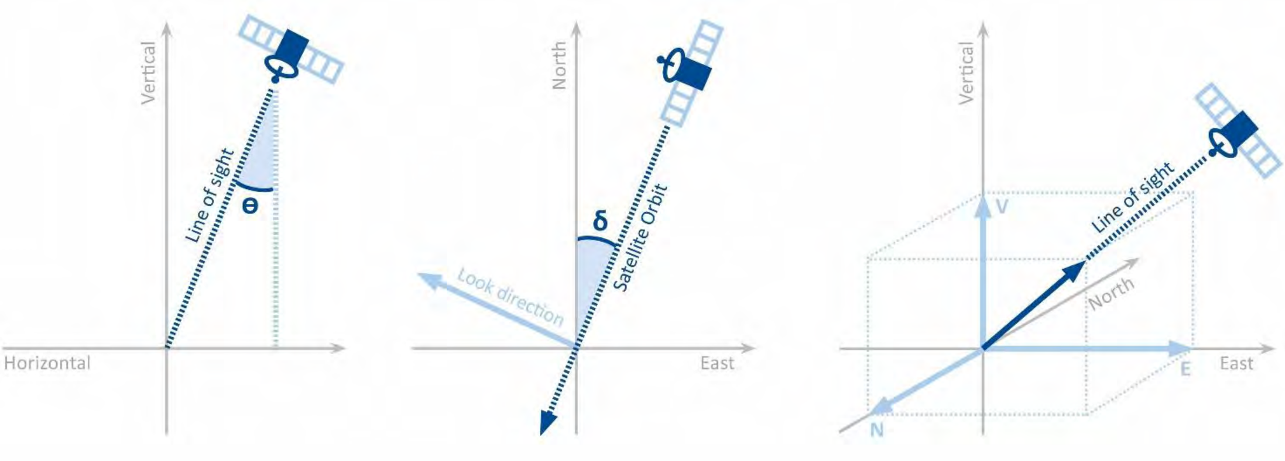


Figure 17: Geometry of the image acquisitions along the descending orbit.

Table 6 lists all the radar images used for the data processing.

Table 6: Radar images acquired over the site by the Sentinel satellite.

SENTINEL Ascending			SENTINEL Descending		
Count	**Image Date**	**Frequency**	**Count**	**Image Date**	**Frequency**
1	13-03-2015		1	31-12-2014	
2	25-03-2015	12	2	01-03-2015	60
3	06-04-2015	12	3	25-03-2015	24
4	18-04-2015	12	4	18-04-2015	24
5	24-05-2015	36	5	12-05-2015	24
6	05-06-2015	12	6	05-06-2015	24
7	17-06-2015	12	7	29-06-2015	24
8	11-07-2015	24	8	23-07-2015	24
9	23-07-2015	12	9	16-08-2015	24
10	16-08-2015	24	10	09-09-2015	24
11	28-08-2015	12	11	03-10-2015	24
12	09-09-2015	12	12	27-10-2015	24
13	21-09-2015	12	13	20-11-2015	24
14	03-10-2015	12	14	02-12-2015	12
15	27-10-2015	24	15	14-12-2015	12
16	19-01-2016	84	16	26-12-2015	12
17	12-02-2016	24	17	07-01-2016	12
18	19-03-2016	36	18	19-01-2016	12
19	12-04-2016	24	19	31-01-2016	12

SENTINEL Ascending			SENTINEL Descending		
Count	**Image Date**	**Frequency**	**Count**	**Image Date**	**Frequency**
20	24-04-2016	12	20	12-02-2016	12
21	06-05-2016	12	21	24-02-2016	12
22	18-05-2016	12	22	07-03-2016	12
23	30-05-2016	12	23	19-03-2016	12
24	11-06-2016	12	24	31-03-2016	12
25	05-07-2016	24	25	12-04-2016	12
26	17-07-2016	12	26	24-04-2016	12
27	29-07-2016	12	27	06-05-2016	12
28	10-08-2016	12	28	18-05-2016	12
29	22-08-2016	12	29	30-05-2016	12
30	03-09-2016	12	30	11-06-2016	12
31	27-09-2016	24	31	05-07-2016	24
32	03-10-2016	6	32	29-07-2016	24
33	21-10-2016	18	33	10-08-2016	12
34	27-10-2016	6	34	22-08-2016	12
35	14-11-2016	18	35	03-09-2016	12
36	20-11-2016	6	36	15-09-2016	12
37	08-12-2016	18	37	27-09-2016	12
38	14-12-2016	6	38	09-10-2016	12
39	20-12-2016	6	39	21-10-2016	12
40	26-12-2016	6	40	02-11-2016	12
41	01-01-2017	6	41	14-11-2016	12
42	07-01-2017	6	42	26-11-2016	12
43	13-01-2017	6	43	08-12-2016	12
44	19-01-2017	6	44	20-12-2016	12
45	25-01-2017	6	45	01-01-2017	12
46	31-01-2017	6	46	13-01-2017	12
47	06-02-2017	6	47	19-01-2017	6
48	24-02-2017	18	48	25-01-2017	6
49	08-03-2017	12	49	06-02-2017	12
50	20-03-2017	12	50	18-02-2017	12
51	01-04-2017	12	51	02-03-2017	12
52	13-04-2017	12	52	26-03-2017	24
53	25-04-2017	12	53	07-04-2017	12
54	07-05-2017	12	54	19-04-2017	12
55	19-05-2017	12	55	01-05-2017	12
56	31-05-2017	12	56	13-05-2017	12

SENTINEL Ascending			SENTINEL Descending		
Count	**Image Date**	**Frequency**	**Count**	**Image Date**	**Frequency**
57	12-06-2017	12	57	25-05-2017	12
58	24-06-2017	12	58	06-06-2017	12
59	06-07-2017	12	59	18-06-2017	12
60	18-07-2017	12	60	30-06-2017	12
61	30-07-2017	12	61	12-07-2017	12
62	11-08-2017	12	62	24-07-2017	12
63	23-08-2017	12	63	05-08-2017	12
64	04-09-2017	12	64	17-08-2017	12
65	16-09-2017	12	65	10-09-2017	24
66	28-09-2017	12	66	04-10-2017	24
67	10-10-2017	12	67	16-10-2017	12
68	22-10-2017	12	68	28-10-2017	12
69	03-11-2017	12	69	09-11-2017	12
70	15-11-2017	12	70	21-11-2017	12
71	27-11-2017	12	71	03-12-2017	12
72	09-12-2017	12	72	15-12-2017	12
73	02-01-2018	24	73	27-12-2017	12
74	07-02-2018	36	74	08-01-2018	12
75	03-03-2018	24	75	20-01-2018	12
76	15-03-2018	12	76	01-02-2018	12
77	07-06-2018	84	77	13-02-2018	12
78	01-07-2018	24	78	25-02-2018	12
79	13-07-2018	12	79	21-03-2018	24
80	06-08-2018	24	80	02-04-2018	12
81	17-10-2018	72	81	14-04-2018	12
82	22-11-2018	36	82	26-04-2018	12
83	03-01-2019	42	83	08-05-2018	12
84	09-01-2019	6	84	20-05-2018	12
85	15-01-2019	6	85	01-06-2018	12
86	21-01-2019	6	86	13-06-2018	12
87	08-02-2019	18	87	25-06-2018	12
88	14-02-2019	6	88	07-07-2018	12
89	26-02-2019	12	89	19-07-2018	12
90	04-03-2019	6	90	31-07-2018	12
91	10-03-2019	6	91	12-08-2018	12
92	16-03-2019	6	92	24-08-2018	12
93	22-03-2019	6	93	05-09-2018	12

SENTINEL Ascending			SENTINEL Descending		
Count	Image Date	Frequency	Count	Image Date	Frequency
94	28-03-2019	6	94	17-09-2018	12
95	03-04-2019	6	95	29-09-2018	12
96	09-04-2019	6	96	11-10-2018	12
97	15-04-2019	6	97	23-10-2018	12
98	21-04-2019	6	98	04-11-2018	12
99	27-04-2019	6	99	16-11-2018	12
100	09-05-2019	12	100	28-11-2018	12
101	15-05-2019	6	101	10-12-2018	12
102	21-05-2019	6	102	22-12-2018	12
103	27-05-2019	6	103	03-01-2019	12
104	02-06-2019	6	104	15-01-2019	12
105	08-06-2019	6	105	27-01-2019	12
106	14-06-2019	6	106	08-02-2019	12
107	20-06-2019	6	107	20-02-2019	12
108	26-06-2019	6	108	04-03-2019	12
109	02-07-2019	6	109	16-03-2019	12
110	08-07-2019	6	110	28-03-2019	12
111	14-07-2019	6	111	09-04-2019	12
112	20-07-2019	6	112	21-04-2019	12
113	26-07-2019	6	113	03-05-2019	12
114	01-08-2019	6	114	15-05-2019	12
115	07-08-2019	6	115	27-05-2019	12
116	13-08-2019	6	116	08-06-2019	12
117	19-08-2019	6	117	20-06-2019	12
118	25-08-2019	6	118	02-07-2019	12
119	31-08-2019	6	119	14-07-2019	12
120	12-09-2019	12	120	26-07-2019	12
121	24-09-2019	12	121	07-08-2019	12
			122	13-08-2019	6
			123	19-08-2019	6
			124	25-08-2019	6
			125	31-08-2019	6
			126	06-09-2019	6
			127	12-09-2019	6
			128	18-09-2019	6
			129	24-09-2019	6
			130	30-09-2019	6

Appendix 3: Calibration Methodology

The **calibration methodology** applied to Livermore consists of the following steps (Figure 18):

1. Data collection: InSAR LOS measurements and GNSS measurements are collected independently.
2. Time series filtering:
    a) To reduce the noise of GNSS measurements, the daily time series are filtered using a 30-day moving average (15 days prior and 15 days following any given date). The filtered GNSS 3-D measurements are then projected to the satellite 1-D LOS to create a GNSS LOS time series (LTS). This step allows a direct comparison of the two independent measurements (measurement direction correspondence).

    b) All InSAR measurement points (MP) within a 100 meter radius of each GNSS are selected and used to calculate an average time series (ATS) for the period of overlap with the GNSS time series (one ATS for each GNSS). This step allows the comparison of data collected at a same location over a corresponding period of time (spatial and temporal correspondence).
3. Plane removal: to remove possible linear errors related to potential satellite orbital inaccuracies, a difference in average velocity (linear trend) is calculated for each ATS and corresponding LTS. The differences calculated for each ATS and LTS pair are then used to estimate and remove a first order surface (plane) from the InSAR data. The time series of each InSAR MP are now corrected from any possible linear trend related to orbital inaccuracies.
4. Absolute calibration: to tie the two measurement techniques together and convert the relative InSAR measurements to the absolute reference of the GNSS network, it is necessary to calibrate the InSAR time series. The procedure involves the generation of a time series of residuals by comparing the ATS to the corresponding LTS for each GNSS location. All the time series of residuals are then averaged to define a common time series of residuals (cRTS). This cRTS represents the movement of the local InSAR reference points with respect to the absolute GNSS reference frame. The cRTS is then removed from every InSAR MP time series.

5. Absolute Vertical InSAR: The output of the absolute calibration is a LOS InSAR data set fixed to the same absolute reference system of the GNSS network. The calibration is performed separately for each orbit (ascending and descending) and the absolute LOS InSAR results will then be combined to produce the vertical and horizonal east/west deformation.

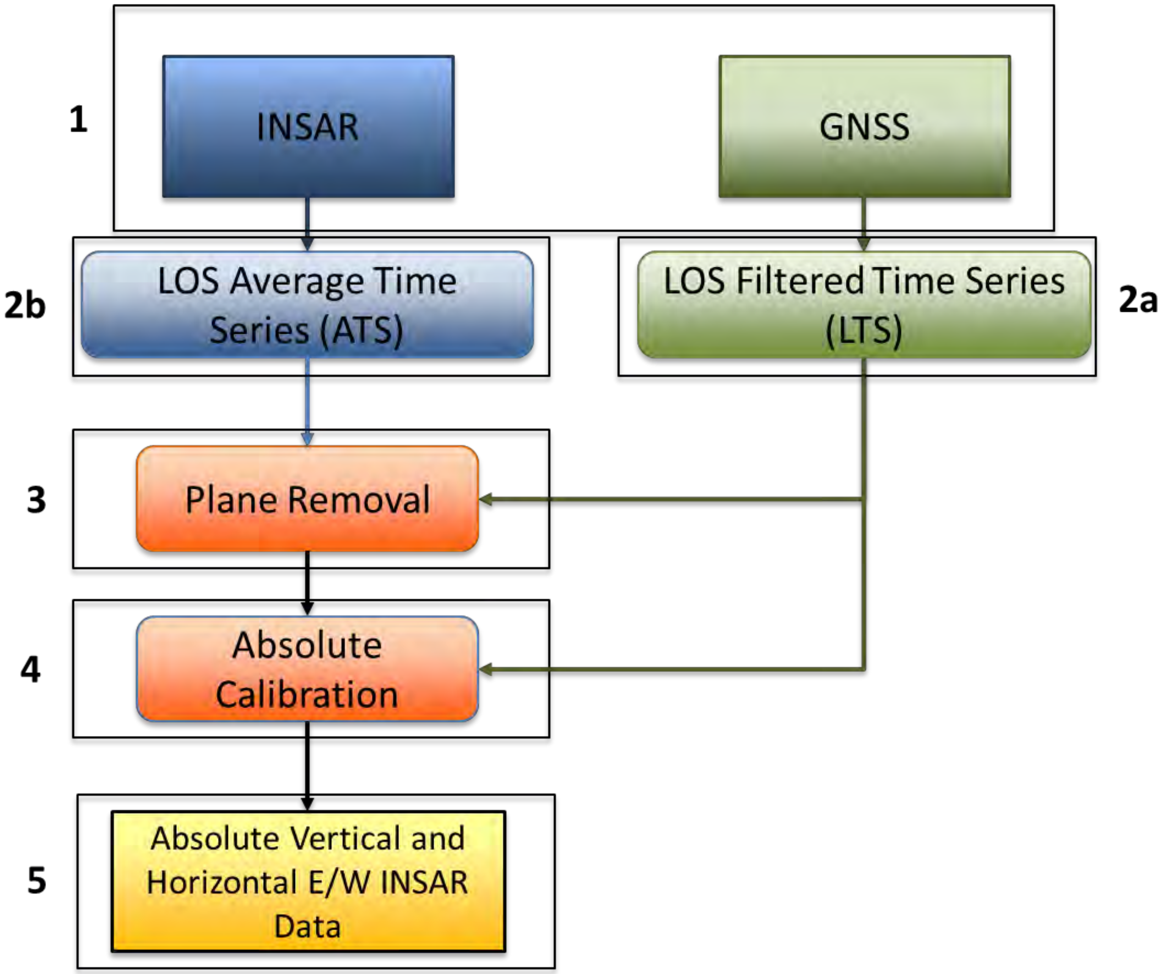


Figure 18: Diagram of the calibration methodology applied over the site.

9 Land Use

9.1 Program Description

9.1.1 Monitoring Network

This section presents the results of Zone 7's Land Use Monitoring Program for the 2019 WY. Zone 7 monitors land use changes in the Valley as part of the long-range groundwater basin management program. The Land Use Monitoring Program identifies significant changes in land use using aerial photography, site visits, and development referrals reviewed by Zone 7. The emphasis is on changes in pervious areas, and quantity and quality of irrigation water that could affect the volume or quality of water recharging the Main Basin. The information is used by Zone 7 to quantify areal recharge (i.e., "rainfall recharge" and "applied water recharge").

For more information on Zone 7's Land Use Monitoring Program, see the *Section 1.3.1, Land Use*, of the Alternative GSP.

9.1.2 Program Changes for the Water Year

There were no changes to the Land Use Monitoring Program during the 2019 WY.

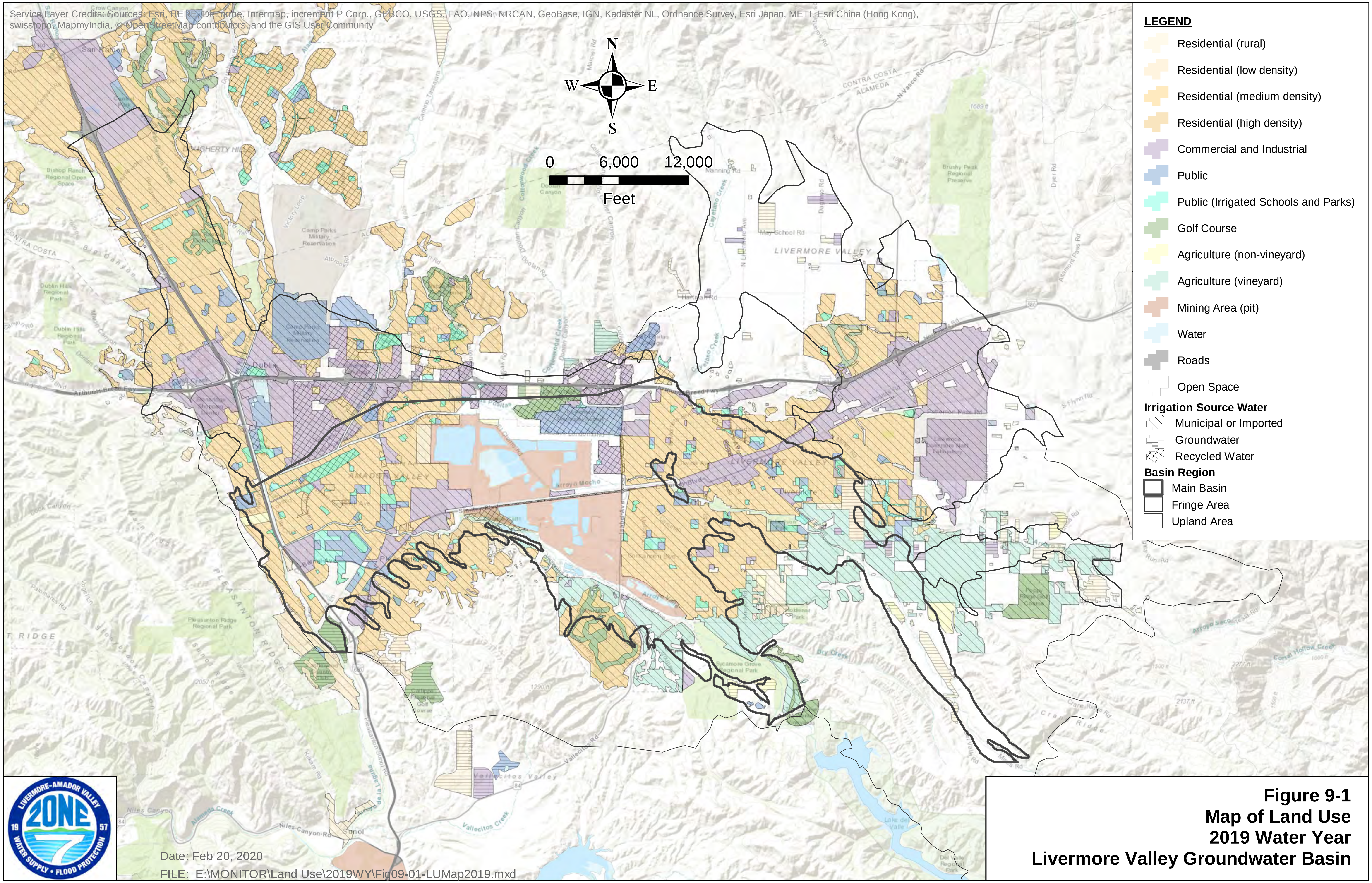
9.2 Results for the 2019 Water Year

Although there was some in-fill development that occurred during the 2019 WY, no major land use changes that would significantly affect the groundwater supply or groundwater quality were identified by Zone 7's land use review efforts. *Figure 9-1* shows the various land use areas in the Livermore Valley Groundwater Basin, and their main source of irrigation water, as understood by Zone 7. *Table 9-1* lists the acreage of each type of the land use type by Groundwater Management Area and main irrigation water type: i.e., delivered water, groundwater, or recycled water.

TABLE 9-1
LAND USE ACREAGE (in acres)
2019 WATER YEAR
LIVERMORE VALLEY GROUNDWATER BASIN

Basin	Main Basin					Fringe Basin					Upland Basin				
Category *Irrigation Water Source*	**DW**	**GW**	**RW**	**none**	**Total**	**DW**	**GW**	**RW**	**none**	**Total**	**DW**	**GW**	**RW**	**none**	**Total**
Agriculture (non-vineyard)	56	94	0	0	150	0	28	0	0	28	146	47	0	0	193
Agriculture (vineyard)	1,497	19	0	0	1,516	708	0	0	0	708	1,840	1	0	0	1,841
Total Agricultural	***1,552***	***113***	***0***	***0***	***1,666***	***708***	***28***	***0***	***0***	***735***	***1,986***	***48***	***0***	***0***	***2,033***
Commercial and Business	1,406	42	347	0	1,796	3,831	117	1,190	0	5,138	387	15	28	0	430
Public	563	0	399	0	961	886	3	57	0	946	143	0	88	0	232
Public (Irrigated Park)	563	0	118	0	680	164	0	87	0	251	97	0	11	0	108
Residential (high density)	421	0	0	0	421	261	0	158	0	419	28	0	15	0	43
Residential (medium density)	6,437	0	17	0	6,454	5,367	0	33	0	5,399	2,863	0	49	0	2,912
Residential (low density)	165	150	0	0	315	20	0	0	0	20	250	173	0	0	423
Roads	0	0	0	78	78	0	0	0	703	703	0	0	0	93	93
Total Urban	***9,555***	***192***	***880***	***78***	***10,705***	***10,527***	***120***	***1,526***	***703***	***12,876***	***3,768***	***188***	***192***	***93***	***4,241***
Golf Course	140	90	128	0	357	230	15	66	0	311	466	172	0	0	638
Residential (rural)	43	155	0	0	198	13	373	0	0	386	166	147	0	0	314
Mining Area (pit)	0	0	0	2,038	2,038	0	0	0	0	0	0	0	0	0	0
Open Space	0	0	0	3,811	3,811	0	0	0	7,583	7,583	0	0	0	20,384	20,384
Water	0	0	0	1,035	1,035	0	0	0	65	65	0	0	0	170	170
Total Other	***182***	***245***	***128***	***6,884***	***7,439***	***243***	***389***	***66***	***7,648***	***8,345***	***632***	***319***	***0***	***20,553***	***21,505***
TOTALS FOR 2019 WY	**11,290**	**550**	**1,008**	**6,961**	**19,809**	**11,477**	**536**	**1,592**	**8,350**	**21,955**	**6,385**	**555**	**192**	**20,647**	**27,779**
TOTALS FOR 2018 WY	**11,274**	**550**	**1,008**	**6,977**	**19,809**	**11,468**	**536**	**1,576**	**8,376**	**21,956**	**6,382**	**553**	**192**	**20,651**	**27,778**
CHANGE SINCE PREVIOUS YEAR	**15**	**0**	**0**	**-15**	**0**	**9**	**0**	**16**	**-26**	**0**	**3**	**2**	**0**	**-5**	**0**

Irrigation Water Sources
DW = Delivered Municipal Water
GW = Groundwater
RW = Recycled Water



Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Date: Feb 20, 2020

FILE: E:\MONITOR\Land Use\2019WY\Fig09-01-LUMap2019.mxd

Figure 9-1
Map of Land Use
2019 Water Year
Livermore Valley Groundwater Basin

10 Wastewater and Recycled Water

10.1 Program Description

10.1.1 Monitoring Network

The City of Livermore and the DSRSD are currently responsible for treating the vast majority of wastewater produced within the Valley. Both of these publicly-owned treatment works (POTWs) produce secondary-treated and tertiary-treated effluent, which is disinfected and either reclaimed and used for landscape irrigation or exported from the Valley through the Livermore-Amador Valley Water Management Agency (LAVWMA) export pipeline.

Beginning in the 2017 WY and continuing through the 2019 WY, City of Pleasanton used recycled water produced by Livermore and DSRSD for landscape irrigation in the City of Pleasanton. Pleasanton's usage is included in the Livermore Water Reclamation Plant (LWRP) and DSRSD recycled water totals reported in this report.

Elsewhere in the Basin, a minor amount of untreated or partially-treated wastewater may reach the groundwater supply as percolate. The sources of this unmanaged supply component include the Veterans Administration (VA) Hospital onsite sewage treatment plant, residential and commercial septic systems located over the entire groundwater basin, and leaking municipal sewer lines throughout the cities. This report attempts to quantify (estimate) these minor water supply components, as they often have some significance for the computed Main Basin's salt and nutrient loading (*Sections 13.4* and *13.5*).

For more information on Zone 7's Wastewater and Recycled Water Monitoring Program, see the *Section 4.8, Wastewater and Recycled Water Monitoring*, of the Alternative GSP.

10.1.2 Program Changes for the Water Year

There were no changes to the Wastewater and Recycled Water Monitoring Program during the 2019 WY.

10.2 Results for the 2019 Water Year

10.2.1 Wastewater and Recycled Water Volumes

In the 2019 WY, about 97% of the wastewater produced over the groundwater basin was treated at LWRP and DSRSD. A total of 18,041 AF of municipal wastewater was treated at the two POTWs, of which 11,963 AF (66%) was exported and about 6,185 (34%) was recycled and used primarily for landscape irrigation (38% in the 2018 WY). About 26% of the LWRP's recycled water (505 AF) and 9% of DSRSD's recycled water (370 AF) was applied to landscapes over the Main Basin (including City of Pleasanton's applications). The remaining recycled water was applied on areas outside of the Main Basin; primarily on areas overlying the Northern Fringe Subarea and the Tassajara Uplands (*Figure 10-1*). A summary of the wastewater volumes for the 2019 WY are presented in *Table 10-A* below.

Table 10-A: Municipal Wastewater and Recycled Water Volumes (AF) for the 2019 Water Year

Water Type	LWRP	DSRSD	Total
Wastewater Influent	6,356	11,685	18,041
Treated Effluent Exported via LAVWMA*	4,833	7,130	11,963
Total Volume Recycled	1,962	4,223	6,185
RW Applied to Main Basin**	505	370	875

*	Does not include Zone 7 Demin Plant discharge to LAVWMA via DSRSD
**	Only portion recycled water applied over the Main Basin as landscape irrigation.
DSRSD	Dublin San Ramon Services District
LAVWMA	Livermore-Amador Valley Water Management Agency
LWRP	Livermore Wastewater Reclamation Plant
RW	Recycled Water

Recycled water continues to account for small fractions of the Valley's water supply (15%) and Main Basin recharging waters (approximately 2%); however, of greater benefit, the recycled water use in the 2019 WY potentially conserved up to 6,185 AF of water that might have otherwise come from groundwater storage.

The program also assumes that a small amount of untreated wastewater leaches to the Main Basin from the VA Hospital wastewater treatment ponds located in southern Livermore, domestic onsite wastewater treatment systems (OWTS) (e.g., septic systems), and leaking wastewater pipelines that run throughout the groundwater basin. There have been no significant changes in land use or septic system densities over the Main Basin that would change the estimated water contribution from these sources in recent years. The pipeline age is considered in the estimation of "Pipe Leakage." The estimated volumes of leachate from these three sources for the 2019 WY are presented in *Table 10-B* below.

Table 10-B: Other Wastewater Volumes (AF) for the 2019 Water Year

	VA Hospital*	Septic Tanks*	Pipe Leakage**	Total
Wastewater Leachate	50	80	522	652

*	Estimated total over the Main Basin, based on size and number of OWTS
**	Calculated. Includes leakage from sanitary sewer and recycled water pipes
AF	acre-feet
OWTS	Onsite Wastewater Treatment System

10.2.2 Wastewater and Recycled Water Quality

The recycled water from both wastewater plants met the DDW's "Title 22" water quality standards for irrigation uses during the 2019 WY. While salt (*Section 10.2.2.1*, below) and nutrients (specifically nitrate, see *Section 10.2.2.2*) are the primary constituents of concern for wastewater and recycled water applied over the Main Basin, other constituents of emerging concern (CECs) would need to be considered if recycled water is used for future aquifer recharge projects.

10.2.2.1 Salt Loading

Table 10-C below presents the estimated salt loading over the Main Basin from applied wastewater and recycled water during the 2019 WY.

Table 10-C: Salt Loading from Applied Recycled Water and Wastewater for 2019 WY

Source	**Volume (AF)**	**TDS Average (mg/L)**	**Salt Applied (tons)**
LWRP RW	505	578	396
DSRSD RW	370	726	365
Total RW	*875*	*640*	*761*
VA Hospital	50	0	0
Septic	80	600	65
Pipe Leakage	522	467	331
Total WW	*652*	*447*	*396*
Total	***1,527***	***606***	***1,158***

DSRSD	Dublin San Ramon Services District
LWRP	Livermore Wastewater Reclamation Plant
RW	Recycled Water
WW	Wastewater

Zone 7 assumes that the entire salt mass in the applied water is transported through the vadose zone, surficial clays, if any, and eventually reaches groundwater. This leads to a conservative (potentially high) estimate of the salt loading attributed to recycled water applications. About 753 tons (approximately 6%) of the Main Basin's salt inflow (12,928 tons) was attributed to recycled water use over the Main Basin during the 2019 WY (see *Table 13-B*). However, if potable water supplies would have been used for this irrigation demand, the salt loading would have been about 379 tons or only about 378 tons less. This difference is significantly less than the 1,873 tons that were removed by Zone 7's Mocho Groundwater Demineralization Plant (MGDP) in the 2019 WY (see *Table 13-C*).

10.2.2.2 Nitrogen Loading

Table 10-D below presents the estimated nitrogen loading over the Main Basin from applied wastewater and recycled water during the 2019 WY.

Table 10-D: Nitrogen Loading from Applied Recycled Water and Wastewater for the 2019 WY

Source	Volume (AF)	Nitrogen Compounds (mg/L) NO3(N)	NO2(N)	TKN	Nitrogen Applied (lbs)
LWRP RW	505	0.1	0.4	47.8	65,822
DSRSD RW	370	2.6	3.2	24.5	26,234
Total RW	*875*	*1.2*	*1.6*	*37.9*	*92,055*
VA Hospital	50	9.7	0.2	4.3	890
Septic	80	35.0	0.0	0.0	1,719
Pipe Leakage	522	0.6	0.7	17.5	25,333
Total WW	*652*	*5.5*	*0.6*	*14.3*	*27,942*
Total	***1,527***	***3.0***	***1.2***	***27.9***	***119,997***

DSRSD	Dublin San Ramon Services District	NO3(N)	Nitrate as Nitrogen
LWRP	Livermore Wastewater Reclamation Plant	NO2(N)	Nitrite as Nitrogen
RW	Recycled Water	TKN	Total Kejldahl Nitrogen
WW	Wastewater	lbs	pounds

The three nitrogen compounds in *Table 10-D* above represent the nitrogen content potentially available for conversion to nitrate as the water percolates through the soil. The table shows that about 120,000 pounds of nitrogen was applied over the Main Basin during the 2019 WY. However, from a practical standpoint, much of the nitrogen will be removed from the percolate through soil denitrification and plant uptake processes.

Starting in about the 2017 WY, Concannon Winery ceased discharging their domestic waste onsite, and began hauling it offsite for disposal at a licensed POTW. In 2018-2019, Concannon received approval from the City of Livermore to discharge their sanitary waste directly into the Livermore municipal sanitary sewer system. This has reduced the nitrogen loading on the groundwater basin by an estimated 165 pounds of nitrogen per year (*Kennedy/Jenks Consultants, 2012*). The winery continues to discharge their wastewaters from their winemaking and bottling processes along with their stormwater to land within their property, following the requirements and limitations set forth in their Waste Discharge Requirement (WDR) permit issued by the San Francisco Bay RWQCB.

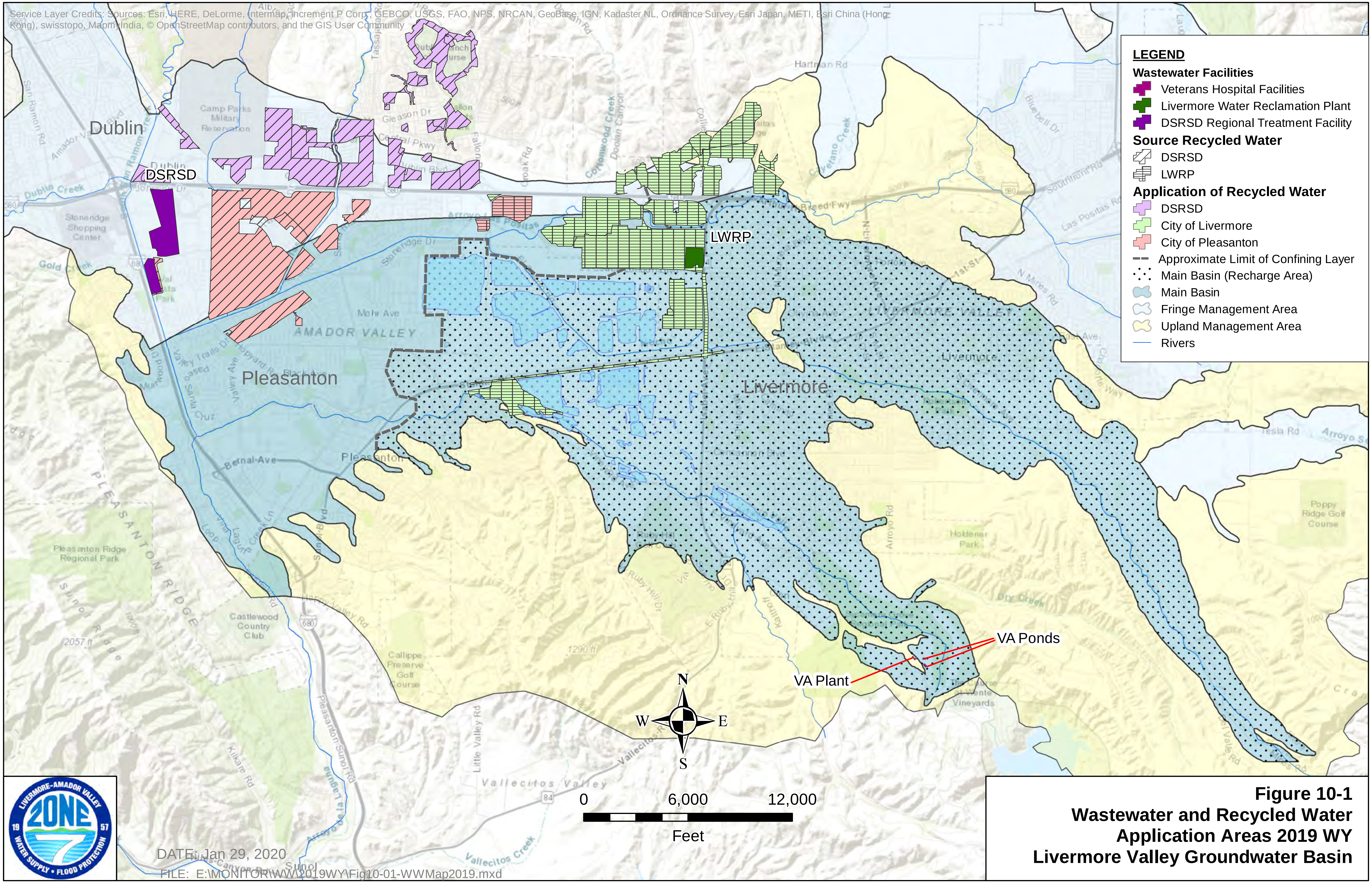


Figure 10-1
Wastewater and Recycled Water Application Areas 2019 WY
Livermore Valley Groundwater Basin

DATE: Jan 29, 2020

FILE: E:\MONITOR\WW\2019WY\Fig10-01-WWMap2019.mxd

11 Groundwater Storage

11.1 Groundwater Storage Calculations

11.1.1 Groundwater Storage Threshold

To avoid significant depletion of groundwater storage, Zone 7 operates the Livermore Basin such that groundwater in storage remains between a full basin volume (254 thousand acre-feet [TAF]) and the historic low storage of 128 TAF, or about one half of total storage volume. This 126 TAF (254 TAF – 128 TAF) is considered the Operational Storage. Groundwater below this minimum threshold is regarded as Reserve Storage that is unavailable during nonemergency conditions. Most of the groundwater in storage is contained in the Main Basin, which is characterized by the largest saturated thickness.

11.1.2 Calculation Methods

Zone 7 uses two methods for calculating groundwater storage in the Main Basin: The Groundwater Elevation (GWE) Method and the Hydrologic Inventory (HI) Method. The GWE method (*Section 11.1.3*) uses groundwater level data and storage coefficients for "nodes" (originally developed by DWR in 1974) to estimate the total volume of water in the Main Basin (see *Sections 2.2.3.4, Representation of Aquifers and Aquitards in Groundwater Models*, and *2.4.1, Overview of Methodology*, in the Alternative GSP). The HI method (*Section 11.1.4*) involves accounting for inflows and outflows for each water year and adds the net change in storage to the previous year's volume (see *Sections 2.4.2, Current Groundwater Budget*, and *2.4.3, Historical Groundwater Budget*, in the Alternative GSP). Storage volumes from the two methods are averaged to quantify the total storage of the Main Basin (*Section 11.1.5*. See *Section 2.4.1, Overview of Methodology*, of the Alternative GSP for more details).

11.1.3 Groundwater Elevation Results

The GWE method yielded a total storage of 248.6 TAF at the end of 2019 WY, which is 3.9 TAF more than the GWE value calculated for the 2018 WY. *Figure 11-1* shows the Upper and Lower Aquifer groundwater elevations used to calculate the GWE method storage for the 2019 WY. The change in storage from fall 2018 to fall 2019 for each Main Basin node is shown in *Figure 11-2*. *Table 11-1* shows the historical annual GWE groundwater storage volumes for each subarea from the 1974 WY to 2019 WY.

11.1.4 Hydrologic Inventory Results

The HI method produced a total storage value of 255.0 TAF for the end of 2019 WY, which is about 4.4 TAF more than the end of 2018 WY HI value. The results of the HI method for the 2019 WY are summarized below in *Table 11-A*. All of the HI components are listed in *Table 11-2* along with their method of measurement and their approximate accuracy. The historic HI components and results for water years 1974 to 2019 are tabulated in *Table 11-3,* and charted in *Figure 11-3* along with the water year type (e.g., wet, normal, dry, etc.) noted for each year. *Figure 11-4* shows a map of the pumping well locations during the 2019 WY, and a representation of the relative volumes of water pumped from each well.

Table 11-A: HI Method Groundwater Storage Supply and Demand Volumes, 2019 WY (AF)

CATEGORY	Sustainable Avg	2019	% of Avg	Change from 2018
SUPPLIES	19,800	23,625	119%	6,461
Stream Recharge Artificial	5,300	2,943	56%	-3,830
Stream Recharge Natural	6,600	7,662	116%	4,875
Rainfall Recharge	4,300	8,588	200%	5,368
Applied Water Recharge	1,600	2,286	143%	-64
Pipe Leakage	1,000	1,146	115%	111
Subsurface Inflow	1,000	1,000	100%	0
DEMANDS	18,800	19,177	102%	2,299
Zone 7 Pumping excluding DSRSD	5,300	8,021	151%	3,806
Other Pumping	8,400	6,614	79%	-1,137
Agricultural Pumping	400	113	28%	0
Mining Losses	1,400	700	50%	0
Evapotranspiration	3,200	2,920	91%	-615
Subsurface Outflow	100	809	809%	245
NET CHANGE (SUPPLY - DEMAND)	1,000	4,447		4,162
TOTAL STORAGE (HI Method)		254,996		4,447

AF = acre-feet
Avg = average
DSRSD = Dublin San Ramon Services District

11.1.5 Total Storage

The total groundwater storage for the Main Basin is computed by averaging the storage estimates from the GWE and HI methods (*Table 11-B)*. As a result, the total groundwater in storage at the end of 2019 WY was calculated to be 251.8 TAF, with 123.8 TAF of groundwater available as operational storage, which is about 98% of the total operational storage capacity (i.e., 126 TAF from 1983 WY).

Table 11-B: Groundwater Storage Summary, 2019 WY (in Thousand AF)

Storage Calculation Method	End of 2018 WY	End of 2019 WY	Change in Storage
Groundwater Elevations (GWE)	244.7	248.6	3.9
Hydrologic Inventory (HI)	250.5	255.0	4.5
Total Storage (average of GWE & HI)	247.6	251.8	4.2
Operational Storage*	119.6	123.8	4.2

* Operational Storage = Total Storage - Reserve Storage (i.e., 128 TAF)

11.2 Groundwater Budget

11.2.1 Budget Categories

Groundwater inflows and outflows in the Main Basin are budgeted in two categories.

- Natural Recharge and Demand—groundwater not managed or pumped by Zone 7
- Artificial Recharge and Zone 7 Pumping—groundwater managed and pumped by Zone 7 (i.e., “Conjunctive Use”)

Annual recharge and demand for both the natural and artificial components, from the 1974 WY to the 2019 WY, are charted in *Figure 11-5*. The figure also shows the cumulative groundwater storage relative to the 1974 WY storage value, which supports the notion that that groundwater storage has been managed sustainably over the last 45 years.

11.2.2 Natural Recharge and Demand

In 1992, Zone 7 estimated that the long-term average “natural” groundwater inflow into the Main Basin is about 13,400 AF annually (*Zone 7, 1992*). This long-term average (shown as the “sustainable values” in the tables below) was primarily based on average local precipitation and natural recharge over a century of hydrologic records; however, the actual amount of natural recharge varies from year to year depending on the amount of local precipitation during the year. Recharge from irrigation (applied water) is also included in the “natural” inflow total, because of its steady, sustainable, contribution to groundwater recharge in the Basin.

The “natural” groundwater demand (outflow), which includes groundwater pumping (other than Zone 7’s), evapotransporation (ETo), mining losses, and groundwater basin overflow is allocated to the “natural” inflow. As a routine, Zone 7 monitors each “natural” demand component and checks whether it is within the projected sustainable average range. *Table 11-C* below summarizes the results for the 2019 WY.

Table 11-C: Natural Groundwater Inflow and Demand, 2019 WY

Component	Estimated Sustainable Values (AF/Yr)	2019 WY (AF)	Percentage of Sustainable Average
Natural Recharge	13,400	18,727	140%
Natural Demand	13,400	10,348	77%
Net Natural Recharge	0	8,379	63%*

AF = acre-feet
AF/Yr = acre-feet per year
* = percent of Sustainable Natural Recharge

Just over half (7,214 AF) of the "natural" demand (13,400 AF) comes from groundwater pumped by Zone 7's retailers. The retailers are permitted by contract to pump a Groundwater Pumping Quota (GPQ) (accounted for on a calendar year [CY] basis) without having to pay a replenishment fee to Zone 7. They are allowed to carry forward any un-pumped GPQ (up to 20% of their GPQ). The retailer's GPQ, along with their groundwater pumping volumes for the 2019 CY, are shown in *Table 11-D* below. None of the retailers pumped more than their respective GPQ in 2019 WY.

Table 11-D: Retailer Groundwater Pumping and Quotas in 2019 Calendar Year (AF)

Retailer	GPQ	Carryover from 2018	Pumped in 2019	Carryover to 2020**
City of Pleasanton	3,500	3	3,496	7
Cal Water Service	3,069	614	996	614
DSRSD (pumped by Zone 7)	645	0	645	0
City of Livermore (not used)*	31	-	0	-
Total	7,214	623.2	5,137	627.2

AF = Acre-feet
GPQ = Groundwater Pumping Quota
* = City of Livermore no longer pumps groundwater, GPQ not included in totals or carryover.
** = Maximum of 20% of GPQ can be carried over

11.2.3 Artificial Recharge and Demand—Conjunctive Use

Since the 1960s, Zone 7 has actively embraced a "conjunctive use" approach to basin management by integrating local and imported surface water supplies with the local conveyance, storage, and groundwater recharge features. These features include local arroyos (which are also used as flood protection facilities during wet seasons) and two former quarry pits (Lake I and Cope Lake). Zone 7's "artificial recharge" operation involves releasing imported water supplies into the "losing stream" local arroyos to recharge the groundwater basin. The volume of artificial recharge is dependent on Zone 7's annual SWP allocations, precipitation captured locally, and water supply operations plans. Typically, Zone 7 will commence artificial recharge operations during times of surplus imported water availability.

While groundwater pumping by the retailers is accounted for in the "natural" budget (see above), Zone 7's groundwater pumping and artificial recharge volumes are accounted for in the "conjunctive use" budget. Zone 7's annual groundwater production and artificial recharge operations vary with the availability of surface water, treatment plant capacity, and the available groundwater storage space.

Table 11-E below shows the artificial recharge and Zone 7's groundwater pumping totals for the 2019 WY. Since 1974, Zone 7 has artificially recharged 74,326 AF more than it has pumped (*Figure 11-6)*. These totals do not include the water Zone 7 pumps for DSRSD (usually 645 AF/yr), which is considered part of the "natural" demand.

Table 11-E: Conjunctive Use Supply and Demand, 2019 WY

Component	Estimated Sustainable Avg (AF/Yr)	2019 WY (AF)	Percentage of Sustainable Average
Artificial Recharge	5,300	2,943	56%
Zone 7 Pumping	5,300	8,021	151%
Net Artificial Recharge	0	-5,078	-96%*

AF = acre-feet
AF/Yr = acre-feet per year
Avg = average
* = percent of Sustainable Artificial Recharge

TABLE 11-1
TOTAL MAIN BASIN STORAGE BY SUBAREA (AF)
GROUNDWATER ELEVATION METHOD
1974 TO 2019 WATER YEARS

Water		Amador			
Year	Bernal	Amador West	Amador East	Mocho II	Total
1974	49,651	52,916	80,671	29,821	213,060
1975	51,149	54,220	80,840	28,872	215,080
1976	54,180	56,319	86,194	29,012	225,705
1977	51,970	53,968	81,889	27,954	215,782
1978	50,272	52,077	79,541	27,751	209,641
1979	52,863	56,739	89,122	29,210	227,933
1980	55,952	60,000	94,014	29,500	239,466
1981	57,910	61,890	95,688	30,224	245,712
1982	57,623	61,228	93,235	29,156	241,242
1983	58,654	63,488	100,642	31,492	254,277
1984	59,021	64,418	102,569	31,626	257,635
1985	58,487	64,024	95,703	31,568	249,782
1986	56,723	60,837	95,019	27,719	240,298
1987	55,723	58,635	91,170	25,147	230,675
1988	54,486	53,217	83,377	25,672	216,752
1989	52,754	51,260	82,836	27,433	214,282
1990	50,712	50,879	80,834	27,321	209,746
1991	44,627	49,348	76,543	24,631	195,148
1992	29,663	35,438	74,569	44,036	183,707
1993	29,749	38,787	83,668	58,498	210,702
1994	30,941	39,437	88,405	56,713	215,496
1995	32,193	43,156	89,255	60,834	225,438
1996	32,217	42,917	87,147	60,865	223,146
1997	32,240	41,992	88,781	59,157	222,171
1998	32,292	43,411	88,094	61,336	225,132
1999	32,065	43,310	86,462	60,595	222,432
2000	31,894	42,591	87,539	59,947	221,971
2001	30,720	40,853	73,347	58,231	203,151
2002	30,685	37,537	84,101	59,655	211,979
2003	30,597	41,563	87,464	60,749	220,372
2004	30,518	43,784	79,394	59,614	213,311
2005	31,969	48,734	93,624	61,720	236,047
2006	32,382	53,465	91,801	60,685	238,333
2007	32,401	54,368	90,431	54,733	231,934
2008	32,365	54,160	91,852	56,097	234,473
2009	32,350	51,088	91,709	57,605	232,752
2010	32,350	50,282	92,034	59,167	233,833
2011	32,353	50,631	92,683	59,214	234,881
2012	31,772	47,442	90,429	58,154	227,798
2013	30,892	44,226	87,040	58,684	220,843
2014	30,313	42,686	82,580	53,961	209,541
2015	31,714	46,575	81,338	53,952	213,579
2016	32,205	53,894	82,970	57,583	226,651
2017	32,391	67,727	86,073	59,564	245,755
2018	32,409	70,222	85,745	56,347	244,724
2019	32,410	70,271	84,985	60,942	248,608

Calculated as one aquifer

Calculated as Upper and Lower Aquifers

TABLE 11-2
DESCRIPTION OF HYDROLOGIC INVENTORY COMPONENTS
LIVERMORE VALLEY GROUNDWATER BASIN

COMPONENTS	***DESCRIPTION/REMARK***	***Direct/ Indirect***	***HOW CALCULATED/MEASURED***	***ESTIMATED ACCURACY***
SUPPLY INDICES				
Rainfall	Pleasanton rainfall (Parkside Office)	Direct	Measured by Zone 7	0.5 in
Evaporation	Evaporation at Lake Del Valle Station	Direct	Collected by DWR	0.5 in
Streamflow	Arroyo Valle Streamflow if Lake Del Valle Dam did not exist	Direct	USGS Stream Gage Station AV_BLC	10 AF
Water Year Type	Indicator of Water Year in Sacramento Valley	Direct	DWR California Data Exchange Center	-
SUPPLY COMPONENTS				
NATURAL STREAM RECHARGE				
ARROYO VALLE	AV natural recharge.	Indirect	Stream Inflows - Stream Outflows	100 AF
ARROYO MOCHO	AM natural recharge.	Indirect	Stream Inflows - Stream Outflows	100 AF
ARROYO LAS POSITAS	ALP natural recharge.	Indirect	Stream Inflows - Stream Outflows	100 AF
ARTIFICIAL RECHARGE				
ARROYO VALLE	Total artificial recharge on Arroyo Valle minus AV_RC_PR	Indirect	Stream Inflows - Stream Outflows	100 AF
ARROYO VALLE PRIOR RIGHTS	AVBLC flow that would have recharged if no dam. Subset of AV_RC.	Indirect	Formula based on AVBLC flow.	100 AF
ARROYO MOCHO	Total artificial recharge on Arroyo Mocho	Indirect	Stream Inflows - Stream Outflows	100 AF
ARROYO LAS POSITAS	Total artificial recharge on Arroyo Las Positas	Indirect	Stream Inflows - Stream Outflows	100 AF
INJECTION WELL RECHARGE	Injection at Hop 6 from 1998 to 2000	Direct	Metered by Zone 7	10 AF
RAINFALL RECHARGE	Recharge from rainfall	Indirect	Calculated by Areal Recharge Model	1000 AF
PIPE LEAKAGE	Pipe leakage that recharges the GW basin	Indirect	Estimated using length and age of pipes	500 AF
APPLIED WATER RECHARGE				
URBAN MUNICIPAL (GW & SBA)	Applied recharge in urban area - delivered water (gw & sba)	Indirect	Calculated by Areal Recharge Model	100 AF
URBAN RECYCLED WATER	Applied water recharge from urban area - recycled water	Indirect	Calculated using Wastewater Plant deliveries	10 AF
AGRICULTURAL (SBA)	Total applied recharge from 'untreated' ag sources (untreated SBA)	Indirect	Calculated by Areal Recharge Model	100 AF
AGRICULTURAL (GW)	Total applied water recharge from groundwater ag sources	Indirect	Calculated by Areal Recharge Model	100 AF
GOLF COURSES (GW)	Applied water from golf courses on groundwater	Indirect	Calculated by Areal Recharge Model	100 AF
GOLF COURSES (RW)	Applied water from golf courses from recycled water	Indirect	Calculated using Wastewater Plant deliveries	10 AF
SUBSURFACE BASIN INFLOW	Subsurface Inflow from Northern Fringe Basin	Indirect	Estimated historically groundwater contours	500 AF
DEMAND COMPONENTS				
MUNICIPAL PUMPING				
ZONE 7	Total pumping by Zone 7, including pumping to waste	Direct	Metered by Zone 7	10 AF
DSRSD	*Pumping by Zone 7 for DSRSD.*	*Direct*	*DSRSD Groundwater Pumping Quota*	*0 AF*
PLEASANTON	Pumping by Pleasanton.	Direct	Metered by Pleasatnon	10 AF
CALIFORNIA WATER SERVICE	Pumping by CWS.	Direct	Metered by CWS	10 AF
SFPUC	Pumping by SF Public Utilities Commission	Direct	Metered by SFPUC	10 AF
FAIRGROUNDS	Pumping by Alameda County Fairgrounds	Indirect	Metered by Fairgrounds	10 AF
DOMESTIC	Pumping from active domestic, supply, and potable wells	Indirect	Estimated: Number of Wells x 0.5 AF/yr	50 AF
GOLF COURSES				
CASTLEWOOD GOLF COURSE	*Pumping for Castlewood Golf Course*	*Indirect*	*Estimated using historical meter data*	*50 AF*
TRI VALLEY GOLF CENTER	*Pumping for TriValley Golf Driving Range*	*Indirect*	*Calculated by Areal Recharge Model*	*50 AF*
AGRICULTURAL PUMPING	Unmetered pumping for agriculture	Indirect	Calculated by Areal Recharge Model	100 AF
MINING				
EXPORT	Total mining area releases that leave the basin	Indirect	Calculated from metered data and stream recharge rate	50 AF
EVAPORATION	Pond evaporation & rainfall.	Indirect	Calculated using lake area, evaporation, and rainfall	100 AF
PROCESSING	Mining Area processing losses	Indirect	Estimated at 700 AF/Yr	100 AF
SUBSURFACE BASIN OUTFLOW	Basin overflow leaving basin	Indirect	Formula based on GW elevation and synoptic data	100 AF

TABLE 11-3
HISTORICAL GROUNDWATER STORAGE
HYDROLOGIC INVENTORY (HI) METHOD
1974-2019 WATER YEARS (in Acre-Feet, except where indicated)

	WATER YEAR (Oct - Sep)																
COMPONENTS	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
INDICES																	
Rainfall at Livermore (in)	16.1	14.8	6.2	6.0	18.5	13.6	17.6	10.3	24.4	32.0	13.0	12.6	19.8	8.9	8.7	11.2	9.4
Evap at Lake Del Valle (in)	60.9	62.7	63.5	66.0	64.2	67.7	59.7	72.1	60.5	59.7	70.2	64.9	61.1	64.0	66.9	63.6	65.9
Arroyo Valle Stream flow (AF)	30538	28307	475	177	43749	9721	45800	5817	61427	125882	25653	7282	67903	3023	1506	1988	815
Water Year Type*	W	W	C	C	AN	BN	AN	D	W	W	W	D	W	D	C	D	C
SUPPLY	**18,140**	**21,437**	**11,121**	**8,683**	**24,813**	**22,213**	**23,830**	**18,821**	**29,942**	**35,412**	**15,547**	**8,784**	**20,866**	**6,670**	**8,071**	**11,170**	**10,353**
Injection Well Recharge	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Stream Recharge	**11,340**	**15,400**	**6,910**	**3,820**	**16,330**	**16,110**	**16,480**	**15,040**	**16,420**	**17,158**	**9,486**	**4,747**	**9,045**	**3,565**	**4,549**	**7,880**	**7,026**
Artificial Stream Recharge	3,509	6,750	5,695	3,190	6,442	12,266	10,211	11,918	5,952	901	0	0	0	0	1,172	4,320	4,488
Arroyo Valle	*1,439*	*4,320*	*1,875*	*1,300*	*3,002*	*5,886*	*4,541*	*6,328*	*2,442*	*0*	*0*	*0*	*0*	*0*	*0*	*139*	*304*
Arroyo Mocho	*1,670*	*1,830*	*3,220*	*1,290*	*2,840*	*5,780*	*5,270*	*5,130*	*3,290*	*901*	*0*	*0*	*0*	*0*	*1,172*	*4,181*	*4,184*
Arroyo las Positas	*400*	*600*	*600*	*600*	*600*	*600*	*400*	*460*	*220*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Natural Stream Recharge	6,060	7,110	1,100	630	8,850	2,860	4,850	2,200	8,620	14,387	8,326	3,541	8,168	2,696	2,653	2,589	2,250
Arroyo Valle	*2,400*	*2,950*	*360*	*290*	*2,450*	*1,290*	*1,750*	*840*	*2,970*	*4,893*	*2,580*	*751*	*2,831*	*527*	*679*	*458*	*418*
Arroyo Mocho	*3,160*	*3,760*	*540*	*140*	*5,900*	*1,170*	*2,500*	*880*	*4,810*	*8,514*	*4,616*	*1,716*	*4,176*	*843*	*902*	*809*	*428*
Arroyo las Positas	*500*	*400*	*200*	*200*	*500*	*400*	*600*	*480*	*840*	*980*	*1,130*	*1,074*	*1,161*	*1,326*	*1,072*	*1,322*	*1,404*
Arroyo Valle Prior Rights	1,771	1,540	115	0	1,038	984	1,419	922	1,848	1,870	1,160	1,206	877	869	724	971	288
Rainfall Recharge	**3,031**	**2,523**	**0**	**0**	**4,398**	**2,002**	**3,891**	**967**	**11,423**	**16,357**	**3,110**	**1,249**	**9,008**	**290**	**398**	**283**	**141**
Lake Recharge	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Pipe Leakage	**31**	**37**	**44**	**51**	**60**	**71**	**82**	**95**	**109**	**124**	**139**	**155**	**169**	**185**	**200**	**217**	**233**
Applied Water Recharge	**2,738**	**2,477**	**3,158**	**3,022**	**2,795**	**3,041**	**2,727**	**2,089**	**1,360**	**1,344**	**2,162**	**1,884**	**1,904**	**1,860**	**2,004**	**1,630**	**1,694**
Subsurface Basin Inflow	**1,000**	**1,000**	**1,010**	**1,790**	**1,230**	**990**	**650**	**630**	**630**	**430**	**650**	**750**	**740**	**770**	**920**	**1,160**	**1,260**
DEMAND	**18,618**	**15,929**	**15,432**	**14,636**	**12,871**	**15,819**	**15,727**	**19,349**	**18,349**	**26,220**	**19,750**	**18,506**	**22,550**	**14,575**	**17,176**	**16,143**	**15,881**
Municipal Pumpage	**11,806**	**9,881**	**7,782**	**6,721**	**7,022**	**8,207**	**6,982**	**7,361**	**7,281**	**7,965**	**8,473**	**7,990**	**8,652**	**8,152**	**9,431**	**10,393**	**11,209**
Zone 7 (excluding DSRSD)	5,403	3,090	1,292	309	776	816	41	0	0	25	348	1,199	1,163	480	2,017	3,213	3,327
Zone 7 for DSRSD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
City of Pleasanton	2,264	2,497	1,707	3,271	2,640	3,273	2,961	3,089	3,565	3,886	3,486	3,056	3,705	3,310	3,548	3,316	3,856
Cal. Water Service	2,612	2,852	2,781	1,312	1,964	2,358	2,489	2,695	2,286	2,660	3,035	2,788	2,774	3,276	2,761	2,850	3,073
Camp Parks	769	808	980	925	796	881	819	808	713	630	647	40	0	0	0	0	0
SFWD	302	242	495	374	397	413	372	402	348	321	378	353	484	491	472	443	362
Fairgrounds	200	200	200	200	200	200	200	267	217	242	281	272	280	280	280	280	280
Domestic	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Golf Courses	156	92	227	230	149	166	0	0	52	101	198	182	146	215	253	191	211
Agricultural Pumpage	**3,744**	**2,217**	**4,596**	**4,970**	**3,191**	**3,711**	**2,628**	**2,433**	**1,295**	**1,342**	**1,556**	**1,914**	**1,911**	**1,470**	**1,476**	**1,166**	**1,360**
SFWD	500	0	62	304	252	365	168	513	150	549	107	410	543	663	493	359	430
Concannon	6	15	20	20	20	70	250	112	0	0	68	0	60	26	59	0	0
Calculated	3,238	2,202	4,514	4,646	2,919	3,276	2,210	1,808	1,145	793	1,381	1,504	1,308	781	924	807	930
Mining Use	**3,068**	**3,831**	**3,054**	**2,945**	**2,658**	**3,751**	**5,586**	**9,005**	**7,613**	**13,953**	**7,481**	**7,402**	**11,387**	**4,353**	**5,869**	**4,484**	**3,312**
Stream Export	1,219	2,200	690	470	800	2,000	3,480	6,530	6,050	12,760	4,340	4,265	8,858	558	2,443	1,808	665
Discharges to Cope Lake	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Evaporation	1,149	931	1,664	1,775	1,158	1,051	1,406	1,775	863	493	2,441	2,437	1,829	3,095	2,726	1,976	1,947
Production	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700
Subsurface Basin Overflow	**0**	**0**	**0**	**0**	**0**	**150**	**530**	**550**	**2,160**	**2,960**	**2,240**	**1,200**	**600**	**600**	**400**	**100**	**0**
NET RECHARGE (AF)	**-478**	**5,508**	**-4,311**	**-5,953**	**11,942**	**6,394**	**8,103**	**-528**	**11,593**	**9,192**	**-4,203**	**-9,722**	**-1,684**	**-7,906**	**-9,106**	**-4,973**	**-5,528**
INVENTORY STORAGE (AF)	**211,522**	**217,030**	**212,719**	**206,766**	**218,708**	**225,102**	**233,205**	**232,677**	**244,270**	**253,462**	**249,259**	**239,537**	**237,853**	**229,947**	**220,841**	**215,868**	**210,340**

STORAGE CALCULATION	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
INVENTORY (Rounded to TAF)	212	217	213	207	219	225	233	233	244	253	249	240	238	230	221	216	210
GW ELEVATIONS (Rounded to TAF)	213	215	226	216	210	228	239	246	241	254	258	250	240	231	217	214	210
AVERAGE STORAGE (TAF)	**213**	**216**	**219**	**211**	**214**	**226**	**236**	**239**	**243**	**254**	**253**	**245**	**239**	**230**	**219**	**215**	**210**
AVAILABLE STORAGE (TAF)	**85**	**88**	**91**	**83**	**86**	**98**	**108**	**111**	**115**	**126**	**125**	**117**	**111**	**102**	**91**	**87**	**82**

Artificial Components	Natural Components

*Water Year Type (CDEC Sacramento Valley)
W = Wet; AN = Above Normal;
BN = Below Normal; D = Dry; C = Critical

TABLE 11-3
HISTORICAL GROUNDWATER STORAGE
HYDROLOGIC INVENTORY (HI) METHOD
1974-2019 WATER YEARS (in Acre-Feet, except where indicated)

	WATER YEAR (Oct - Sep)																			
COMPONENTS	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
INDICES																				
Rainfall at Livermore (in)	11.3	11.6	21.3	11.8	21.3	20.0	15.1	25.3	13.1	14.1	11.0	11.2	17.0	13.1	19.3	17.5	9.7	10.7	11.4	14.8
Evap at Lake Del Valle (in)	64.7	68.2	64.2	65.5	58.3	71.6	69.5	57.2	61.0	68.3	68.5	73.2	69.9	72.1	63.6	68.6	68.9	72.7	71.6	64.0
Arroyo Valle Stream flow (AF)	9909	11692	52831	3424	67142	51058	54115	87819	15169	18949	8156	7848	19648	11410	26930	28325	2027	18059	11231	12914
Water Year Type*	C	C	AN	C	W	W	W	W	W	AN	D	D	AN	BN	AN	W	D	C	D	BN
SUPPLY	**12,715**	**10,610**	**28,529**	**16,095**	**29,095**	**22,556**	**24,184**	**27,201**	**20,780**	**23,211**	**15,858**	**24,062**	**29,840**	**19,778**	**31,021**	**23,960**	**14,998**	**16,258**	**18,659**	**25,382**
Injection Well Recharge	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1,524**	**1,146**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Stream Recharge	**8,347**	**5,247**	**14,714**	**11,838**	**13,058**	**11,109**	**12,284**	**13,603**	**10,813**	**12,842**	**8,768**	**16,205**	**21,483**	**12,885**	**21,025**	**13,418**	**9,154**	**8,448**	**11,249**	**17,144**
Artificial Stream Recharge	3,261	914	5,621	7,883	4,672	2,968	5,314	2,343	5,174	8,019	3,428	10,588	11,409	8,084	11,143	4,583	4,811	2,229	3,984	6,773
Arroyo Valle	*82*	*412*	*1,182*	*798*	*179*	*144*	*1,827*	*413*	*1,181*	*890*	*1,476*	*1,831*	*1,547*	*1,670*	*2,277*	*1,216*	*2,879*	*2,229*	*2,104*	*2,459*
Arroyo Mocho	*3,178*	*502*	*4,439*	*7,085*	*4,493*	*2,824*	*3,487*	*1,930*	*3,993*	*7,129*	*1,930*	*8,755*	*9,862*	*6,414*	*8,698*	*3,205*	*1,932*	*0*	*1,880*	*4,314*
Arroyo las Positas	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*22*	*2*	*0*	*0*	*168*	*162*	*0*	*0*	*0*	*0*
Natural Stream Recharge	4,418	3,997	8,247	3,080	7,259	7,743	6,607	10,533	5,091	4,178	4,679	4,486	8,462	3,458	9,589	6,905	3,536	5,913	6,018	10,371
Arroyo Valle	*1,215*	*970*	*2,754*	*735*	*2,818*	*1,426*	*2,753*	*4,401*	*1,796*	*1,389*	*2,440*	*2,259*	*4,397*	*1,447*	*5,980*	*3,043*	*1,941*	*4,030*	*3,958*	*6,909*
Arroyo Mocho	*1,883*	*1,711*	*3,903*	*1,263*	*3,144*	*5,226*	*2,670*	*4,560*	*1,833*	*1,539*	*961*	*1,279*	*2,980*	*1,082*	*2,854*	*3,104*	*858*	*1,077*	*970*	*2,547*
Arroyo las Positas	*1,320*	*1,315*	*1,591*	*1,082*	*1,297*	*1,091*	*1,184*	*1,572*	*1,462*	*1,250*	*1,278*	*949*	*1,085*	*929*	*755*	*758*	*737*	*806*	*1,090*	*915*
Arroyo Valle Prior Rights	668	337	846	876	1,127	398	362	727	548	644	660	1,131	1,612	1,343	293	1,930	807	306	1,247	0
Rainfall Recharge	**1,838**	**1,760**	**10,761**	**1,242**	**13,243**	**8,176**	**8,634**	**10,692**	**5,540**	**5,924**	**3,644**	**4,239**	**4,899**	**3,192**	**6,378**	**6,969**	**1,987**	**3,782**	**3,375**	**4,315**
Lake Recharge	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Pipe Leakage	**249**	**267**	**285**	**304**	**324**	**344**	**365**	**387**	**410**	**434**	**461**	**490**	**518**	**548**	**579**	**610**	**642**	**675**	**708**	**742**
Applied Water Recharge	**602**	**1,766**	**1,440**	**1,621**	**1,480**	**2,007**	**2,221**	**1,709**	**1,743**	**1,960**	**1,985**	**2,129**	**1,940**	**2,153**	**2,039**	**1,962**	**2,214**	**2,353**	**2,327**	**2,181**
Subsurface Basin Inflow	**1,680**	**1,570**	**1,330**	**1,090**	**990**	**920**	**680**	**810**	**750**	**906**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**
DEMAND	**21,177**	**17,202**	**13,417**	**15,467**	**16,023**	**20,683**	**25,574**	**25,342**	**25,691**	**26,885**	**27,357**	**23,991**	**21,531**	**24,338**	**17,828**	**15,169**	**18,636**	**19,269**	**23,656**	**21,091**
Municipal Pumpage	**17,254**	**13,296**	**8,994**	**6,463**	**4,553**	**6,324**	**8,824**	**10,264**	**11,832**	**15,520**	**17,806**	**19,307**	**17,123**	**19,635**	**14,686**	**11,697**	**12,681**	**13,516**	**18,022**	**16,064**
Zone 7 (excluding DSRSD)	8,119	5,136	2,215	213	368	2,388	1,565	1,682	4,912	6,140	9,864	11,047	7,734	11,175	6,213	3,157	4,146	6,210	9,439	8,274
Zone 7 for DSRSD	0	0	0	0	0	0	0	0	0	0	0	0	645	645	645	645	645	645	645	645
City of Pleasanton	4,164	3,368	3,252	2,578	1,262	1,333	3,208	3,935	2,563	4,558	3,112	3,579	3,674	3,688	3,604	3,587	3,638	2,387	3,660	3,280
Cal. Water Service	3,966	3,744	2,570	2,626	2,053	1,551	2,947	3,595	3,271	3,567	3,707	3,458	3,979	2,911	3,166	3,106	2,971	3,143	3,123	2,844
Camp Parks	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SFWD	408	410	414	396	370	411	477	460	380	532	472	448	423	481	436	467	494	492	446	417
Fairgrounds	346	336	282	325	285	343	342	230	333	369	318	423	327	365	284	441	443	289	335	284
Domestic	100	113	113	116	116	117	117	113	116	109	109	134	134	167	131	93	96	109	123	112
Golf Courses	151	186	148	209	98	182	169	249	256	245	223	218	208	203	207	199	249	241	250	208
Agricultural Pumpage	**556**	**355**	**213**	**218**	**150**	**212**	**266**	**73**	**81**	**231**	**227**	**119**	**93**	**92**	**88**	**88**	**87**	**96**	**95**	**94**
SFWD	194	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Concannon	11	0	0	0	0	0	0	0	0	140	143	25	0	2	0	0	0	0	0	0
Calculated	351	346	213	218	150	212	266	73	81	91	84	94	93	91	88	88	87	96	95	94
Mining Use	**3,367**	**3,551**	**4,210**	**8,786**	**11,120**	**13,381**	**15,724**	**14,255**	**13,416**	**11,010**	**9,324**	**4,564**	**4,314**	**4,610**	**3,055**	**3,385**	**4,947**	**4,452**	**5,346**	**4,934**
Stream Export	639	712	2,219	6,070	9,071	10,577	12,661	12,617	10,082	7,827	5,461	143	0	163	150	487	594	523	1,493	1,996
Discharges to Cope Lake	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Evaporation	2,028	2,139	1,291	2,016	1,349	2,104	2,363	938	2,634	2,483	3,163	3,951	3,764	3,762	2,205	2,198	3,653	3,230	3,153	2,238
Production	700	700	700	700	700	700	700	700	700	700	700	470	550	686	700	700	700	700	700	700
Subsurface Basin Overflow	**0**	**0**	**0**	**0**	**200**	**766**	**760**	**750**	**362**	**125**	**0**	**0**	**0**	**0**	**0**	**0**	**921**	**1,205**	**194**	**0**
NET RECHARGE (AF)	**-8,462**	**-6,592**	**15,112**	**628**	**13,072**	**1,873**	**-1,390**	**1,859**	**-4,911**	**-3,674**	**-11,499**	**72**	**8,309**	**-4,560**	**13,193**	**8,790**	**-3,639**	**-3,011**	**-4,997**	**4,290**
INVENTORY STORAGE (AF)	**201,878**	**195,286**	**210,398**	**211,026**	**224,098**	**225,971**	**224,581**	**226,440**	**221,529**	**217,855**	**206,356**	**206,428**	**214,737**	**210,177**	**223,370**	**232,160**	**228,521**	**225,510**	**220,513**	**224,803**

STORAGE CALCULATION	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
INVENTORY (Rounded to TAF)	202	195	210	211	224	226	225	226	222	218	206	206	215	210	223	232	229	226	221	225
GW ELEVATIONS (Rounded to TAF)	195	184	211	215	225	223	222	225	222	222	203	212	220	213	236	238	232	234	233	234
AVERAGE STORAGE (TAF)	**199**	**189**	**210**	**213**	**225**	**225**	**224**	**226**	**222**	**220**	**205**	**209**	**218**	**212**	**230**	**235**	**230**	**230**	**227**	**229**
AVAILABLE STORAGE (TAF)	**71**	**61**	**82**	**85**	**97**	**97**	**96**	**98**	**94**	**92**	**77**	**81**	**90**	**84**	**102**	**107**	**102**	**102**	**99**	**101**

Artificial Components	Natural Components

*Water Year Type (CDEC Sacramento Valley)
W = Wet; AN = Above Normal;
BN = Below Normal; D = Dry; C = Critical

TABLE 11-3
HISTORICAL GROUNDWATER STORAGE
HYDROLOGIC INVENTORY (HI) METHOD
1974-2019 WATER YEARS (in Acre-Feet, except where indicated)

	WATER YEAR (Oct - Sep)									1974 - 2019		
COMPONENTS	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**AVG**	**Sust Avg**	**TOTAL**
INDICES												
Rainfall at Livermore (in)	16.2	8.8	10.7	6.8	13.1	15.4	25.6	12.4	17.1	15		
Evap at Lake Del Valle (in)	64.5	73.2	73.9	78.3	73.6	72.6	69.3	73.4	72.8	67		
Arroyo Valle Stream flow (AF)	28634	1557	7801	272	2217	19436	89173	2783	36944	25381		**1167535**
Water Year Type*	W	BN	D	C	C	BN	W	BN	AN			
SUPPLY	**27,315**	**18,442**	**20,158**	**10,452**	**18,753**	**28,293**	**38,895**	**17,164**	**23,625**	**20,299**	**19,800**	**933,761**
Injection Well Recharge	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**58**	**0**	**2,670**
Stream Recharge	**17,595**	**12,734**	**13,457**	**5,820**	**11,469**	**18,083**	**20,495**	**9,560**	**10,605**	**12,060**	**11,900**	**554,757**
Artificial Stream Recharge	4,555	8,778	7,887	3,826	3,766	8,910	9,615	6,773	2,943	5,371	5,300	247,067
Arroyo Valle	*768*	*3,613*	*1,916*	*924*	*3,718*	*3,983*	*3,271*	*3,778*	*2,168*	*1,794*	*1,640*	*82,510*
Arroyo Mocho	*3,671*	*5,059*	*5,961*	*2,844*	*0*	*4,927*	*6,344*	*2,995*	*775*	*3,465*	*3,530*	*159,386*
Arroyo las Positas	*116*	*106*	*10*	*58*	*48*	*0*	*0*	*0*	*0*	*112*	*130*	*5,172*
Natural Stream Recharge	11,272	3,355	4,200	1,987	6,822	8,289	10,433	1,938	6,439	5,787	5,700	266,196
Arroyo Valle	*8,540*	*1,676*	*2,790*	*891*	*4,567*	*4,749*	*6,053*	*740*	*3,419*	*2,577*	*1,800*	*118,522*
Arroyo Mocho	*2,293*	*1,225*	*838*	*587*	*1,748*	*2,794*	*3,775*	*590*	*2,393*	*2,316*	*2,600*	*106,552*
Arroyo las Positas	*439*	*454*	*572*	*509*	*507*	*746*	*605*	*608*	*627*	*894*	*1,300*	*41,122*
Arroyo Valle Prior Rights	1,768	601	1,370	7	881	884	447	849	1,223	902	900	41,493
Rainfall Recharge	**5,771**	**1,462**	**2,708**	**1,075**	**3,735**	**6,554**	**14,087**	**3,220**	**8,588**	**4,714**	**4,300**	**216,861**
Lake Recharge	*0*	*0*	*0*	*2,428*	*4,322*	*6,785*	*13,029*	*15,003*	*13,266*	*1,192*	*NA*	*54,833*
Pipe Leakage	**776**	**811**	**847**	**884**	**921**	**958**	**996**	**1,034**	**1,146**	**429**	**1,000**	**19,712**
Applied Water Recharge	**2,172**	**2,435**	**2,147**	**1,674**	**1,629**	**1,697**	**2,316**	**2,350**	**2,286**	**2,053**	**1,600**	**94,424**
Subsurface Basin Inflow	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**986**	**1,000**	**45,336**
DEMAND	**20,421**	**28,880**	**25,700**	**22,604**	**12,717**	**12,888**	**13,636**	**16,879**	**19,177**	**19,364**	**18,800**	**890,764**
Municipal Pumpage	**13,430**	**20,463**	**16,823**	**16,662**	**8,284**	**9,176**	**10,714**	**11,966**	**14,635**	**11,551**	**13,700**	**531,324**
Zone 7 (excluding DSRSD)	5,618	11,461	8,909	8,137	1,920	1,357	3,243	4,215	8,021	4,052	5,300	186,377
Zone 7 for DSRSD	646	644	646	645	645	645	645	645	645	238	645	10,966
City of Pleasanton	3,435	3,900	3,301	3,740	2,775	3,752	4,222	3,913	3,785	3,276	3,500	150,685
Cal. Water Service	2,673	3,333	2,770	3,085	2,012	2,575	1,878	2,389	1,296	2,802	3,070	128,876
Camp Parks	0	0	0	0	0	0	0	0	0	192	0	8,819
SFWD	442	482	482	398	309	286	214	253	286	405	450	18,634
Fairgrounds	301	318	350	286	268	231	208	196	270	287	310	13,206
Domestic	107	90	105	115	112	110	107	115	116	109	200	5,015
Golf Courses	208	236	260	257	243	220	198	240	216	190	225	8,747
Agricultural Pumpage	**85**	**95**	**486**	**640**	**590**	**115**	**109**	**113**	**113**	**1,017**	**400**	**46,762**
SFWD	0	0	0	0	0	0	0	0	0	132	0	6,071
Concannon	0	0	0	0	0	0	0	0	0	23	0	1,047
Calculated	85	95	486	640	590	115	109	113	113	862	400	39,643
Mining Use	**6,906**	**8,322**	**8,391**	**5,302**	**3,843**	**3,597**	**2,813**	**4,236**	**3,620**	**6,403**	**4,600**	**294,532**
Stream Export	4,277	4,676	4,796	850	0	0	0	0	0	3,418	700	157,219
Discharges to Cope Lake	*0*	*0*	*0*	*5,420*	*4,890*	*7,700*	*13,452*	*15,562*	*13,864*	*1,324*	*NA*	*60,887*
Evaporation	1,929	2,946	2,895	3,752	3,143	2,897	2,113	3,536	2,920	2,294	3,200	105,507
Production	700	700	700	700	700	700	700	700	700	691	700	31,806
Subsurface Basin Overflow	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**564**	**809**	**394**	**100**	**18,146**
NET RECHARGE (AF)	**6,893**	**-10,438**	**-5,542**	**-12,153**	**6,037**	**15,405**	**25,259**	**285**	**4,447**	**935**	**1,000**	**42,996**
INVENTORY STORAGE (AF)	**231,696**	**221,258**	**215,716**	**203,563**	**209,600**	**225,005**	**250,264**	**250,549**	**254,996**	**223,335**	**13,400**	

STORAGE CALCULATION	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
INVENTORY (Rounded to TAF)	232	221	216	204	210	225	250	251	255
GW ELEVATIONS (Rounded to TAF)	235	228	221	210	214	227	246	245	249
AVERAGE STORAGE (TAF)	**233**	**224**	**218**	**207**	**212**	**226**	**248**	**248**	**252**
AVAILABLE STORAGE (TAF)	**105**	**96**	**90**	**79**	**84**	**98**	**120**	**120**	**124**

Artificial Components Natural Components

*Water Year Type (CDEC Sacramento Valley)
W = Wet; AN = Above Normal;
BN = Below Normal; D = Dry; C = Critical

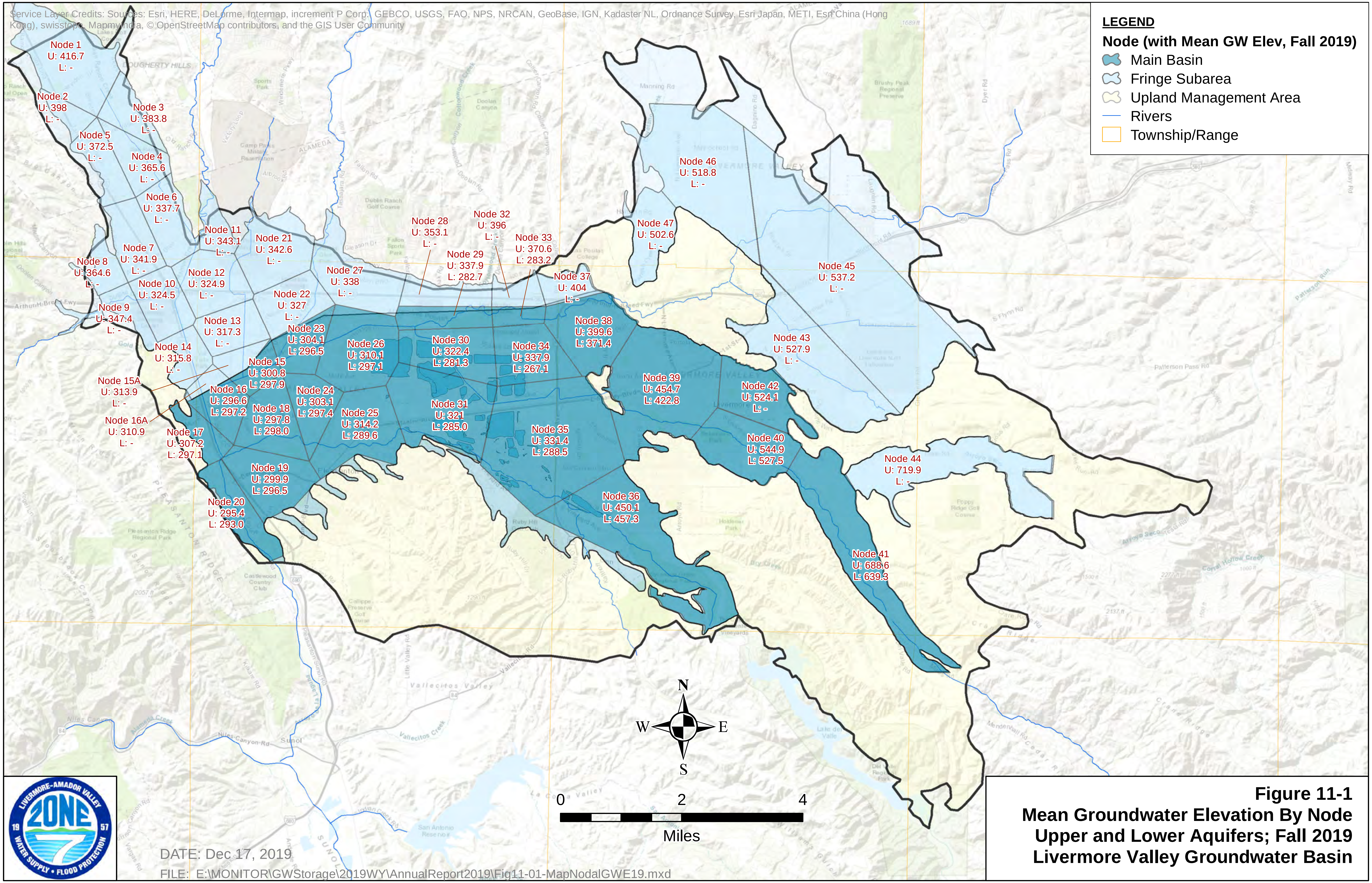


Figure 11-1
Mean Groundwater Elevation By Node
Upper and Lower Aquifers; Fall 2019
Livermore Valley Groundwater Basin

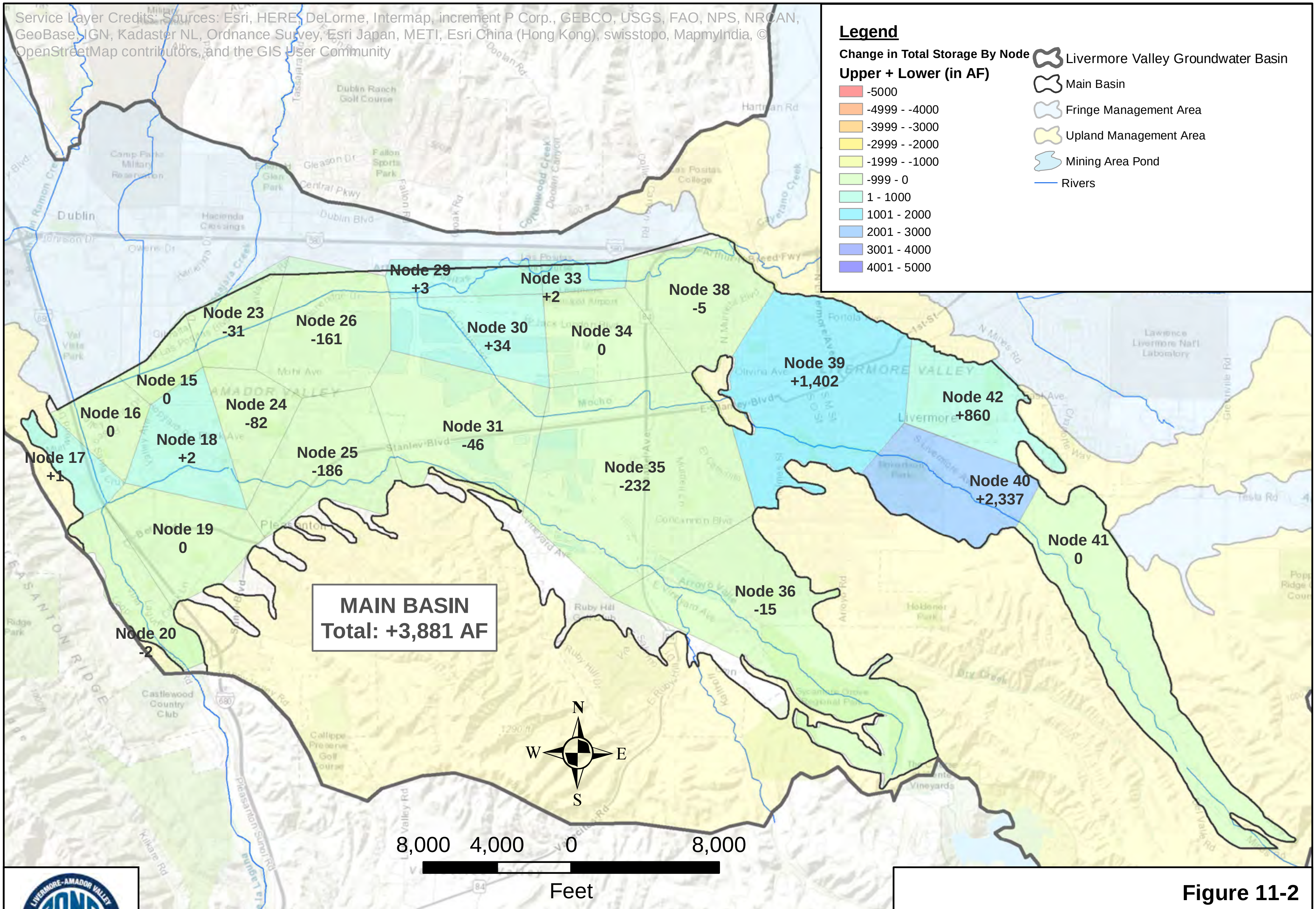


Figure 11-2
Change in Groundwater Storage
Fall 2018 to Fall 2019
Livermore Valley Main Basin

DATE: Dec 17, 2019

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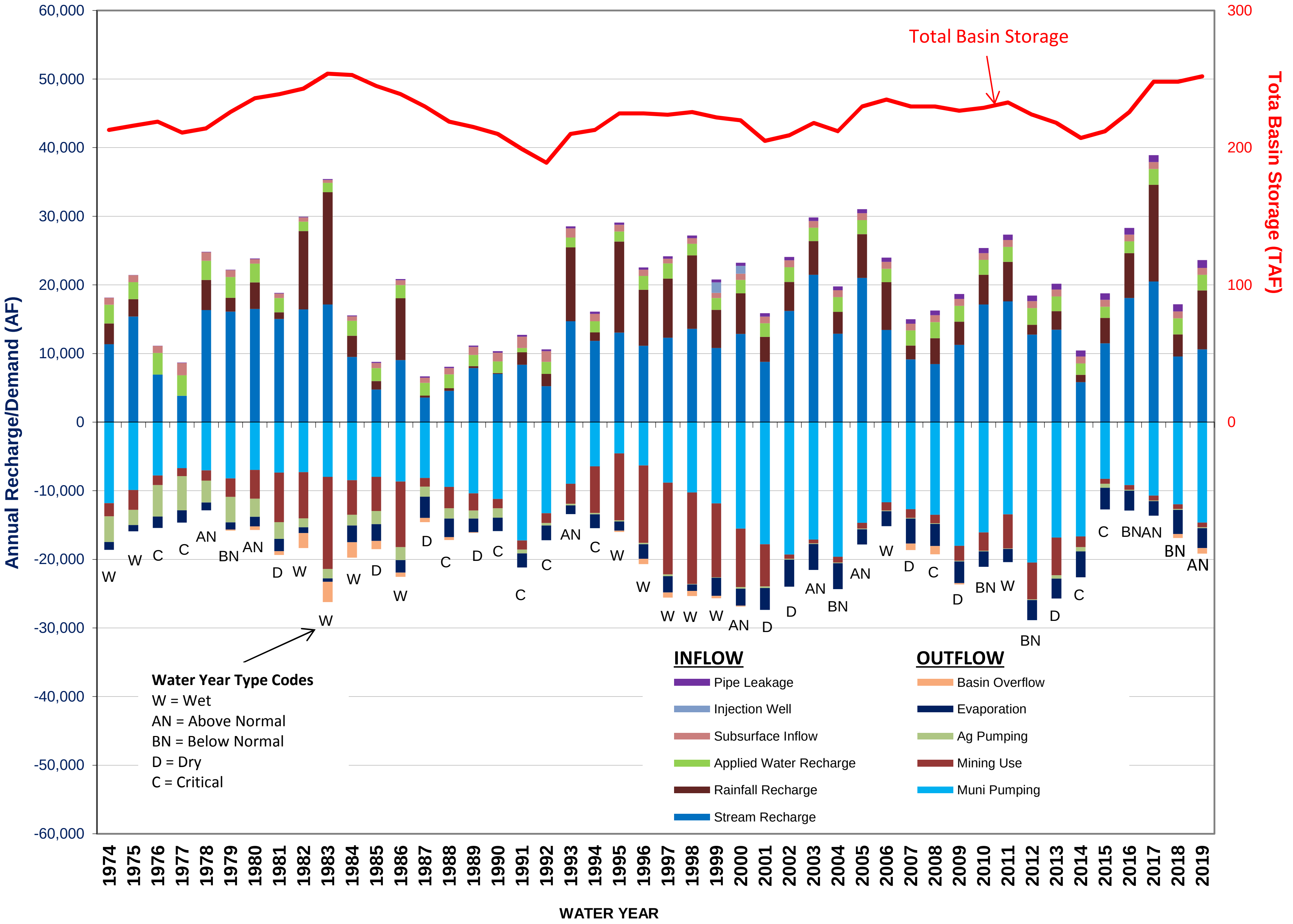
FIGURE 11-3
GRAPH OF GROUNDWATER STORAGE 1974 - 2019 WATER YEARS
LIVERMORE VALLEY GROUNDWATER BASIN



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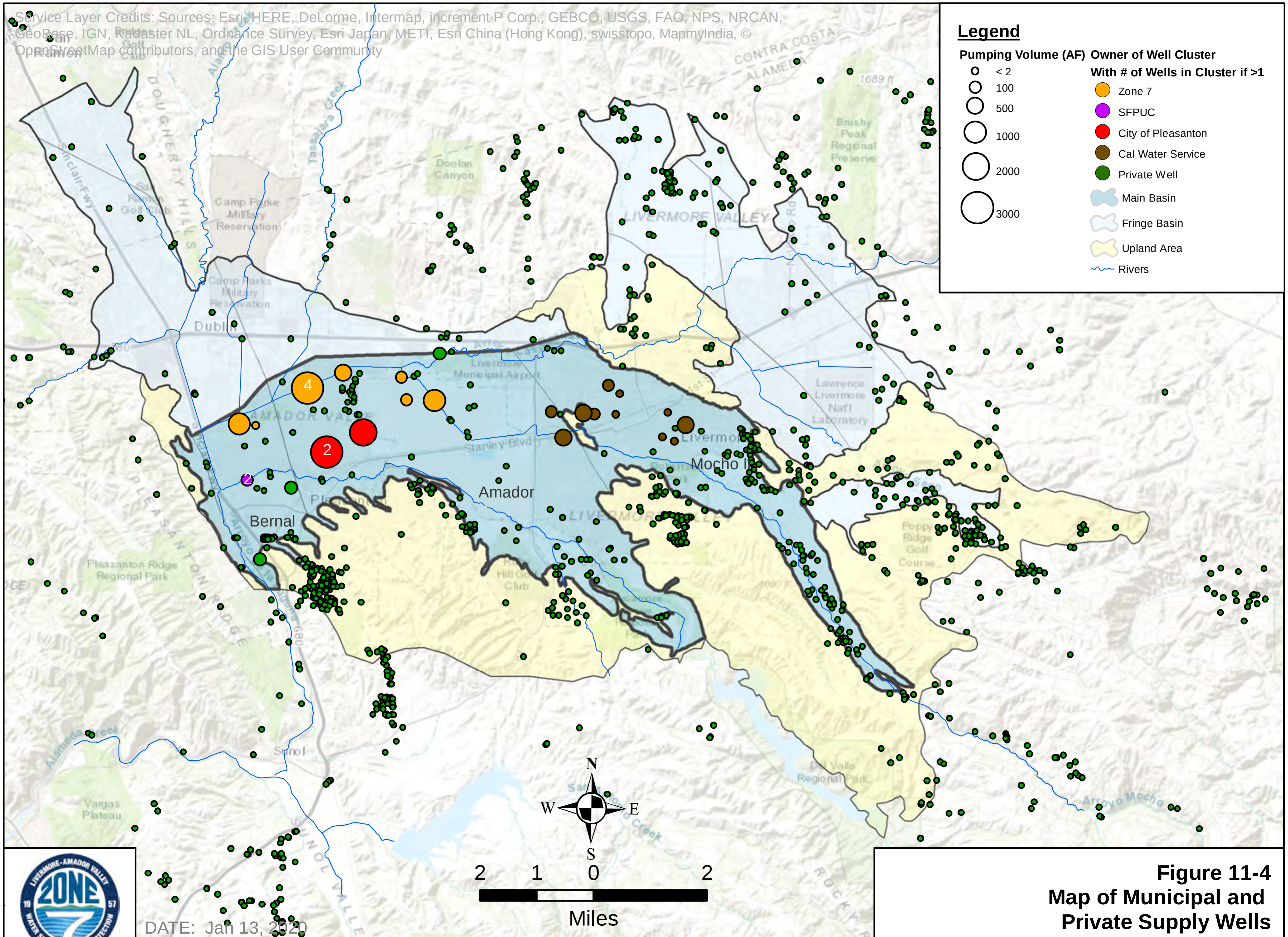
1/27/2020



Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

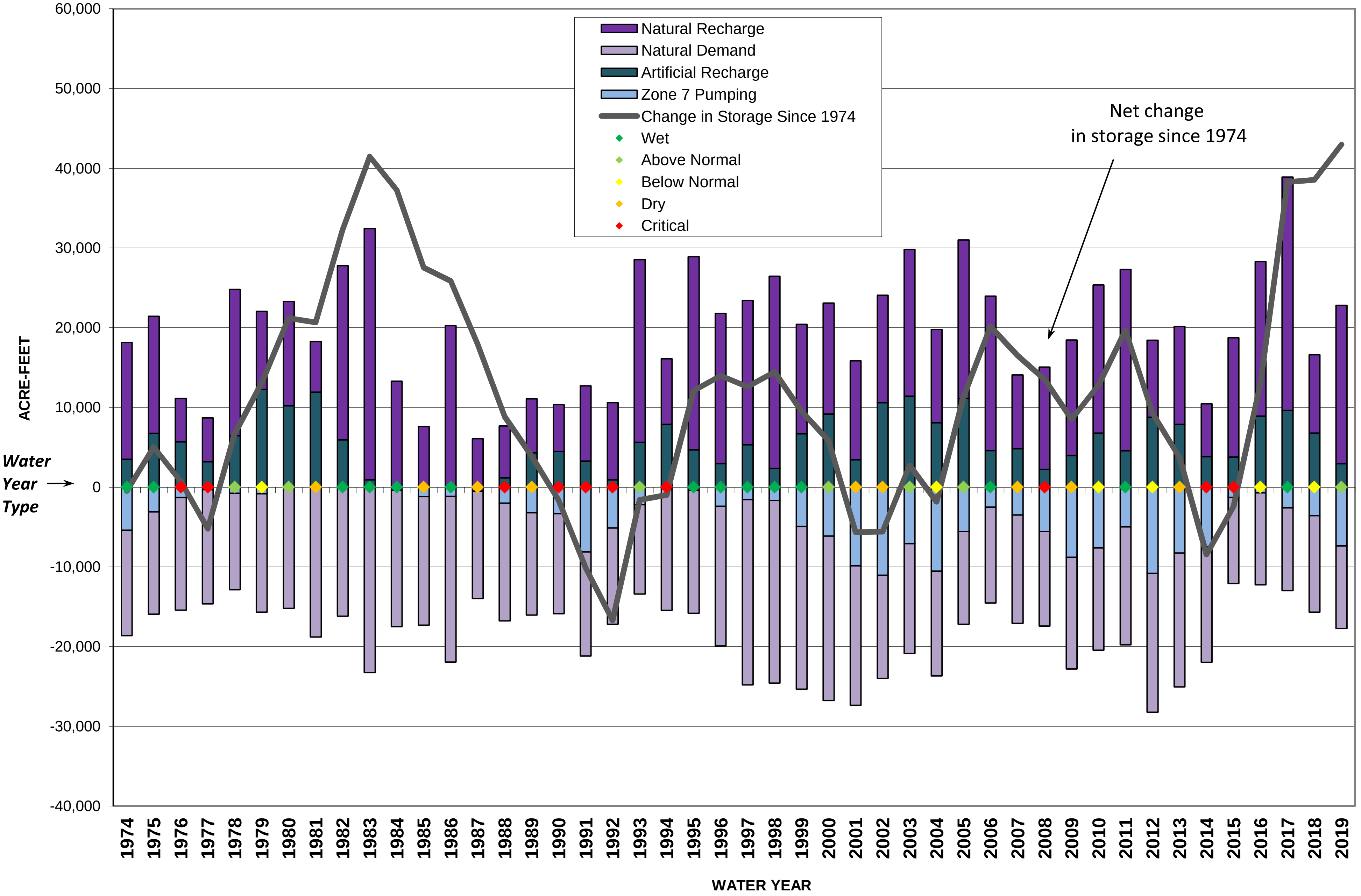
DATE: Jan 13, 2020

FILE: E:\MONITOR\GWStorage\2019WY\AnnualReport2019\Fig11-04-MapMuniWells19.mxd

Figure 11-4
Map of Municipal and
Private Supply Wells
Livermore Valley Groundwater Basin

FIGURE 11-5

CUMULATIVE CHANGE IN NATURAL AND ARTIFICIAL RECHARGE AND DEMAND 1974 - 2019 WATER YEARS
LIVERMORE VALLEY GROUNDWATER BASIN



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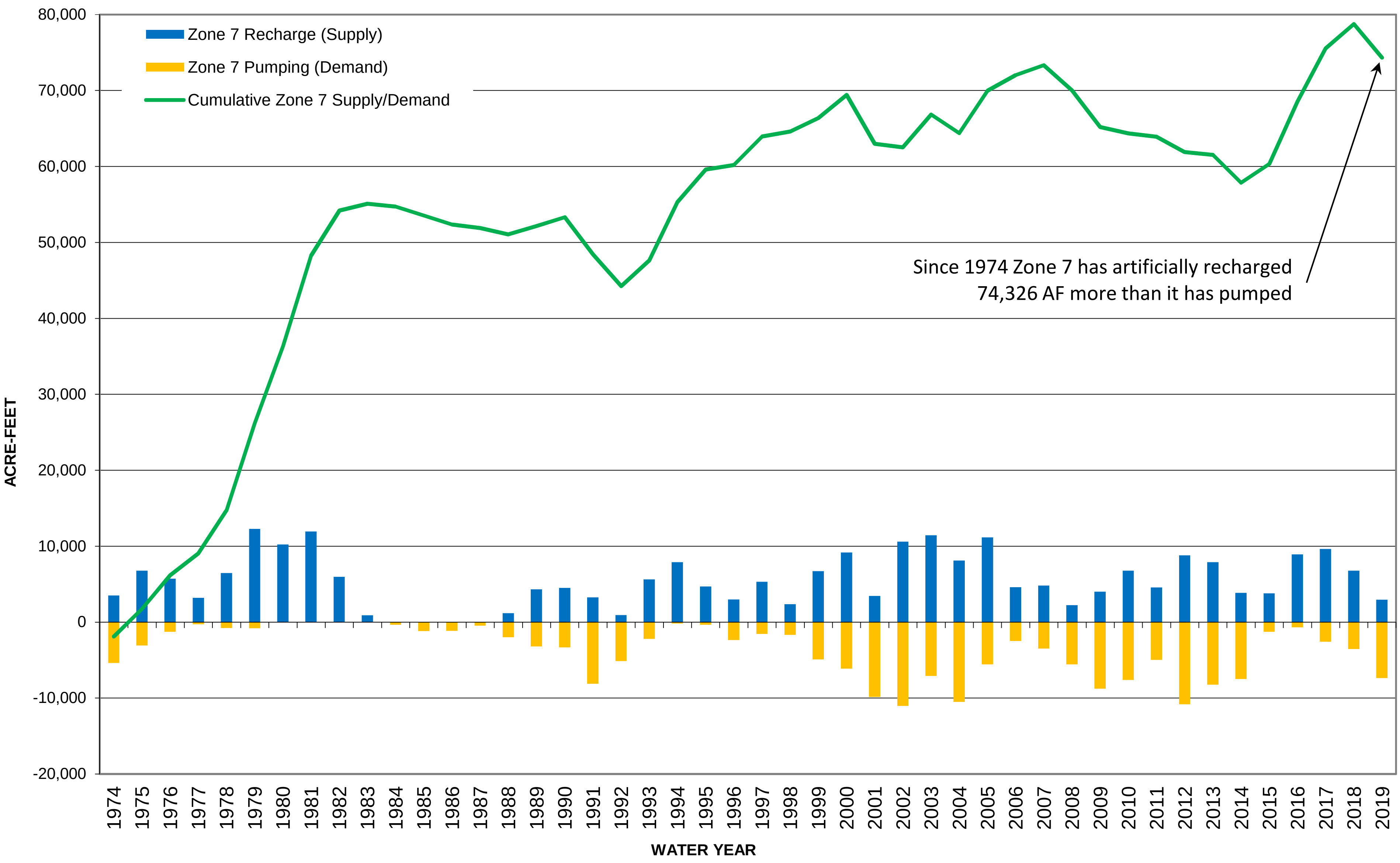
1/27/2020

FIGURE 11-6
GRAPH OF CUMULATIVE CONJUNCTIVE USE SUPPLY AND DEMAND SINCE 1974 WY
LIVERMORE VALLEY GROUNDWATER BASIN



Since 1974 Zone 7 has artificially recharged 74,326 AF more than it has pumped

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3/5/2020

12 Groundwater Supply Sustainability

12.1 Introduction

This section provides an update on the project and management actions described in *Section 5*, *Projects and Management Actions*, of the Alternative GSP. Zone 7 is sustainably managing the Livermore Valley Groundwater Basin through numerous interrelated programs to assess, manage, monitor, and protect the groundwater supply. Using information from its robust monitoring programs, Zone 7 adaptively manages its groundwater supply with regard for current hydrologic conditions, water demands, water quality conditions, and future water supply/demand forecasts. In addition to continuing the monitoring programs that are critical to Zone 7's sustainable groundwater management, Zone 7 is also working to improve long-term surface water supply reliability, maximize conjunctive use opportunities, provide watershed protection, and support water recycling operations.

12.2 Import of Surface Water

The availability of State Water Project (SWP) supplies is fundamental to Zone 7's maintenance of its basin measurable objectives with regard to sustainable groundwater levels and storage, avoidance of subsidence, and protection of groundwater dependent eco-systems. Zone 7 ensures that local groundwater supplies are not depleted by importing an average of 75% of the Valley's water demand (61% in 2019 WY). This imported water is delivered to Zone 7 through the South Bay Aqueduct (SBA), and used for municipal and agricultural supplies and for recharging the Main Basin aquifers (artificial recharge). Details regarding the surface water supply sources and contract amounts are provided in *Section 2.4.4.2*, *Imports and Surface Water Supplies*, of the Alternative GSP.

The SWP allocation for 2019 CY was 75% of Zone 7's maximum allocation or 60,464 AF. *Table 12-A* shows Zone 7's imported water supplies for 2019 CY and the amounts being carried over to the 2020 CY. In accordance with DWR's accounting time-interval of SWP water, the totals in this table are presented by calendar year.

- Imported surface water supplies in 2019 CY made up 61% of regional water demands. This imported surface water allowed 31,598 AF of groundwater to be conserved instead of being pumped to meet this demand.

Table 12-A: Imported Water Sources for the 2019 Calendar Year (AF)

Source	Available at end of 2018	Added in 2019 *	Used in 2019	Carryover to 2019
State Water Project	7,047	60,464	52,296	10,812
Table A		60,464	49,652	10,812
Article 56	7,047	0	2,644	0**
Byron-Bethany Irrigation District	0	0	0	0
Kern Groundwater Basin	104,065	13,010	0	117,075
Semitropic	79,160	8,010	0	87,170
Cawelo	24,905	5,000	0	29,905
Other	0	0	0	0
Turnback Pool	0	0	0	0
Yuba/Other	0	0	0	0
Lake Del Valle (AV Water Rights)	1,180	8,129	1,180	8,129
Total	216,357	94,613	53,476	253,091

* = 75% State Water Project Allocation for 2019 WY

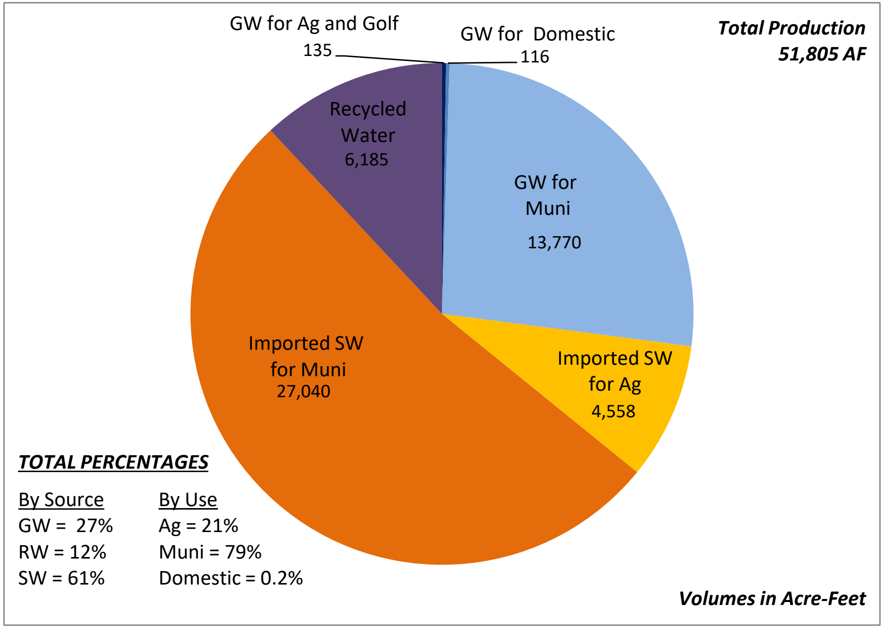
** = 4,403 AF lost from Article 56

AV = Arroyo Valle

12.3 Valley-Wide Water Production and Use

The volume of water produced and used in the Livermore Valley is shown in *Figure 12-A* (by Water Year) and *Figure 12-1* (by Water Year except where noted).

Figure 12-A: Valley-Wide Water Production for the 2019 Water Year (AF)



Ag = Agriculture; Muni = Municipal; GW= Groundwater; RW = Recycled Water; SW = Surface Water

Figure 12-2 shows the historical percentage of groundwater production relative to total Valley-wide production from the 1974 to 2019 WYs. The following activities occurred during 2019 WY:

- Total groundwater production in the Valley (including by Zone 7, retailers, agriculture, domestic, etc.) supplied about 27% of the total Valley-wide water demand in the 2019 WY.
- Of the 8,666 AF of groundwater pumped by Zone 7 during 2019 WY, about 8,133 AF went into production; the remainder of which is accounted for in pumping losses and exported brine from the groundwater demineralization process.
- Zone 7's total produced groundwater was about 23% of the total treated water production that Zone 7 delivered to its retailers during the 2019 WY (on average, groundwater makes up about 15% of Zone 7's annual treated water deliveries).

12.4 Future Supply Reliability

Zone 7 continues to implement a multifaceted strategy for securing the long-term reliability of the water supply system to meet the needs of both existing and future customers. This strategy includes the following components:

- Increased yield from the Arroyo Valle local water right using the Chain of Lakes (COLs).
- Maximized groundwater storage in Kern County groundwater banks.
- Access to emergency water supply in the local COLs.
- Support of the Delta Conveyance Project (former CA WaterFix) to restore yield from the SWP.
- Pursuit of alternative water supply (e.g., Sites Reservoir, potable reuse, interagency transfers and regional desalination) and storage (e.g., Los Vaqueros Expansion) options.

Local water is a key component of Zone 7's future water supply portfolio. In 2019, Zone 7 continued its petition to extend Zone 7's water rights permit for diverting surface water captured in Lake Del Valle from the upper Arroyo Valle. Under the existing permit, Zone 7's average annual yield from the upper Arroyo Valle is about 7,300 AF/yr. A diversion structure from Arroyo Valle into Lake A, and a pipeline connecting Lake A to other lakes in the COLs, are included in Zone 7's Capital Improvement Plan (CIP, 2018-2028). Once constructed, these projects will facilitate the capture and storage of additional water from the Del Valle Watershed up to about 3,000 AF/year on average.

Investments in out-of-basin groundwater banks in Kern County (i.e., Cawelo Groundwater Banking Program and Semitropic Stored Water Recovery Unit) allow Zone 7 to augment imported surface water supplies during times of low SWP allocations. Zone 7 elected to bank 13,010 AF of its allocation in Cawelo and Semitropic in the 2019 CY. Zone 7 currently has 117,075 AF of water banked in the Kern Groundwater Basin. Note that there was an error reported in the 2018 Annual Report (*Zone 7, 2019)* that the water banked in the Kern Groundwater Basin at the end of 2018 was 128,970 AF; the correct volume was 104,065 AF.

In a normal year, about 80% of Zone 7's supply is derived from the SWP. The SWP reliability has been declining over the years due to increasingly stringent regulations, declining Delta conditions and infrastructure, and climate change. To protect the Valley's major water supply, Zone 7 had been supporting the CA WaterFix (now the Delta Conveyance Project), the State of California's proposed project to upgrade the SWP system infrastructure and operations and improve its long-term reliability while protecting the Sacramento-San Joaquin Delta (Delta) ecosystem. As of early 2020, the project's design is still being re-evaluated under California's new governor. At this time, Zone 7 is assuming that some form of the Delta Conveyance Project would be in-service around 2035.

Zone 7 also continues to evaluate alternative water supply and storage options such as the Bay Area Regional Desalination Project, potable reuse, Los Vaqueros Expansion, Sites Reservoir, and water transfers. Ultimately, Zone 7 may choose to implement one or several of these options depending on the results of the studies and planning efforts, the amounts and timing of development and conservation, and the determination of costs and benefits to the Valley.

Finally, Zone 7 has been evaluating the feasibility of an intertie with another major water agency (e.g., East Bay Municipal Utilities District or San Francisco Public Utilities Commission). An outage of the SBA, or major disruptions in the Delta, would prevent Zone 7 access to most of its water supplies, leaving only groundwater, water in the Chain of Lakes, and water in Lake Del Valle available to meet its demands. An intertie with another agency could provide an additional source of water during an emergency or drought and could also facilitate water transfers.

Additional information regarding Zone 7's efforts to increase future supply reliability is provided in *Section 5.2.1, Import of Surface Water*, of the Alternative GSP and Zone 7's Water Supply Evaluation Update (*Zone 7, 2016b*).

12.5 Water Conservation

By managing water demands, water conservation is basic to ongoing achievement of basin measurable objectives including management of groundwater levels and storage, avoidance of land subsidence, maintenance of groundwater quality, and protection of groundwater dependent eco-systems. Responsive to the Urban Water Management Planning Act, all of the urban retailers within the Basin (Cal Water, DSRSD, Livermore, and Pleasanton) have prepared Urban Water Management Plans which include a Water Shortage Contingency Plan that provides a response to drought and other shortages. As documented in Zone7's *2015 Urban Water Management Plan*, Zone 7 is on track with all applicable best management practices (BMPs) for water demand management.

In addition, Zone 7 continues to work closely with the retailers on the Valley-wide conservation program, providing rebates, offering public outreach and education, and securing grants to support the program. Zone 7 regularly updates the program to focus on the most cost-effective elements and to implement the latest regulations. Water conservation by Zone 7 and the retailers is ongoing and discussed in greater detail in *Section 5.2.6*, *Water Conservation*, of the Alternative GSP. Throughout the 2019 WY, Zone 7 continued its regional coordination of conservation programs, including community workshops and other events, school education programs, and rebates and water-saving giveaway programs.

12.6 Chain of Lakes Recharge Projects

The COLs is a series of former quarry lakes located in the heart of the Livermore-Amador Valley (*Figure 12-3*). Best described in the 1981 Specific Plan for Livermore Amador Valley Quarry Area Reclamation (*Alameda County, 1981*), the COLs were envisioned as a large water management facility to be used by Zone 7. The COLs will ultimately consist of ten lakes (named Lakes A through Lake I, and Cope Lake) connected through a series of conduits. The general vision is that Zone 7 would use the lakes for water management and related purposes. Water management includes, but is not limited to, groundwater recharge, surface water storage and conveyance, and flood protection.

Of the ten lakes, two have been transferred to Zone 7 ownership (Lake I and Cope Lake) and are currently operated and maintained by Zone 7 for water storage and groundwater replenishment. The remaining lakes are still being mined or reclaimed under surface mining permits (SMPs) issued to the individual quarry operators by the Alameda County Community Development Agency (ACCDA) (the administrative representative of the state for mining operations and reclamation). Background information on the COLs is provided in *Section 2.3.10.3*, *Mining Areas*, *Section 4.4*, *Chain of Lakes and Quarry Operations Monitoring*, and *Section 5.2.4*, *COLs Recharge Projects* of the Alternative GSP.

During the 2019 WY, Zone 7 continued to work with Hanson Aggregates (former quarry operator for Lakes H, I, and Cope) while they continue the process of permitting a future diversion structure to divert artificial flows from Arroyo Mocho into Lake H. The U.S. Army Corp of Engineers approved the permit application submitted by Hanson in the 2017 WY. Hanson is still responding to the RWQCB comments on the design submitted in the 2017 WY and future operations of the diversion are still being evaluated. Once installed, this diversion facility will allow SWP water released from the SBA to be diverted from the Arroyo Mocho into Lake H and, and ultimately, Lake I for groundwater recharge. Lake H is connected to Lake I via a 30-inch-diameter conduit.

Another quarry operator, CEMEX, submitted a revised application to amend SMP-23 and the associated reclamation plan in the 2019 WY that eliminated any additional mining in Pits P28 and P41 (Lake A), while increasing the amount mined in Pit P42 (Lake B) and P46 (Lake J). Zone 7 is working with CEMEX to understand the potential impacts the proposed deeper mining in Lakes B and J will have on the groundwater basin. Zone 7 and CEMEX participated together on a hydrogeologic study to further characterize the hydrogeology in the area of Lake B during the 2018 WY. CEMEX has also had additional studies completed as part of the Environmental Impact Report (EIR) process for their 2019 amendment. In addition, staff continue to work closely with the ACCDA on the SMP-23 amendment process.

12.7 Well Master Plan

In the early 2000s, Zone 7 identified the need to increase its groundwater production capacity to meet customer demands during projected droughts and water shortage emergencies. Zone 7’s Well Master Plan (WMP), adopted by the Zone 7 Board in 2005, concluded that Zone 7 would need to install several new municipal water supply wells over the next 20-30 years to maintain Zone 7’s potable water reliability goal. Additional benefits of these new wells would include providing Zone 7 with improved operational flexibility to pump its stored water resources and remove dissolved salts from more of the groundwater basin.

Since 2005, Zone 7 has constructed three new municipal supply wells (COL 1, COL 2 and COL 5) bringing Zone 7's total to ten wells. In 2012, Zone 7's Board adopted new reliability goals. Together with implementation of additional water conservation measures, and expansion of recycled water use by retailers, the need for new wells has changed. During the 2019 WY, Zone 7 staff continued the process of reevaluating Zone 7's supply well needs and plans to update the well construction schedule in 2020.

12.8 Sustainable Groundwater Management Ordinance

On June 21, 2017, the Zone 7 Board of Directors adopted the Zone 7 Sustainable Groundwater Management Ordinance (Zone 7 Ordinance 2017-01). The ordinance was created to enhance existing sustainable management programs for the local groundwater basin. The ordinance can be viewed and downloaded from Zone 7 website:

http://www.zone7water.com/images/pdf_docs/groundwater/groundwater_ordinance_2017-01.pdf

The Zone 7 Sustainable Groundwater Management Ordinance recognizes groundwater as an essential resource for municipal, industrial, and domestic uses, as well as agricultural production, and sets provisions for groundwater protection within Eastern Alameda County. Not protecting the Basin from unsustainable extraction of groundwater could have adverse economic effects, including loss of arable land, a decline in property values, increased pumping costs due the lowering groundwater levels, and increased water quality treatment. Nothing in the ordinance determines or alters water rights, groundwater rights, or existing county ordinances (such as the well ordinance that establishes fees and criteria for permitting new wells).

Under the ordinance, the following actions are prohibited:

- The unsustainable extraction or wasteful use of groundwater within the service area.
- The export of water to areas or users outside the service area.
- The waste or unreasonable use of surface water within the service area.

Zone 7 plans to establish a permit system to authorize water management practices otherwise prohibited where those practices are for reasonable and beneficial use of groundwater.

The ordinance also includes provisions that allow Zone 7 to continue to collect groundwater data from all parties, including public water agencies that extract groundwater within the service area, for the purpose of monitoring existing groundwater conditions and trends.

12.9 Existing and Future Recycled Water Use

Zone 7 views recycled water as a valuable component of the local water portfolio when managed appropriately under a Salt Nutrient Management Plan (SNMP). Recycled water can reduce the demand for surface water imports and pumped groundwater and can contribute to groundwater storage when incidental percolation occurs during irrigation of landscapes and crops.

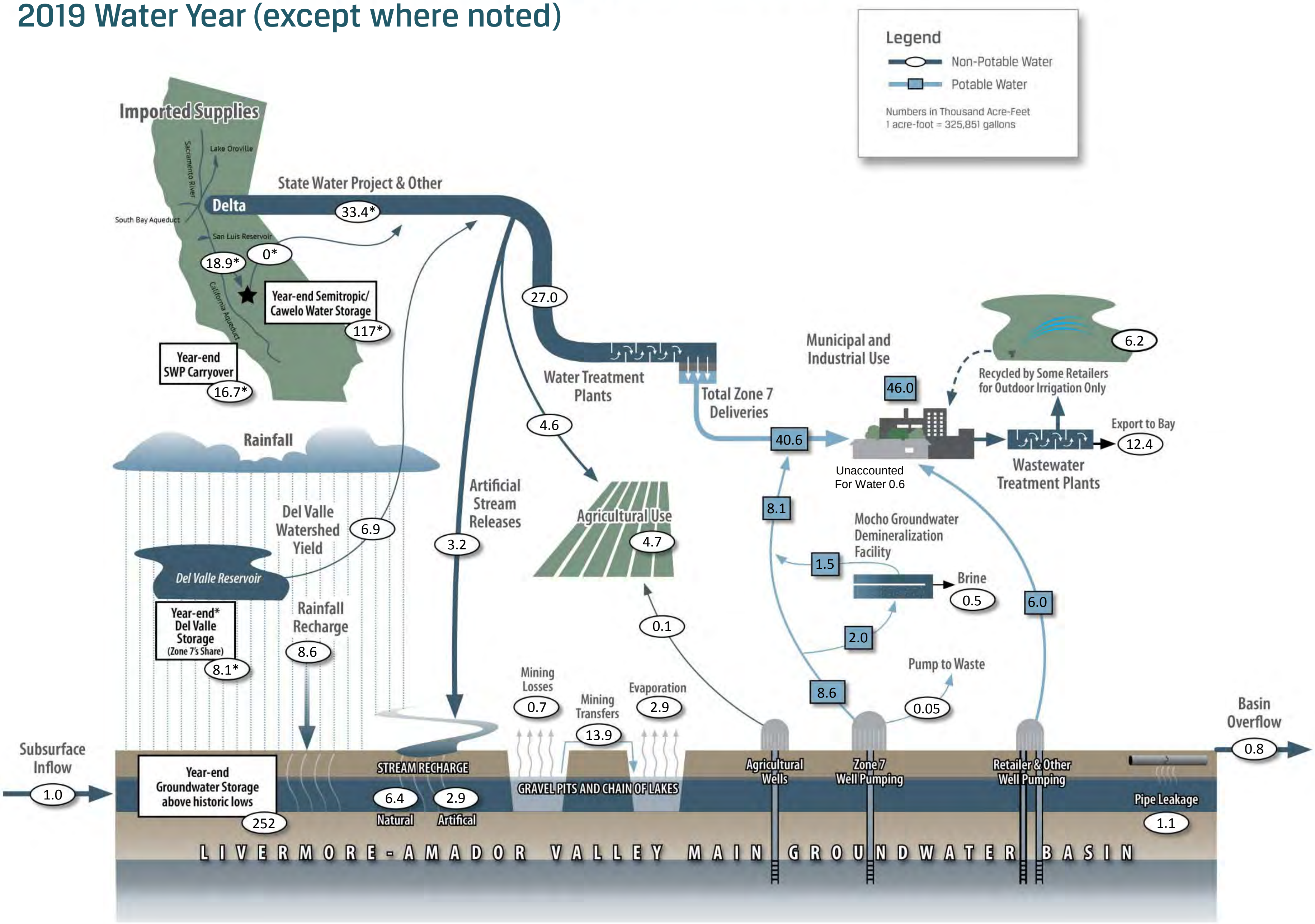
Most of the recycled water used in the Valley is for landscape irrigation, with a minor amount used for dust suppression, grading projects, and crop irrigation. Only a small portion of the applied recycled water percolates to the groundwater supply; most of the applied water is evaporated, taken up by plant roots, lost through plant transpiration, or retained as moisture in the unsaturated zone. The total amount of recycled water for the 2019 WY is discussed in *Section 10*, *Wastewater and Recycled Water*.

From 2016 to the present, Zone 7 continues to be part of a joint effort by the Tri-Valley water agencies, studying the technical feasibility of potable reuse, or purified recycled water, to enhance long-term water supply reliability. In May 2018, the Tri-Valley water agencies completed the Joint Tri-Valley Potable Reuse Technical Feasibility Study. The primary goals of the study were to evaluate the feasibility of a wide range of potable reuse options for the Tri-Valley based on technical, financial, and regulatory considerations, and to recommend next steps for the agencies, if potable reuse was found to be technically feasible. The results suggested that potable reuse was indeed technically feasible. Options for potable reuse that were evaluated include purification followed by either groundwater recharge (through injection or surface water recharge) or blending with other surface water and treating the blend at a Zone 7 surface water treatment plant. Connecting a water purification facility directly to the water transmission system was not considered in the study. The next steps that were identified include a regional water demand study, regional water supply updates, and technical studies regarding the COLs and potential groundwater injection well locations.

Livermore-Amador Valley Water Supply & Use (in Thousands of Acre-Feet)

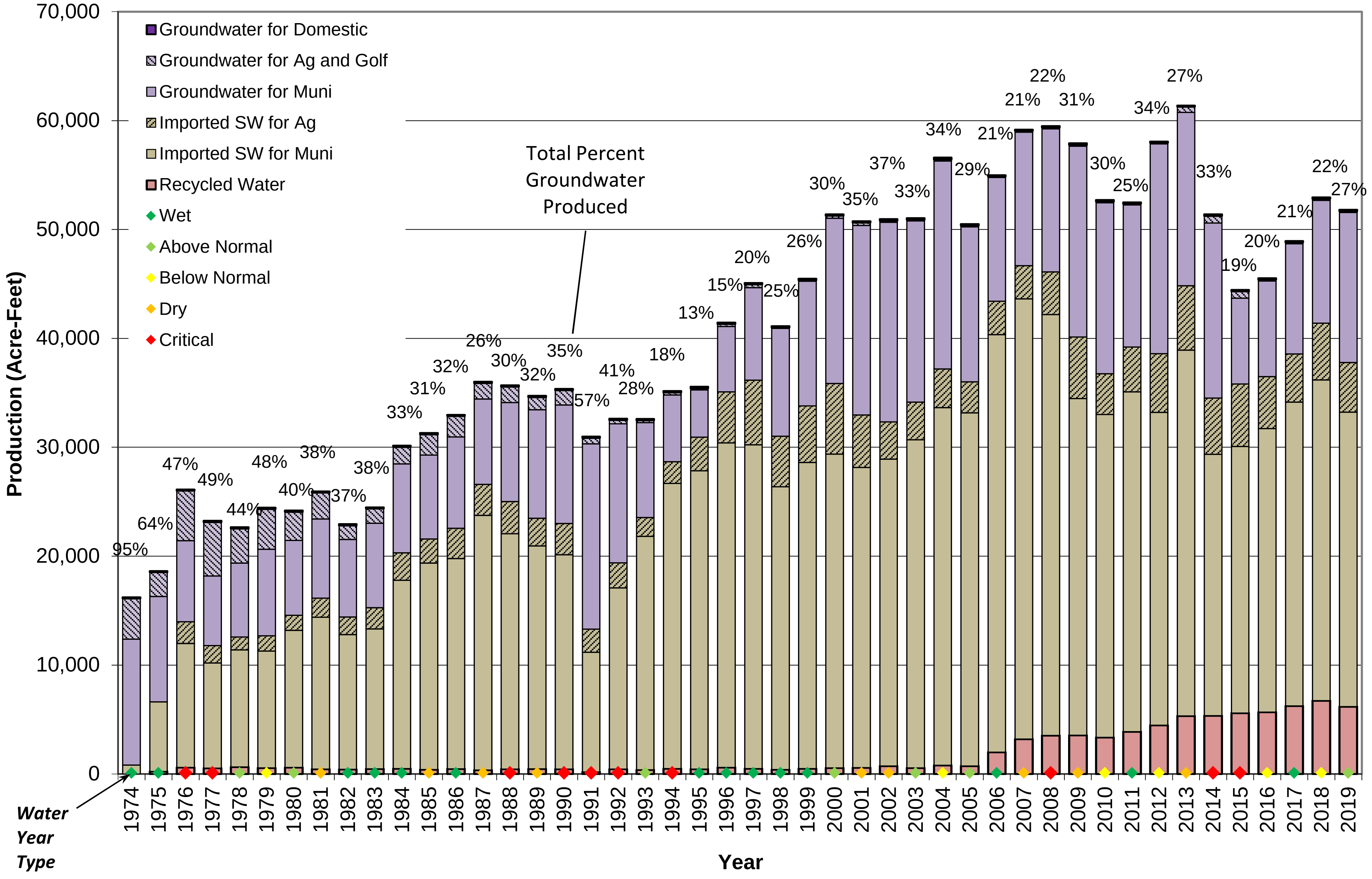
2019 Water Year (except where noted)

Figure 12-1



* 2019 Calendar Year

FIGURE 12-2
VALLEY WATER PRODUCTION FROM IMPORTED WATER AND GROUNDWATER
1974 TO 2019 WATER YEARS



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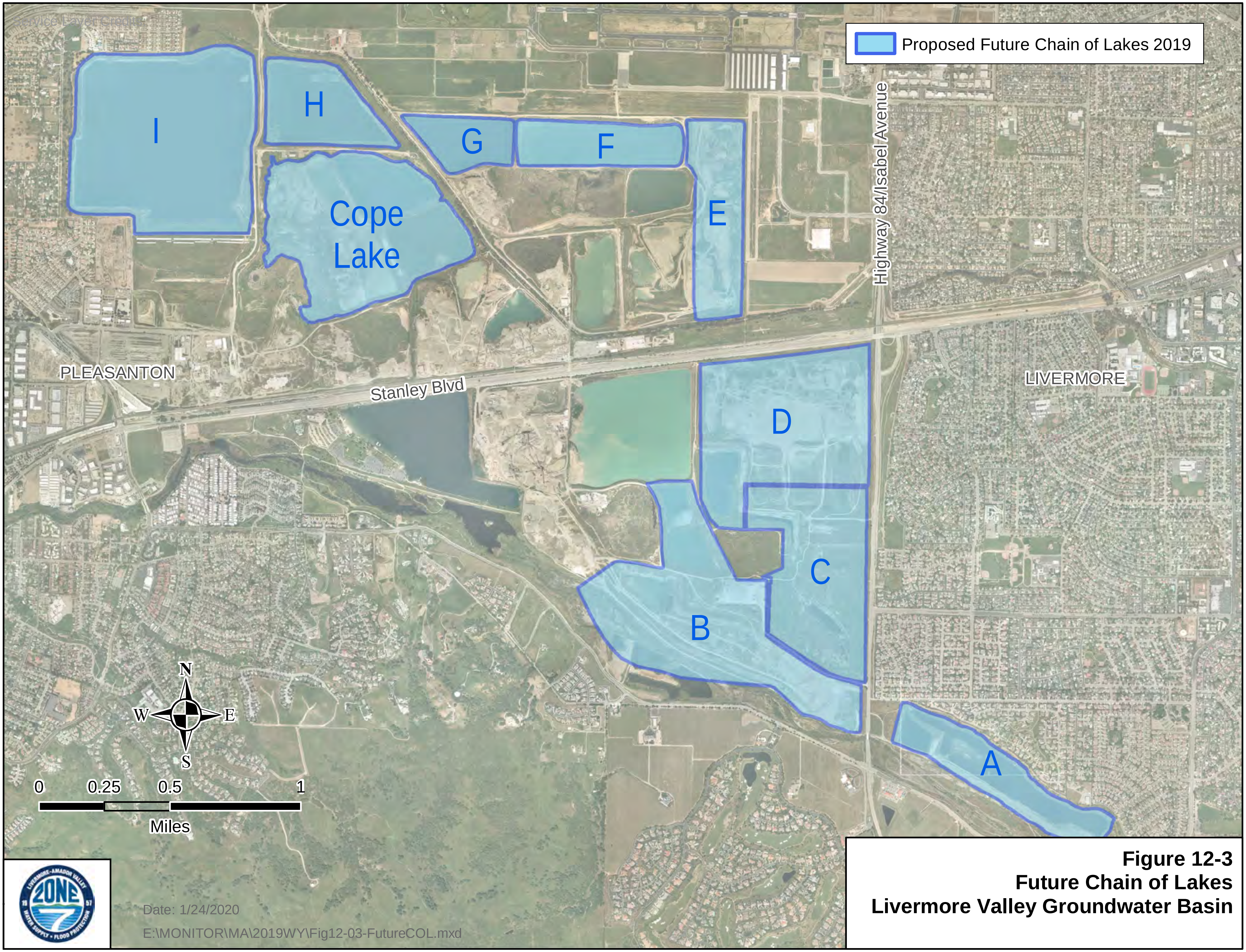

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Figure 12-3
Future Chain of Lakes
Livermore Valley Groundwater Basin

13 Water Quality Sustainability

13.1 Introduction

Recognizing the importance of the groundwater basin for supply and storage, Zone 7 has long championed groundwater quality protection. Its ongoing programs are directly beneficial for maintaining groundwater quality, meeting basin plan objectives (*California RWQCB, 2011*), and are indirectly supportive of groundwater supply objectives. Specific Zone 7 groundwater quality projects and management actions include:

- The Well Ordinance Program, which requires permitting for the construction, repair, reconstruction, and destruction or abandonment of wells and borings. The program also includes permit compliance inspections.

- The Toxic Sites Surveillance (TSS) Program, which tracks progress of polluted sites across the groundwater basin that pose a potential threat to drinking water. Zone 7 also interfaces with lead regulatory agencies to ensure that their actions adequately protect groundwater quality.

- The 2004 Salt Management Plan (SMP, *Zone 7 2004*) is a substantial, 450-page document reflecting a cooperative effort to address the increase in TDS observed in some portions of the groundwater basin. Implementation has included modifications to existing conjunctive use programs, plus development of the Zone 7 Mocho Groundwater Demineralization Plant (MGDP).

- The 2015 Nutrient Management Plan (NMP, *Zone 7 2015b*) was conceived as an addendum to the SMP. Implementation of the NMP involves ongoing monitoring of nitrate in groundwater, and coordination with land use agencies for BMP requirements to manage nitrogen loading to the Basin, plus coordination with ACDEH.

The following sections provide the 2019 WY updates to the above programs including details of any significant changes that were made during the water year.

13.2 Well Ordinance Program

Zone 7 administers the associated well permit program within its service area and the three incorporated cities (Dublin, Livermore, and Pleasanton) pursuant to a MOU with Alameda County and ordinances adopted by the three cities. As a result, any planned new well construction, soil-boring construction, or well destruction must be permitted by Zone 7 before the work is started. Additionally, all unused or abandoned wells must be properly destroyed, or, if there are plans to use the well in the future, a signed statement of future intent must be filed at Zone 7.

During the 2019 WY, Zone 7 issued 139 drilling permits, 26 less permits than in the 2018 WY. *Table 13-A* details the breakdown of the types of permits issued during the 2019 WY and their quantities.

Table 13-A: Well Ordinance Permits Issued in the 2019 Water Year

Permit Type	Quantity
Geotechnical Investigations	74
Well Destructions	12
Contamination Investigations/Remediation	21
Water Supply Wells	17
Groundwater Monitoring	14
Cathodic Protection Wells	1
Total	139

- Seventeen (17) water supply well permits were issued in the 2019 WY. The pre-drought average was 25 per year.

- About 83% of the permitted well work was physically inspected by Zone 7 permit compliance staff; the remaining 17% was allowed to proceed with self-monitoring and reporting efforts when a licensed professional was supervising the project.

13.3 Toxic Site Surveillance Program

13.3.1 Program Description

Through the TSS Program, Zone 7 documents and tracks polluted sites that pose a potential threat to drinking water. In general, the TSS Program monitors two types of contamination threatening groundwater: petroleum-based fuel products and industrial chemical contamination (e.g., chlorinated solvents).

The TSS Program is directly applicable to the basin measurable objective of maintaining and protecting groundwater quality through its provision of information to agencies and the public. The TSS Program also supports basin measurable objectives of maintaining groundwater levels and storage; the TSS Program helps to protect municipal wells that have an integral role in conjunctive use. There were no administrative changes to the TSS monitoring program in the 2019 WY.

13.3.2 Active Cases

In the 2019 WY, Zone 7 tracked the progress of 44 active sites where contamination has been detected in groundwater or is threatening groundwater. Eight of these active sites have a contaminant plume that is within 2,000 ft of a water supply well or a surface water source, and are therefore classified as “High Priority” cases due to their impact or threat of impact on potable groundwater supplies. Zone 7’s database also contains 284 other contamination cases that have been either “Closed” or classified as “No Action Required” because they have been sufficiently cleaned up and/or pose minimal threat to drinking water supplies.

The locations of all the toxic sites, and their proximity to the Valley's municipal water wells, are shown on the accompanying individual area maps (*Figure 13-1 through Figure 13-3*, Livermore, Pleasanton/Sunol, and Dublin, respectively). *Table 13-1* contains a summary for each of the 44 active sites including the case status, its priority, and which agency is responsible for providing oversight for the case. It also identifies the contaminants of concern for each case and provides brief notes regarding the cases in the 2019 WY. In addition, copies of plans, reports, directive letters, and background data on the cases can be found at the SWRCB's GeoTracker website: *http://geotracker.waterboards.ca.gov/*. The GeoTracker number for each case (if one is assigned) is also included in *Table 13-1*.

13.3.3 Case Closures

No toxic sites were granted "Case Closed" status in the 2019 WY; however, closure requests for eight cases were pending decisions at the end of the 2019 WY (see the following Section). Four new cases (Sites 328, 329, 330, and 331) were added to the Zone 7 database in the 2019 WY.

13.3.4 Sites Pending Closure Review

"Case Closure" was requested by representatives for the eight contamination sites listed below. Their locations are provided on *Figure 13-4.* At the end of the 2019 WY, the lead agencies were still considering the requests, but may ask for additional information before making their decision. Cases approved for closure by ACDEH must be reviewed and accepted by the RWQCB before they are officially closed. Information on each pending closure request, including Zone 7's recommendations, is summarized as follows:

- Site 31: Dublin Toyota Pontiac, Dublin. ACDEH has recommended the case for closure under the Low-Threat Underground Storage Tank Closure Policy (LTCP). Closure will be granted after the well destruction, waste removal, and the supporting report, which was due October 22, 2018. In May of 2019, the RWQCB issued a Notice to Comply to the owners requesting proper well destruction paperwork. A well destruction permit was issued by Zone 7 in July 2019. Staff does not object to the pending case closure.

- Site 37: Applied Biosystems, Pleasanton. A 5-year remedial action review report was submitted by the Responsible Party (RP) in July 2018. The report showed that the groundwater concentrations in the sole remaining monitoring well were below MCLs for tetrachloroethylene (PCE), trichloethylene (TCE), and 1, 1-Dichloroethene (DCE). The RP requested permission to discontinue groundwater monitoring, for the well to be destroyed, the case closed, and the deed restriction rescinded. The Department of Toxic Substances Control (DTSC) approved discontinuing the groundwater sampling and then requested a well decommissioning plan. DTSC said the removal of the deed restriction will need to be done in accordance with Health and Safety Code 25224 following the well decommissioning. Staff does not object to the pending closure.

- Site 68: Chevron, #9-2582 (Dublin Auto Wash), Dublin. This case meets the LTCP Scenario 2 criteria for closure. Some localized methyl tertiary-butyl ether (MTBE) contamination remains in groundwater, but the plume appears to be decreasing. There are no municipal supply wells in

Dublin. The site is over 1,000 ft from any private supply wells, and Zone 7 staff does not object to its closure. ACDEH notified the RP that they were out of compliance on uploading reports to GeoTracker in August 2019. There was no progress made by the RP in the 2019 WY.

- Site 191: Former Beacon, #3604/Ultramar, Livermore. In September 2018, the RP submitted a Conceptual Site Model Update and Closure Request. Multiple remedial technologies have been conducted at the site over the past 25 years including excavation, soil vapor extraction (SVE), air sparging, oxygen injection, and in-situ chemical oxidation (ISCO). ACDEH agreed to the case being closed under LTCP category 5 because the remaining contaminant plume poses low risk to human and environmental health. The well destruction report was uploaded in July 2019. The site will be closed after the landowner has been notified and a waste removal report has been submitted. Staff does not object to the closure of this case.

- Site 284: Former Crow Canyon Dry Cleaner, Dublin. The RP requested closure in the 2015 WY based on the success of remedial actions, and because the vapor measurements are below Environmental Screening Levels (ESLs). Vapor contamination is the main concern at the site. The groundwater detections for PCE and trichloroethylene (TCE) are below their respective MCL. ACDEH directed the RP to conduct additional work to move ACDEH's consideration forward. The RP has not followed through with the work requested by ACDEH. Zone 7 staff does not object to the groundwater case closure.

- Site 308: Green on Park Place, Dublin. The case was slated for closure in 2014 but the case closure was never finalized. In October 2014 the only items remaining involved properly disposing of contaminated stockpiled soil. ACDEH sent a compliance letter to the RP in the 2019 WY. Staff does not object to the closure of this case.

- Site 313: Just Tires, Livermore. This case is slated for closure. Comments on pending closure were due January 2016. The case is a soil contamination case. No fuel contaminants were detected in groundwater beneath the site. Staff does not object to the pending case closure. ACDEH sent multiple letters to the RP to finalize the closure report, but they have not responded. There was no progress in the 2019 WY.

- Site 317: Walgreens Spill, Sunol. Case was approved for closure by ACDEH under the LTCP. The RP was required to remove any remaining waste from the site and provide ACDEH with a report by April 22, 2018 to finalize the requirements for case closure. The report has not been submitted to GeoTracker so the case closure is still pending. Staff does not object to the case closure approval. There was no progress in the 2019 WY.

13.3.5 New Cases

Four new cases (Sites 328, 329, 330 and 331) were added to the Zone 7 TSS Program in the 2019 WY. Their locations are shown on *Figure 13-4.*

- Site 328: Pleasanton Lucky Cleaners, Pleasanton. The site is a "non-case" (information only) site being evaluated by the RWQCB as part of a regional dry cleaner assessment. PCE and TCE were detected at low levels in soil vapors, but no volatile organic compounds (VOCs) were detected in groundwater. The RWQCB will assess whether the site needs to become an official case or if "no further action" is warranted.

- Site 329: Pleasanton French Laundry (Former), Pleasanton. This site started as a "non-case" site through the RWQCB regional dry cleaner assessment. A site assessment was opened in June 2019 after preliminary sampling showed elevated VOCs in a soil vapor sampling survey. A second phase of sampling resulted in one detection of PCE in groundwater, just under the MCL.
- Site 330: City Cleaners, Pleasanton. The case was included in the RWQCB dry cleaner survey and started as a "non-case" site. As data was collected the site was determined to be a contamination case and officially opened in the 2019 WY. PCE and other VOCs have been detected in soil and soil vapor, but no VOCs have been detected in groundwater beneath the site.
- Site 331: Taylor Corporation, Livermore. This case was opened in the 2019 WY as a result of the ongoing investigation at TS#36 Salinas Reinforcement. Some of the VOCs detected in groundwater beneath the Salinas site appear to be originating from upgradient. The RWQCB has directed Taylor Corporation to conduct a soil and groundwater investigation at their site.

13.4 Salt Management

13.4.1 Introduction and Strategy

Agriculture and urban development over the Basin has led to rising salt concentrations in local groundwater. Mainly, irrigation of crops and landscape concentrates the salts and minerals delivered in the source water through evapotranspiration processes, which results in higher salinity leachate and percolate recharging groundwater and impacting its TDS concentration. Impacts from historic, and to a lesser degree current wastewater disposal practices, have also contributed to the increase of groundwater salinity in the Basin. Without management and/or mitigation, groundwater salinity would continue to rise (*Zone 7, 2004)*.

In 2004, Zone 7 prepared a SMP (*Zone 7, 2004*) to reduce annual salt loading and increase salt removal to protect the long-term water quality of the Main Basin, while expanding the area's use of recycled water. The SMP was approved by the RWQCB in October 2004 and then incorporated into Zone 7's Groundwater Management Plan in 2005 (*Zone 7, 2005a*).

The SMP is an active ongoing program that uses an adaptive management approach to select the combination of salt management strategies to be implemented in a given year. The available SMP strategies include: salt removal by groundwater pumping; salt exportation through the operation of Zone 7's groundwater demineralization facility (MGDP), and reduction of groundwater salinity by artificially recharging lower salinity imported water. See *Section 5.3.3.2, Salt Management Strategy* of the Alternative GSP for more information on the salt management strategies employed by Zone 7.

13.4.2 Salt Management for 2019 WY

13.4.2.1 Salt Management Actions

No changes were made involving the SMP or SMP strategies in the 2019 WY. The following is a summary of the salt management actions conducted by Zone 7 during the 2019 WY:

- Zone 7 pumped 8,666 AF of higher TDS (584 mg/L, average) groundwater into its distribution system, which resulted in 6,877 tons of salts being removed from the groundwater basin.
- Zone 7 exported 1,873 tons of salts from the Valley with the operation of its MGDP groundwater demineralization facility (discussed in *Section 13.4.2.3*).
- Zone 7 imported and artificially recharged 2,943 AF of lower TDS (139 mg/L, average) into the Basin.

13.4.2.2 Salt Loading Calculations

Table 13-2 contains the salt loading totals for each Hydrologic Inventory (HI) component for water years 1974 through 2019*. Table 13-B* below shows the salt loading summary for the 2019 WY. These salt loading calculations take into account the addition and removal of salt mass to and from the Main Basin by tracking or estimating the TDS concentration of each Supply and Demand component of the HI and multiplying it by the volume for each HI component (*Section 11.1.3., Hydrologic Inventory Results).* Net change in salt mass alone is not a good indicator of the change in water quality because it does not take into account the amount of water associated with the salt mass increase (or decrease). For example, a larger volume of water having a lower TDS concentration could conceivably contain more salt mass than a smaller volume with higher TDS concentration. Accordingly, Zone 7 calculates an end-of-water-year theoretical average TDS concentration for the entire Main Basin for comparison with previous years (*Figure 13-5*). For this approximation, Zone 7 assumes a starting average TDS concentration of 450 mg/L in 1973 (*DWR, 1974*), and then calculates a running annual average TDS concentration based on the annual inflows and outflows and net salt load and removals for each year since then. The results are believed to be conservative or “worst case” because the computation assumes that all of the salts in the applied waters are added to groundwater during the annual time-step that they are applied. In reality, some of the salts may end up being fixed in the vadose zone and confining clays.

Table 13-B: Salt Loading Summary for 2019 WY

Category	Volume (AF)	Salt Mass (Tons)	TDS Concentration (mg/L)	Change in Concentration from 2018 WY
Inflow	23,626	12,929	403	8 mg/L
Outflow	19,177	11,659	448	-4 mg/L
Net (In – Out)	4,448	1,270	210	
Basin Total	255,332	227,974	657	-9 mg/L

- In the 2019 WY, the total salt mass added to the Main Basin by all the inflow (Supply) components was approximately 12,929 tons, whereas, the total mass of salts removed from the Basin by all the outflow (Demand) components is estimated at 11,659 tons; a net increase of 1,270 tons.

- While the salt load increased during the 2019 WY, the end-of-water-year theoretical average TDS concentration for the Main Basin decreased by 9 mg/L from the previous water year average to 657 mg/L (*Figure 13-5*). This is because the salt load was accompanied by 4,484 AF of recharge, which is essentially the same as diluting the water in storage (666 mg/L TDS in 2018 WY) with water having a TDS concentration of 210 mg/L (1,270 tons/4,4484 AF).

13.4.2.3 Groundwater Demineralization Program

Zone 7's MGDP reduces salt buildup in the groundwater basin while improving delivered water quality to meet targets established in Zone 7's Water Quality Policy. The MGDP is a reverse osmosis (RO) membrane-based treatment system that produces product water with extremely low TDS. The demineralized water is blended with other groundwater (non-demineralized) or system water to achieve the desired overall delivered water TDS and hardness. The brine concentrate from the RO process is exported out of the watershed to San Francisco Bay by way of the regional wastewater export pipeline operated by the LAVWMA and DSRSD-EBMUD Recycled Water Authority (DERWA).

- During the 2019 WY, the MGDP produced 481 AF of brine (compared to 268 AF in the 2018 WY) that resulted in the export of about 1,873 tons of salt from the Main Basin through the LAVWMA pipeline (compared to 1,168 tons in the 2018 WY).

- Since its inception, the MGDP has exported 17,405 tons of salt from the Valley. *Table 13-C* below presents the salts removed by the MGDP from its construction in 2009 through the 2019 WY.

Table 13-C: Salts Removed by Zone 7's Mocho Groundwater Demineralization Plant Operations

Water Year	Brine Volume Exported from Valley (AF)	Average Brine TDS Concentration (mg/L)	Salt Mass Exported (Tons)	Salt Removed per AF of Brine Export (Tons/AF)
2009	192	3,059	798	4.16
2010	675	3,010	2,760	4.09
2011	429	3,445	2,008	4.68
2012	935	3,198	4,062	4.34
2013	518	3,522	2,478	4.78
2014	214	3,607	1,049	4.9
2015	16	3,474	76	4.75
2016	51	2,662	184	3.61
2017	244	2,863	949	3.89
2018	268	3,209	1,168	4.36
2019	481	2,867	1,873	3.89
TOTAL	4,023	3,185	17,405	4.33

AF = acre-feet TDS = total dissolved solids

mg/L = milligrams per liter

13.5 Nutrient Management

13.5.1 Introduction

The principal nutrient of concern in the Livermore Valley is nitrate. The State MCL for nitrate in drinking water is 10 mg/L, which is also the value used as the Basin Objective by the RWQCB and as the minimum threshold by Zone 7. The results of monitoring for nutrients in the groundwater for the 2019 WY are reported in *Section 7.1.*

13.5.2 Nutrient Management Plan

In June 2015, Zone 7 adopted its NMP (*Zone 7, 2015b*), and by resolution the RWQCB concurred with the findings and measures of the NMP in March 2016. The NMP assesses the existing and projected future groundwater nutrient concentrations relative to the current and planned expansion of recycled water projects and future development in the Livermore Valley. The NMP concludes that although overall basin groundwater quality is not expected to degrade, there is still a need to monitor and manage nutrient loading. A description of the NMP is provided in *Section 5.3.4.1*, *NMP*, of the Alternative GSP.

The NMP outlines plans to minimize nitrogen loading from existing sources. The NMP also presents planned actions for addressing positive nutrient loads and high groundwater nitrate concentrations in localized AOCs where the use of OWTS is the typical method for sewage disposal (which can be a contributor to nitrate contamination). To minimize nitrogen loading, the NMP calls for the continued use of Best Management Practices (BMPs) for such facilities as horse boarding facilities, vineyards, irrigated turf/landscapes, and wineries. The NMP also recommends implementing additional OWTS performance measures for new and replacement OWTS in the AOCs (see *Section 13.5.3* below). The NMP includes an implementation schedule that recognizes the ongoing monitoring and BMPs and presents a specific schedule for AOC investigations.

- During the 2019 WY, Zone 7 continued working with ACDEH to implement the NMP measures.

- Zone 7 also took advantage of opportunities to obtain additional groundwater samples from private homeowners' wells as they arose, and to work with ACDEH and RWQCB to require monitoring wells for OWTS projects where appropriate.

13.5.3 OWTS Management

ACDEH administers the County OWTS Ordinance and is responsible for reviewing OWTS plans and issuing permits for the installation, repair, alteration, and operation of OWTS within Alameda County. In addition, Zone 7 Board approval is explicitly required for nonresidential uses of OWTS within the Upper Alameda Creek Watershed (Resolution 1165). See *Section 5.3.5*, *OWTS Management*, of the Alternative GSP for more information on Zone 7's role in managing OWTS densities within the Livermore Valley Groundwater Basin and watershed.

- One new authorization for nonresidential OWTS was granted by the Zone 7 Board of Directors in the 2019 WY. However, that authorization was later rescinded by the Zone 7 Board when the County's California Environmental Quality Act (CEQA) analysis described the project as having the potential for greater onsite wastewater loading than that originally considered by the Zone 7 Board. The applicant has been asked to resolve the discrepancies before the Board will reconsider the authorization request.

TABLE 13-1
TOXIC SITES SURVEILLANCE - ACTIVE SITES SUMMARY
2019 WATER YEAR

ID: 1 **NAME:** Lawrence Livermore Lab **OWNER:** Lawrence Livermore National Laboratory **PRIORITY:** 3A3 **STATUS** 7

ADDRESS: 7000 East Avenue , Livermore

LEAD AGENCY: ACEH

GEOTRACKER ID: T0600191466

CHEMICAL	CONCENTRATION ug/L
TCE	610

At the end of the 3rd Quarter 2019, a cumulative site total of approximately 1,765 kilograms (kg) of volatile organic compounds (VOCs) from groundwater and 1,618 kg of VOCs from soil vapor have been removed from the site. In 2018, VOC concentrations declined or remained stable; 3 ground water monitoring wells were installed in the TFD and TFE areas; and 14 obsolete wells were destroyed in accordance with Zone 7 guidelines.The 2018 annual report is available at: https://saer.llnl.gov/. The 2019 annual report is not yet available but the 3rd Quarter self monitoring report shows similar concentrations to 2018 and is available on GeoTracker.

ID: 5 **NAME:** Sandia National Labs **OWNER:** Sandia National Laboratory **PRIORITY:** 3A3 **STATUS** 8

ADDRESS: 7011 East Avenue, Livermore

LEAD AGENCY: RWQCB

GEOTRACKER ID: T0600191470

CHEMICAL	CONCENTRATION ug/L
TPHd	650
NO3	NS
CCL4	1.5
CR(IV)	0.23

The Site Environmental Report for 2018 Sandia National Laboratories, California is the most recent report available. It is not uploaded to GeoTracker but is available on the Sandia website:
https://www.sandia.gov/news/publications/environmental_reports/_assets/documents/ASER_2018_CA_web.pdf
Monitoring results continued to show carbon tetrachloride in groundwater at the Navy Landfill in 2018 with a concentration similar to that detected in past years. Diesel was detected in groundwater from wells at the Fuel Oil Spill site in 2018. The average annual gamma radiation dose from all sources at the site perimeter in 2018 was 43 mrem (0.43 mSv), well below the allowable annual exposure dose to the public of 100 mrem established by DOE.

ID: 11 **NAME:** Intel Livermore Fabrication Plant 3 **OWNER:** Intel **PRIORITY:** 2A3 **STATUS** 8

ADDRESS: 250 North Mines Road, Livermore

LEAD AGENCY: RWQCB

GEOTRACKER ID: SL18368788

CHEMICAL	CONCENTRATION ug/L
TCE	100
1,2-DCE	120
VC	71
PCE	5.9

On 8/23/19 the RWQCB sent an official response to the 2015 request for clouse. The RWQCB will require the following before the RWQCB will issue a letter stating that no further action is warranted for this site:
- Risk Management Plan (RMP) must be submitted by Nov 2019 and approved,
- A deed restriction that references the RMP must be recorded, and
- Existing wells must be appropriately destroyed.

A covenant and environmental restriction was filed for the propoerty in Feb 2019. There has been some discusion between all the parties regarding the well destructions and a permit has not been issued yet.

ID: 31 **NAME:** Dublin Toyota Pontiac **OWNER:** Ozzie Davis Pontiac Toyota **PRIORITY:** 2C **STATUS** 8

ADDRESS: 6450 Dublin Court, Dublin

LEAD AGENCY: ACEH

GEOTRACKER ID: T0600102153

CHEMICAL	CONCENTRATION ug/L
TPHg	ND
MTBE	110
BENZ	ND
TBA	330

The case has been considered for closure since July 2018. In May of 2019, the RWQCB issued a Notice to Comply to the owners requesting proper well destruction paperwork. A well destruction permit was issued in July 2019. Last report was 2nd Semi Annual GW Monitoring 2017.

ID: 36 **NAME:** Salinas Reinforcing Inc. **OWNER:** Richmond Lox/ Salinas Reinforcement **PRIORITY:** 3A3 **STATUS** 5C

ADDRESS: 355 South Vasco Road, Livermore

LEAD AGENCY: RWQCB

GEOTRACKER ID: SL18266687

CHEMICAL	CONCENTRATION ug/L
TCE	770
TPHg	NA
BENZ	NA

RWQCB met with the RP and conditionally approved the workplan to investigate the deeper groundwater and soil gas. If concentrations are shown to be decreasing then the case may be eligible for closure with conditions. A drilling permit application was submitted in October. A report of findings is due to the RWQCB by the end of December 2019.

ID: 37 **NAME:** Applied Biosystems **OWNER:** Applied Biosystems (formerly Kaiser Aluminum & Chemical) **PRIORITY:** 2C **STATUS** 8

ADDRESS: 6001 (Formerly 6177) Sunol Boulevard, Pleasanton

LEAD AGENCY: DTSC

GEOTRACKER ID: 01280050

CHEMICAL	CONCENTRATION ug/L
PCE	22
TCE	0.59
1,1-DCE	9.8

The links to files on EnviroStor are broken. An Annual Land Use Restriction Monitoring Report was submitted in January 2019. A monitoring well closure work plan was submitted in September 2019. A permit for the well destruction was issued in April 2019.

ID: **68** ***NAME:*** Chevron, #9-2582 (Dublin Auto Wash) ***OWNER:*** Chevron ***PRIORITY:*** 2C ***STATUS*** 8

ADDRESS: 7240 Dublin Boulevard, Dublin

LEAD AGENCY: ACEH

GEOTRACKER ID: T0600100355

CHEMICAL	***CONCENTRATION ug/L***
MTBE	130
BENZ	270
TPHg	2,700

ACDEH sent a follow up Notice to Comply on 1/30/2019. In addtion ACDEH attemped to send a Notice of Responsibility to the various RPs but the letters were retruned as undeliverable. No progress appears to be made in the 2019 water year.

ID: **84** ***NAME:*** Arrow Rentals ***OWNER:*** Livermore Redevelopment Agency ***PRIORITY:*** 1A2 ***STATUS*** 7

ADDRESS: 187 North L Street, Livermore

LEAD AGENCY: ACEH

GEOTRACKER ID: T0600100116

CHEMICAL	***CONCENTRATION ug/L***
TPHg	9,200
TPHd	NA
MTBE	48
BENZ	3,000

ACDEH response to submittals required destruction of remaining monitoring wells screened across multiple water bearing zones and installation of new monitoring wells. Zone 7 received permits with 5 wells proposed for destruction and 5 for construciton. Groundwater monitoring was postposed (beginning May 2019) until the Work Plan is completed. Work plan for site investigation and report on well installation & destruction are due by October 12, 2019.

ID: **115** ***NAME:*** Livermore Arcade (Miller's Outpost) ***OWNER:*** LASC/MOSC (Livermore Arcade) ***PRIORITY:*** 1A2 ***STATUS*** 7

ADDRESS: 1410/1554 First Street, Livermore

LEAD AGENCY: RWQCB

GEOTRACKER ID: SL18227625

CHEMICAL	***CONCENTRATION ug/L***
PCE	14
TCE	3.9
cis-1,2-DCE	6.9
Vinyl Chloride	6.3

RWQCB approved the workplan to complete the second round of transects three and four enhanced in-situ biodegradation (EISB) injections for the site. The required pre-injection activities include obtaining a drilling permit from Zone 7 and encroachement permit from City of Livermore. A round of groundwater sampling will be conducted in identified wells semi-annually to monitor the effectiveness of the EISB injections. The 5 year status report for this site is due by 9/30/19.

ID: 137 **NAME:** Busick Gearing Properties

OWNER: Busick Air Conditioning

PRIORITY: 2A3 **STATUS** 5C

LEAD AGENCY: RWQCB

ADDRESS: 6341 Scarlett Court, Dublin

GEOTRACKER ID: SL20256874

CHEMICAL	CONCENTRATION ug/L
TCE	5,200
PCE	120

No monitoring reports uploaded to GeoTracker since 2007. According to the Annual Estimate for SCP Cost Recovery Oversight letter from the RWQCB the expected upcoming activies for the site are to work on tech reports and cleanup for site closure, inspections, and update site cleanup requirements during 2019/2020 fiscal year.

ID: 149 **NAME:** Hanson Aggregates

OWNER: Kaiser Sand and Gravel

PRIORITY: 2A4 **STATUS** 5R

LEAD AGENCY: ACEH

ADDRESS: 3000 Busch Road, Pleasanton

GEOTRACKER ID: SLT19719376

CHEMICAL	CONCENTRATION ug/L
BENZ	ND
TPHd	50

ADDENDUM TO SUMMARY OF ENVIRONMENTAL STATUS REPORT: AOCS 1-5, 8 & 9 FORMER HANSON AGGREGATES RADUM FACILITY PLEASANTON, CALIFORNIA was submitted January 2019. TS#149 represents three separate GeoTracker IDs (SLT19719376, SL0600101555, and T10000009398). The 2019 Addendum and previous investigations of the Site's nine AOCs identified TPHd burdened areas in AOCs 1 and 3 that warrant further measures prior to moving forward with redevelopment in their vicinity. For AOCs 2, 4, 5 and 9, the investigation results indicated no residual impacts that would warrant further measures. The RP is requesting closure of these four AOCs. Further evaluation of AOC 8 will be performed.

ID: 191 **NAME:** Former Beacon, #3604

OWNER: Ultramar/Tesoro No. 67076

PRIORITY: 1C3 **STATUS** 8

LEAD AGENCY: ACEH

ADDRESS: 1619 First Street, Livermore

GEOTRACKER ID: T0600101410

CHEMICAL	CONCENTRATION ug/L
TPHg	35,700
MTBE	15
BENZ	2,100
TBA	190

No monitoring reports since 7/27//18. ACDEH stated that contaminant plume poses low risk to human and environmental health and site can be closed under LTCP. Site is approved for closure after landowner is notified, monitoring wells are destroyed, and well destruction and waste removal report is submitted. Well destruction report was uploaded 7/17/19 with WCRs for destruction. Z7 has received destrcution WCRs and entered destruction info.

ID: **232** **NAME:** Groth Brothers Chevrolet

ADDRESS: 59 South L Street, Livermore

OWNER: Bordoni Ranch LLC and Green Valley Corporation Tenancy in Common (BGTIC)

PRIORITY: 2A2 **STATUS** 5R

LEAD AGENCY: RWQCB

GEOTRACKER ID: SL0600147081

CHEMICAL	CONCENTRATION ug/L
BENZ	46
MTBE	1,200
TPHg	61,000
PCE	3000

Revised Soil and GW Management Plan (SGMP), revised Vapor Intrusion Risk Assessment (VIRA), and sewer screening evaluation were submitted and approved by RWQCB in June, 2019. More documentation was required for the vapor monitoring system (VIMS). An additional Vapor Intrusion Mitigation System design report was submitted in September, 2019.

ID: **238** **NAME:** All Rents

ADDRESS: 2247 Second Street, Livermore

OWNER: All Rents

PRIORITY: 1A2 **STATUS** 5C

LEAD AGENCY: UNK

GEOTRACKER ID: T10000008261

CHEMICAL	CONCENTRATION ug/L
1,2-DCE	14
TCE	250
PCE	430

Staff have been working with the RWQCB to try to elevate this site to an official contamination case. It is currently a non-case infomration site. No moniroting reports uploaded. Report summarizing environmental assessment and workplan due by May 10,2019 has not been uploaded.

ID: **242** **NAME:** Fairground Main Well (3S/1E 20B 2)

ADDRESS: 4501 Pleasanton Avenue, Pleasanton

OWNER: Alameda County Fairgrounds

PRIORITY: 1A1 **STATUS** 1

LEAD AGENCY:

GEOTRACKER ID:

CHEMICAL	CONCENTRATION ug/L
PCE	16

In 2016, RWQCB staff started looking into potential RPs. They sent letters to all current and former dry cleaners in the area. Zone 7 staff provided all the data we have to help with the investigation. In 2018 a dozen former dry cleaner sites upgradient of the Fairgrounds remain in GeoTracker as "non-case information sites". One case was turned into an active case with ongoing investigation in the 2018 WY. Two additional sites upgradient of the fairgrounds were upgraded to investigation cases in the 2019 WY.

ID: **250** **NAME:** Sunol Tree Gas **OWNER:** Murray Kelsoe **PRIORITY:** 1A1 **STATUS** 7

ADDRESS: 3004 andrade Road, Sunol

LEAD AGENCY: RWQCB

GEOTRACKER ID: T0600114064

CHEMICAL	CONCENTRATION ug/L
TBA	23.3
TPHg	54.3
MTBE	94.5

The April 2019 Notice of Pending Case Closure was withdrawn on 10/17/18. RP required to fully delineate MTBE GW plume, monitoring GW, and add site improvments to work plan. GW monitoring samples were taken from 12 wells, 3 borings and 4 adjacent properties. In January, 2019 the Work plan for additional site investigation was approved by RWQCB. Technical report for additional site investigation was submitted by RP in March.

ID: **259** **NAME:** CHEVRON #30-7233 /Mills Square Park/Performing Arts Theater **OWNER:** City of Livermore **PRIORITY:** 2A4 **STATUS** 7

ADDRESS: 2259 First Street, Livermore

LEAD AGENCY: ACEH

GEOTRACKER ID: T0600196622

CHEMICAL	CONCENTRATION ug/L
TPHg	3000
BENZ	0.5
TPHd	140

No signaficant impact was shown in the deep zone according to data from the 3 deep monitoring wells. 3 shallow wells are also being monitored. Eight permeable fill borings were installed to deliver gypsum to the areas with the most significant hydrocarbon impacts. These borings are about 40ft deep and are to be monitored in the future for effectiveness. Well competion reports for 6 monitoring wells were uploaded and 5 vapor probes were removed.

ID: **264** **NAME:** Railroad Ave-Livermore Site **OWNER:** Livermore Redevelopment Agency/Signature Properties **PRIORITY:** 2A4 **STATUS** 1

ADDRESS: 1934 - 1950 Railroad Avenue at North L Street, Livermore

LEAD AGENCY: ACEH

GEOTRACKER ID: T06019726132

CHEMICAL	CONCENTRATION ug/L
MTBE	280
BENZ	130
TPHg	1,200
PCE	30

Case inactive since 2005. ACEH transferred case to Reg Board. Only document in GeoTracker is a 2005 Sampling and Analysis Plan. No activity in the 2019 WY.

ID: **284** **NAME:** Former Crow Canyon Dry Cleaner **OWNER:** Gabriel Chiu **PRIORITY:** 3C **STATUS** 8

ADDRESS: 7272 or 7242 San Ramon Road, Dublin

LEAD AGENCY: ACEH

GEOTRACKER ID: T06019764784

CHEMICAL	CONCENTRATION ug/L
TCE	3
PCE	22

No updates in the 2019 WY. The RP requested closure in 2015 but did not respond to ACDEH requirements for additional evaluation and modification to the methodology of the Human Health Risk Assessment. The main concern is vapor contamination at the site. The groundwater detections are below MCLs for chlorinated solvents. Zone 7 staff does not object to case closure for groundwater. In 2018 ACDEH requested additional funding due to past due owed and amount of work still required to reach closure.

ID: **291** **NAME:** Perciva/Metro Valley Cleaners **OWNER:** Country Club Cleaners **PRIORITY:** 3A2 **STATUS** 7

ADDRESS: 224 Rickenbacker Circle, Livermore

LEAD AGENCY: ACEH

GEOTRACKER ID: T06019748481

CHEMICAL	CONCENTRATION ug/L
PCE	4.9

ACDEH issued a conditional approval for the scope of work plan. A multi-phase approach was proposed to evaluate the distribution of chemicals in GW, soil, and aoil vapor. ACDEH recommends a more limited phased approach with data review before additional work.

ID: **292** **NAME:** Former K&S Heavy Equipment **OWNER:** CW Roen **PRIORITY:** 2A4 **STATUS** 3A

ADDRESS: 495 Greenville Road, Livermore

LEAD AGENCY: ACEH

GEOTRACKER ID: T06019726510

The RP submitted a Site Characterization Report after collecting soil and groundwater data from 8 borings. ACDEH responded to the report with items that are still outstanding and will impede case closure. 1) Data Gap with respect to historical excavations of contaminated soil. 2) Data Gap with respect to Pesticides and Herbicides. These compounds were identifed as COCs but were not adequately sampled for in soil. ACDEH also pointed out that a vapor risk analysis had not been conducted.

ID: 298 **NAME:** Former Chevron Records Facility **OWNER:** Chevron **PRIORITY:** 2B4 **STATUS** 7

ADDRESS: 6400 Sierra Court, Dublin

LEAD AGENCY: RWQCB

GEOTRACKER ID: SL0600196603

CHEMICAL	CONCENTRATION ug/L
TCE	690
cis 1,2-DCE	1200
VC	20

The first SA 2019 GW Monitoring report was uploaded to GeoTracker. Jacobs recommends that for the next SA sampling, only VOCs are sampled and that monitoring ends for the 3 wells that have been non-detect for 5+ years.

ID: 299 **NAME:** Nica Metals **OWNER:** TDW Construction **PRIORITY:** 3A2 **STATUS** 3A

ADDRESS: 101 Greenville Road, Livermore

LEAD AGENCY: ACEH

GEOTRACKER ID: SLT19765274

CHEMICAL	CONCENTRATION ug/L
GRO	unknown

Site is non-compliant. Soil removal and implementation of site assessment were due May 2010. ACEH issued NOV letters in 2009 and 2010. No change in 2019 WY.

ID: 302 **NAME:** FCI Dublin **OWNER:** Federal Corrections Institution Dublin **PRIORITY:** 3A1 **STATUS** 3B

ADDRESS: 5701 8th Street, Dublin

LEAD AGENCY: ACEH

GEOTRACKER ID: SLT19749067

CHEMICAL	CONCENTRATION ug/L
TPHd	680,000

In 2010 ACEH responded to the Site Investigation Report that further investigation is needed to determine groundwater gradient and extent of contamination. Quarterly monitoring was required. The RP submitted a case closure request in Oct 2010. The case is still open and ACEH has not agreed to closure. No change in 2019 WY.

ID: ***307*** ***NAME:*** City of Pleasanton Theater Parking Lot ***OWNER:*** City of Pleasanton Public Works ***PRIORITY:*** 3B1 ***STATUS*** 5C

ADDRESS: 0 Kottinger Drive, Pleasanton

LEAD AGENCY: ACEH

GEOTRACKER ID: T10000001164

CHEMICAL	***CONCENTRATION ug/L***
TPHg	
TPHmo	

The new ACEH caseworker sent a letter on May 21, 2018 requesting a meeting to move the case to closure. No updates in GeoTracker for the 2019 WY.

ID: ***308*** ***NAME:*** Green on Park Place ***OWNER:*** Stockbridge/BHV Emerald Place Land Co ***PRIORITY:*** 3C ***STATUS*** 8

ADDRESS: 5411 Martinelli Way, Dublin

LEAD AGENCY: ACEH

GEOTRACKER ID: T10000005547

ACDEH sent a letter requesting funds for oversight on 12/19/18. The case was slated for closure in 2014 but the case closure was never finalized. In October 2014 the only items remaining involved properly disposing of contaminated stock piled soil.

ID: ***311*** ***NAME:*** Aster Apartments/Crown Chevrolet Cadillac Isuzu ***OWNER:*** Crown Chevrolet ***PRIORITY:*** 3A1 ***STATUS*** 5R

ADDRESS: 6775 Golden Gate Drive (formerly 7544 Dublin Boulevard), Dublin

LEAD AGENCY: ACEH

GEOTRACKER ID: T10000010517

CHEMICAL	***CONCENTRATION ug/L***
TPHg	4,900
TPHd	6,200
TPHmo	64
PCE	75
TCE	3.5

Cases for Crown Chevrolet North (T10000001616) and South (T10000005449) were closed and the post closure remediation was transferred to Aster Apartments (T10000010517). Monitoring of the Permable Reactive Barrier (PRB) and a Vapor Mitigation System (VMS) will continue.

ID: **312** ***NAME:*** Cemex Sunol ***OWNER:*** Cemex ***PRIORITY:*** 3A1 ***STATUS*** 1

ADDRESS: 6527 Calaveras Road, Sunol

LEAD AGENCY: ACEH

GEOTRACKER ID: T10000003431

CEMEX responded to ACEH's letter asking for funds to cover oversight. They said the spill was contained and cleaned up immediately after release the same day ACEH was notified. A report was filed within two days. They don't feel there is cause to open a case for investigation/remediation. Case is listed as Inactive on GeoTracker. No update in the 2019 WY.

ID: **313** ***NAME:*** Just Tires ***OWNER:*** Good Year Tire and Rubber Company ***PRIORITY:*** 2C ***STATUS*** 8

ADDRESS: 1485 First Street, Livermore

LEAD AGENCY: ACEH

GEOTRACKER ID: T10000003435

Caseworker sent multiple letters in 2016 that the case was ready for closure. No additional work has been done by the RP to finalize case closure in 2017-2019.

ID: **317** ***NAME:*** Walgreens Spill Sunol ***OWNER:*** Walgreens ***PRIORITY:*** 2C ***STATUS*** 8

ADDRESS: 9494 Koopman Road, Sunol

LEAD AGENCY: ACEH

GEOTRACKER ID: T10000006478

CHEMICAL	***CONCENTRATION ug/L***
TPHd	349

Case was approved for closure by ACDEH under the LTCP. The RP was required to remove any remaining waste from the site and provide ACDEH with a report by April 22, 2018 to finalize the requirements for case closure. The report has not been submitted to GeoTracker so the case closure is still pending. The only 2019 document was a requst for payment for case management by ACDEH.

ID: **318** ***NAME:*** G.I.G Oil Production Facility

OWNER: E&B Natural Resources Management Corporation

PRIORITY: 2A4 ***STATUS*** 8

ADDRESS: 8467 Patterson Pass Road, Livermore

LEAD AGENCY: ACEH

GEOTRACKER ID: T10000007269

CHEMICAL	***CONCENTRATION ug/L***

ACDEH has still not responded to the RP's case closure request. All soil and groundwater samples were non-detect for fuel contaminants and within background range for metals. No updates in the 2019 WY.

ID: **319** ***NAME:*** Former Clorox Site - Building 7

OWNER: Johnson Drive Holdings I, LLC/Clorox Products Manufacturing Company

PRIORITY: 2A2 ***STATUS*** 5R

ADDRESS: 7200 - 7208 Johnson Drive, Pleasanton

LEAD AGENCY: RWQCB

GEOTRACKER ID: T10000007118

The RP submitted a Remedial System Construction Completion and Startup Report, which was approved by the RWQCB in August 2019. The Board requires semi-annual sampling of indoor air and soil vapor for PCE, with the report due by the end of October 2019.

ID: **320** ***NAME:*** Dublin Crossroads Center & Park Ave Cleaners

OWNER: Ready Family Partnership, LP

PRIORITY: 2A4 ***STATUS*** 5C

ADDRESS: 7100-7120 Dublin Boulevard, Dublin

LEAD AGENCY: ACDEH

GEOTRACKER ID: T10000004783

RP submitted an Addendum Work Plan for Additional Investigation to ACDEH which was conditionally approved. ACDEH requested that the RP perform the proposed work and schedule a meeting with ACDEH and the environmental consultant within two weeks of completing field activities, by July 24, 2019, to discuss the data and path forward for the site prior to submission of a site investigation report. The report has not been uploaded to GeoTracker yet.

ID:* 322** ***NAME: Niles Canyon Railway
OWNER: Pacific Locomotive Association DBA Niles Canyon Railway
PRIORITY: 3B1 ***STATUS*** 7
ADDRESS: 9 Kilkare Road, Sunol
LEAD AGENCY: ACDEH
GEOTRACKER ID: T10000006021

CHEMICAL	*CONCENTRATION ug/L*
PCE	36

No updates in the 2019 WY. An oil leak was discovered from a locomotive on the Niles Canyon Railway. Soil was removed and confirmation sampling was conducted under the direction of the ACEH. The very delinquent report was submitted to ACEH on 7/20/2016. The RP requested closure. ACEH response is still pending

ID:* 323** ***NAME: Former American Cleaners
OWNER: Stoll Main Street Trust
PRIORITY: 2A4 ***STATUS*** 7
ADDRESS: 555 Main Street, Pleasanton
LEAD AGENCY: RWQCB
GEOTRACKER ID: T10000008240

CHEMICAL	*CONCENTRATION ug/L*
PCE	49,000
TCE	1,600
Cis 1,2 DCE	2,900

Site Assessment & Soil Vapor Extraction Pilot Test Work Plan was submitted and partially approved. Pilot test and indoor air sampling work plans were approved, and SVE pilot test can be approved after 30 day comment period ends in August. PCE and TCE concentrations are high but have been improving.

ID:* 324** ***NAME: Chestnut Square
OWNER: MidPen Housing Corporation
PRIORITY: 1A2 ***STATUS*** 7
ADDRESS: 1651 and 1665 Chestnut Street, Livermore
LEAD AGENCY: ACDEH
GEOTRACKER ID: T10000007202

CHEMICAL	*CONCENTRATION ug/L*
PCE	15
TPHd	130

The Soil corrective Action Completion Report was approved and a Vapor Intrusion HHRA was submitted. The VI HHRA was revised and reviewed by a third party toxicologist in May 2019 as requested by ACDEH. The owner will address onsite contamination but will not be required to remediate since the source originated offsite.

ID: **325** **NAME:** 217 North N St **OWNER:** MidPen Housing Corporation **PRIORITY:** 2A1 **STATUS** 7

ADDRESS: 217 North N Street, Livermore

LEAD AGENCY: ACDEH

GEOTRACKER ID: T10000011094

CHEMICAL	CONCENTRATION ug/L
PCE	13

Corrective Action Implementation Plan was submitted and includes the following actions: shallow soil excavation, vapor mitigation systems, and utility trench plugs. Architectural plans, Operations & Maintenance Plan, and Volutary Remedial Action Agreement were aubmitted in 2019.

ID: **326** **NAME:** Livermore Department of Public Works **OWNER:** City of Livermore **PRIORITY:** 1A1 **STATUS** 1

ADDRESS: Rincon and Juniper and Spruce, Livermore

LEAD AGENCY: RWQCB

GEOTRACKER ID: SLT2O09096

CHEMICAL	CONCENTRATION ug/L
PCE	

Division of Drinking Water confirmed that treatment is in place for removal of PCE in Well 10-01. the CERCLA Screening Site Inspection (1991) and Expanded Site Inspection Results Report (1993) were uploaded.

ID: **327** **NAME:** VIP Cleaners **OWNER:** BMMR USA, Inc. **PRIORITY:** 2A2 **STATUS** 3B

ADDRESS: 1809 Santa Rita Road, Suite F, Pleasanton

LEAD AGENCY: RWQCB

GEOTRACKER ID: T10000008254

CHEMICAL	CONCENTRATION ug/L
PCE	140
TPHg	130

The Source Area Investigation Report was approved and an additional Source Characterization Workplan with a Public Notification Workplan are required. As of June 2019, additoinal indor air, soil vapor, and GW invstigation is requestedand air ampling is proposed in adjacent units. A Contigency Plan for Indoor Air Sampling underwent revisions and is approved and a Community Profile Plan has ben submitted.

ID: 328 **NAME:** Pleasanton Lucky Cleaners **OWNER:** Diamond Properties, Inc **PRIORITY:** 3B1 **STATUS** 3A

ADDRESS: 6051 W. Las Positas Blvd., Pleasanton

LEAD AGENCY: RWQCB

GEOTRACKER ID: T10000008267

This is a non-case information site being investigated as part of the RWQCB's dry cleaner survey. Low levels of PCE and other VOCs have been detected in soil gas but no PCE or TCE has been detected in groundwater.

ID: 329 **NAME:** Pleasanton French Laundry (Former) **OWNER:** Terrell Bates & Kimberly R Trust **PRIORITY:** 2A4 **STATUS** 3A

ADDRESS: 560 Main Street, Pleasanton

LEAD AGENCY: RWQCB

GEOTRACKER ID: T10000008241

CHEMICAL	CONCENTRATION ug/L
PCE	4.8

This site started as a non-case information case through the RWQCB regional dry cleaner assessment. A site assessment was opened in June 2019 after preliminary sampling showed elevated VOCs in a soil gas sampling survey. A second phase of sampling showed one detection of PCE in groundwater just under the MCL.

ID: 330 **NAME:** City Cleaners **OWNER:** FFHS Associates - Gateway, L.P. ; Margo Foster **PRIORITY:** 2A4 **STATUS** 3A

ADDRESS: 4855 Hopyard Road, Suite C, Pleasanton

LEAD AGENCY: RWQCB

GEOTRACKER ID: T10000008237

The case was included in the RWQCB dry cleaner survey and started as an non-case information site. As data was collected the site was determined to be a contamination case and officially opened in the 2019 WY. PCE and other VOCs have been detected in soil and soil vapor but no VOCs have been detected in groundwater beneath the site.

ID:* 331** ***NAME: Taylor Corporation

OWNER: Taylor Corporation; John Tanke

PRIORITY: 2A1

STATUS 3B

ADDRESS: 5775 Brisa Street, Livermore

LEAD AGENCY: RWQCB

GEOTRACKER ID: T10000013016

This case was opened in the 2019 WY as a result of continuing investigation at TS#36 Salinas Reinforcement. Some of the VOCs beneath the Salinas site appear to be coming from upgradient. Taylor Corporation has been directed by the RWQCB to investigation soil and groundwater at their site. Preliminary investigations show PCE up to 5,000 ug/L in shallow groundwater and 1,000 ug/L in the deeper groundwater zone. TCE was also detected up to 5,100 ug/L in shallow groundwater. RWQCB is requiring an the RP to submit an Additonal Assessment Workplan by November 2019.

Z7 ID - corresponds to file number in TSS database and the location on site maps
OWNER - responsible party for the contamination investigation/cleanup
SITE NAME - indicates a site name if different from owner
PRIORITY - the first number of the priority code indicates whether the case is high priority (1), moderate priority (2), or low priority (3).
STATUS - the status code is based on the RWQCB ranking of the progress of a case (see below)
NOTES - highlights, cureent activites, or concerns at a site.

CASE STATUS CODES:
1 - Leak Confirmed
3A - Preliminary Site Assessment Workplan Submitted
3B - Preliminary Site Assessment Underway
5C - Pollution Characterization Underway
5R Remediation Workplan (Corrective Action Plan) Submitted
7 - Remediation Underway
8 - Post Remediation Monitoring Begun
CL - Case Closure
NR - Further investigation not required
ReO - Reopened

CONCENTRATION ug/L - the most recent concentration in groundwater in micrograms per liter (parts per billion)
CHEMICAL - the chemicals of concern at the site.

BENZ - benzene
CCl4 - carbon tetrachloride
Cr(VI) - hexavalent chromium
1,2-DCE - 1,2-dichloromethene
DRO - diesel range organics
GRO - gasoline range organics
MTBE - methyl tertiary-butyl ether
NO3 - nitrate
PCE - tetrachloroethene
TBA - tertiary-butyl alchohol
TCE - trichloroethene
TOLU - toluene
TPHd - total petroleum hydrocarbons diesel
TPHg - total petroleum hydrocarbons gasoline
TPHmo - total petroleum hydrocarbons motoroil
VC - vinyl chloride
XYL - xylenes

TABLE 13-2
HISTORICAL SALT LOADING (in tons)
1974 TO 2019 WATER YEARS

SALT INFLOW COMPONENTS YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
NATURAL STREAM RECHARGE	**3,210**	**3,464**	**874**	**581**	**4,638**	**1,723**	**2,706**	**1,513**	**4,803**	**7,657**	**5,286**	**3,058**
Total Arroyo Valle	**1,018**	**1,041**	**391**	**315**	**957**	**707**	**777**	**579**	**1,048**	**1,433**	**936**	**375**
Flood releases recharge	100	344	0	0	216	0	128	0	271	624	20	0
Non Flood Natural Inflow	918	697	391	315	741	707	649	579	777	809	916	375
Arroyo Mocho	**1,717**	**2,043**	**293**	**76**	**3,206**	**636**	**1,358**	**478**	**2,614**	**4,626**	**2,508**	**932**
Arroyo Las Positas	**475**	**380**	**190**	**190**	**475**	**380**	**571**	**456**	**1,141**	**1,598**	**1,842**	**1,751**
AV PRIOR RIGHTS	**361**	**418**	**31**	**0**	**494**	**267**	**386**	**251**	**502**	**381**	**236**	**328**
ARTIFICIAL STREAM RECHARGE	**986**	**2,201**	**1,914**	**2,289**	**3,286**	**3,699**	**2,897**	**3,238**	**1,617**	**184**	**0**	**0**
Arroyo Valle	293	1,174	509	883	1,427	1,599	1,234	1,719	663	0	0	0
Arroyo Mocho	340	497	875	876	1,350	1,570	1,432	1,394	894	184	0	0
Arroyo Las Positas	353	530	530	530	509	530	231	125	60	0	0	0
INJECTION WELL RECHARGE	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
RAINFALL RECHARGE	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Lake Recharge	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
LEAKAGE	**21**	**25**	**30**	**35**	**41**	**48**	**56**	**65**	**74**	**84**	**94**	**105**
APPLIED WATER RECHARGE	**7,670**	**7,218**	**9,123**	**10,675**	**8,352**	**8,304**	**7,175**	**5,507**	**4,709**	**4,723**	**5,046**	**5,938**
SUBSURFACE BASIN INFLOW	**2,038**	**2,038**	**2,058**	**3,648**	**2,506**	**2,017**	**1,325**	**1,284**	**1,284**	**876**	**1,325**	**1,528**
	14,286	**15,364**	**14,030**	**17,228**	**19,317**	**16,058**	**14,545**	**11,858**	**12,989**	**13,905**	**11,987**	**10,957**

OUTFLOW COMPONENTS YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
MUNICIPAL PUMPAGE	**-7,217**	**-6,577**	**-5,074**	**-4,382**	**-4,579**	**-5,351**	**-4,458**	**-4,700**	**-4,748**	**-5,410**	**-5,525**	**-5,752**
Zone 7 Wells - Hop, Stone, COL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Zone 7 Wells - Mocho	**-3,303**	**-2,057**	**-842**	**-201**	**-506**	**-532**	**-26**	**0**	**0**	**-17**	**-227**	**-863**
Demin Salts Exported from Valley	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Other Pumpage	**-3,914**	**-4,520**	**-4,232**	**-4,181**	**-4,073**	**-4,819**	**-4,432**	**-4,700**	**-4,748**	**-5,393**	**-5,298**	**-4,889**
AGRICULTURAL PUMPAGE	**-2,289**	**-1,476**	**-2,997**	**-3,241**	**-2,081**	**-2,420**	**-1,678**	**-1,553**	**-844**	**-912**	**-1,015**	**-1,378**
MINING USE	**-1,126**	**-1,725**	**-802**	**-668**	**-869**	**-1,603**	**-2,508**	**-4,372**	**-4,161**	**-7,834**	**-2,857**	**-2,814**
Stream Export	-745	-1,345	-422	-287	-489	-1,223	-2,127	-3,992	-3,781	-7,454	-2,476	-2,433
Evaporation	0	0	0	0	0	0	0	0	0	0	0	0
Processing Losses	-380	-380	-380	-380	-380	-380	-380	-380	-380	-380	-380	-380
GROUNDWATER BASIN OVERFLOW	**0**	**0**	**0**	**0**	**0**	**-173**	**-612**	**-635**	**-2,494**	**-3,418**	**-2,587**	**-1,386**
	-10,632	**-9,778**	**-8,873**	**-8,291**	**-7,529**	**-9,547**	**-9,256**	**-11,260**	**-12,247**	**-17,574**	**-11,984**	**-11,330**

NET SALT INFLOW (Tons)	**3,654**	**5,586**	**5,157**	**8,937**	**11,788**	**6,511**	**5,289**	**598**	**742**	**-3,669**	**3**	**-373**
CUMULATIVE SALT INFLOW (Tons)*	**3,654**	**9,240**	**14,397**	**23,334**	**35,122**	**41,633**	**46,922**	**47,520**	**48,262**	**44,593**	**44,596**	**44,223**

TDS Concentration Calculations	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Net Basin Recharge (AF)		-478	5,508	-4,311	-5,953	11,942	6,394	8,103	-528	11,593	9,192	-4,203	-9,722
Basin Storage (HI Method)(AF)	212,000	211,522	217,030	212,719	206,766	218,708	225,102	233,205	232,677	244,270	253,462	249,259	239,537
Total Salt in Main Basin (tons)	129,598	133,252	138,838	143,995	152,932	164,720	171,231	176,520	177,118	177,860	174,191	174,194	173,821
Main Basin TDS Concentration (mg/L)	**450**	**464**	**471**	**498**	**544**	**554**	**560**	**557**	**560**	**536**	**506**	**514**	**534**
Cumulative Increase in TDS Conc (mg/L)**		**14**	**21**	**48**	**94**	**104**	**110**	**107**	**110**	**86**	**56**	**64**	**84**

* Basinwide salt buildup since 1973

** Basinwide TDS concentration increase relative to 1973 value of 450 mg/L

TABLE 13-2
HISTORICAL SALT LOADING (in tons)
1974 TO 2019 WATER YEARS

SALT INFLOW COMPONENTS YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
NATURAL STREAM RECHARGE	**4,941**	**2,852**	**2,610**	**2,782**	**2,480**	**3,356**	**3,665**	**5,743**	**2,544**	**4,376**	**4,331**	**4,639**	**5,704**	**3,727**	**3,409**
Total Arroyo Valle	**779**	**232**	**372**	**187**	**206**	**575**	**743**	**1,083**	**300**	**1,034**	**400**	**1,450**	**1,661**	**1,361**	**956**
Flood releases recharge	415	0	0	0	0	98	0	528	0	472	336	183	524	0	55
Non Flood Natural Inflow	364	232	372	187	206	477	743	555	300	562	64	1,267	1,137	1,361	901
Arroyo Mocho	**2,269**	**458**	**490**	**440**	**233**	**1,023**	**814**	**2,174**	**995**	**1,580**	**2,627**	**1,741**	**2,292**	**996**	**857**
Arroyo Las Positas	**1,893**	**2,162**	**1,748**	**2,155**	**2,041**	**1,758**	**2,108**	**2,486**	**1,249**	**1,762**	**1,304**	**1,448**	**1,751**	**1,370**	**1,596**
AV PRIOR RIGHTS	**286**	**283**	**325**	**356**	**125**	**290**	**151**	**276**	**321**	**306**	**87**	**93**	**188**	**149**	**175**
ARTIFICIAL STREAM RECHARGE	**0**	**0**	**525**	**1,585**	**1,809**	**1,590**	**410**	**1,953**	**2,795**	**1,026**	**491**	**1,325**	**500**	**1,352**	**2,276**
Arroyo Valle	0	0	0	51	132	36	185	385	293	49	31	472	107	321	242
Arroyo Mocho	0	0	525	1,534	1,677	1,554	225	1,568	2,502	977	460	853	393	1,031	2,034
Arroyo Las Positas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INJECTION WELL RECHARGE	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**497**	**498**
RAINFALL RECHARGE	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Lake Recharge	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
LEAKAGE	**115**	**125**	**136**	**147**	**158**	**169**	**181**	**193**	**206**	**220**	**234**	**248**	**263**	**279**	**294**
APPLIED WATER RECHARGE	**6,632**	**5,558**	**6,834**	**6,015**	**6,541**	**6,918**	**5,793**	**5,109**	**4,989**	**3,323**	**4,071**	**4,887**	**4,367**	**3,479**	**4,314**
SUBSURFACE BASIN INFLOW	**1,508**	**1,569**	**1,875**	**2,364**	**2,568**	**3,423**	**3,199**	**2,710**	**2,221**	**2,017**	**1,875**	**1,386**	**1,651**	**1,528**	**1,846**
	13,482	**10,387**	**12,305**	**13,249**	**13,681**	**15,746**	**13,399**	**15,984**	**13,076**	**11,268**	**11,089**	**12,578**	**12,673**	**11,011**	**12,812**

OUTFLOW COMPONENTS YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
MUNICIPAL PUMPAGE	**-6,465**	**-5,537**	**-6,662**	**-6,915**	**-7,166**	**-10,970**	**-8,736**	**-6,010**	**-3,853**	**-2,665**	**-3,874**	**-5,192**	**-6,468**	**-6,101**	**-8,560**
Zone 7 Wells - Hop, Stone, COL	**0**	**0**	**0**	**-54**	**-441**	**-1,679**	**-1,185**	**-859**	**-85**	**-87**	**-754**	**-270**	**-475**	**-2,362**	**-2,553**
Zone 7 Wells - Mocho	**-869**	**-326**	**-1,425**	**-2,082**	**-1,683**	**-3,313**	**-2,111**	**-609**	**-24**	**-125**	**-767**	**-682**	**-397**	**-167**	**-783**
Demin Salts Exported from Valley	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Other Pumpage	**-5,595**	**-5,211**	**-5,237**	**-4,779**	**-5,042**	**-5,978**	**-5,439**	**-4,542**	**-3,743**	**-2,453**	**-2,353**	**-4,240**	**-5,596**	**-3,572**	**-5,224**
AGRICULTURAL PUMPAGE	**-1,428**	**-998**	**-1,043**	**-776**	**-868**	**-363**	**-236**	**-142**	**-130**	**-88**	**-130**	**-155**	**-47**	**-46**	**-188**
MINING USE	**-6,011**	**-839**	**-2,301**	**-1,728**	**-918**	**-970**	**-1,007**	**-2,134**	**-4,928**	**-6,883**	**-7,507**	**-9,983**	**-9,588**	**-8,642**	**-5,792**
Stream Export	-5,535	-364	-1,825	-1,253	-443	-495	-532	-1,658	-4,453	-6,408	-7,041	-9,460	-9,084	-8,081	-5,316
Evaporation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Processing Losses	-475	-475	-475	-475	-475	-475	-475	-475	-475	-475	-466	-523	-504	-561	-475
GROUNDWATER BASIN OVERFLOW	**-693**	**-693**	**-462**	**-122**	**0**	**0**	**0**	**0**	**0**	**-226**	**-968**	**-960**	**-998**	**-482**	**-175**
	-14,597	**-8,067**	**-10,468**	**-9,541**	**-8,952**	**-12,303**	**-9,979**	**-8,286**	**-8,911**	**-9,862**	**-12,479**	**-16,290**	**-17,101**	**-15,271**	**-14,715**

NET SALT INFLOW (Tons)	**-1,115**	**2,320**	**1,837**	**3,708**	**4,729**	**3,443**	**3,420**	**7,698**	**4,165**	**1,406**	**-1,390**	**-3,712**	**-4,428**	**-4,260**	**-1,903**
CUMULATIVE SALT INFLOW (Tons)*	**43,108**	**45,428**	**47,265**	**50,973**	**55,702**	**59,145**	**62,565**	**70,263**	**74,428**	**75,834**	**74,444**	**70,732**	**66,304**	**62,044**	**60,141**

TDS Concentration Calculations	1973	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Net Basin Recharge (AF)		-1,684	-7,906	-9,106	-4,973	-5,528	-8,462	-6,592	15,112	628	13,072	1,873	-1,390	1,859	-4,911	-3,674
Basin Storage (HI Method)(AF)	212,000	237,853	229,947	220,841	215,868	210,340	201,878	195,286	210,398	211,026	224,098	225,971	224,581	226,440	221,529	217,855
Total Salt in Main Basin (tons)	129,598	172,706	175,026	176,863	180,571	185,300	188,743	192,163	199,861	204,026	205,432	204,042	200,330	195,902	191,642	189,739
Main Basin TDS Concentration (mg/L)	**450**	**535**	**560**	**590**	**616**	**648**	**688**	**724**	**699**	**712**	**675**	**665**	**657**	**637**	**637**	**641**
Cumulative Increase in TDS Conc (mg/L)**		**85**	**110**	**140**	**166**	**198**	**238**	**274**	**249**	**262**	**225**	**215**	**207**	**187**	**187**	**191**

* Basinwide salt buildup since 1973

** Basinwide TDS concentration increase relative to 1973 value of 450 mg/L

TABLE 13-2
HISTORICAL SALT LOADING (in tons)
1974 TO 2019 WATER YEARS

SALT INFLOW COMPONENTS YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NATURAL STREAM RECHARGE	**3,856**	**3,267**	**7,097**	**3,105**	**5,796**	**4,962**	**3,260**	**4,078**	**4,367**	**5,080**	**5,459**	**2,026**	**2,242**	**1,820**	**3,735**
Total Arroyo Valle	**1,823**	**1,399**	**2,833**	**1,081**	**3,652**	**2,274**	**1,450**	**2,691**	**2,554**	**2,974**	**3,039**	**553**	**963**	**356**	**1,664**
Flood releases recharge	0	193	302	0	731	0	0	327	0	1,383	150	0	0	0	0
Non Flood Natural Inflow	1,823	1,206	2,531	1,081	2,921	2,274	1,450	2,364	2,554	1,591	2,889	553	963	356	1,664
Arroyo Mocho	**575**	**886**	**2,996**	**838**	**1,241**	**1,813**	**839**	**380**	**540**	**1,211**	**2,056**	**949**	**751**	**973**	**1,472**
Arroyo Las Positas	**1,458**	**982**	**1,268**	**1,186**	**903**	**875**	**971**	**1,007**	**1,273**	**895**	**364**	**524**	**528**	**491**	**599**
AV PRIOR RIGHTS	**224**	**399**	**416**	**383**	**80**	**524**	**219**	**100**	**407**	**0**	**384**	**196**	**409**	**3**	**395**
ARTIFICIAL STREAM RECHARGE	**1,351**	**3,503**	**2,811**	**2,480**	**1,949**	**1,266**	**1,359**	**727**	**1,248**	**1,690**	**882**	**2,851**	**2,519**	**1,483**	**1,689**
Arroyo Valle	501	647	399	476	619	330	782	727	686	635	167	1,178	573	339	1,667
Arroyo Mocho	839	2,855	2,412	2,004	1,300	914	577	0	562	1,055	698	1,649	1,943	1,120	0
Arroyo Las Positas	11	1	0	0	30	22	0	0	0	0	17	24	3	24	22
INJECTION WELL RECHARGE	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
RAINFALL RECHARGE	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Lake Recharge	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1,603*	*2,736*
LEAKAGE	**313**	**333**	**352**	**372**	**393**	**414**	**436**	**458**	**481**	**504**	**527**	**551**	**403**	**600**	**625**
APPLIED WATER RECHARGE	**5,074**	**5,606**	**4,618**	**5,090**	**4,824**	**3,223**	**5,157**	**6,258**	**6,152**	**5,079**	**4,295**	**6,074**	**8,158**	**5,654**	**6,505**
SUBSURFACE BASIN INFLOW	**1,970**	**1,970**	**1,970**	**1,970**	**2,513**	**2,309**	**2,174**	**2,214**	**2,106**	**1,997**	**2,024**	**2,092**	**448**	**1,834**	**2,051**
	12,788	**15,078**	**17,264**	**13,400**	**15,555**	**12,698**	**12,605**	**13,835**	**14,761**	**14,350**	**13,571**	**13,790**	**14,179**	**11,394**	**15,000**

OUTFLOW COMPONENTS YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
MUNICIPAL PUMPAGE	**-10,467**	**-12,061**	**-11,096**	**-12,419**	**-10,057**	**-5,557**	**-8,423**	**-9,271**	**-14,577**	**-12,609**	**-9,873**	**-16,765**	**-12,781**	**-11,831**	**-6,080**
Zone 7 Wells - Hop, Stone, COL	**-3,867**	**-3,690**	**-3,360**	**-4,198**	**-1,858**	**-1,382**	**-1,340**	**-3,217**	**-3,920**	**-1,290**	**-1,197**	**-2,785**	**-3,595**	**-2,639**	**-870**
Zone 7 Wells - Mocho	**-1,745**	**-3,322**	**-2,271**	**-3,762**	**-3,003**	**-1,170**	**-1,976**	**-1,402**	**-5,448**	**-6,563**	**-4,040**	**-8,204**	**-3,997**	**-3,713**	**-1,080**
Demin Salts Exported from Valley	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*-798*	*-2,759*	*-2,006*	*-4,064*	*-2,479*	*-1,047*	*-76*
Other Pumpage	**-4,855**	**-5,049**	**-5,465**	**-4,459**	**-5,196**	**-3,005**	**-5,107**	**-4,651**	**-5,208**	**-4,756**	**-4,625**	**-5,766**	**-5,179**	**-5,583**	**-4,128**
AGRICULTURAL PUMPAGE	**-182**	**-94**	**-73**	**-79**	**-80**	**-46**	**-43**	**-68**	**-68**	**-73**	**-68**	**-77**	**-393**	**-515**	**-490**
MINING USE	**-4,520**	**-475**	**-276**	**-438**	**-454**	**-658**	**-584**	**-714**	**-1,341**	**-1,428**	**-2,756**	**-3,064**	**-3,042**	**-502**	**-417**
Stream Export	-4,006	-111	0	-84	-94	-218	-274	-305	-913	-1,057	-2,368	-2,665	-2,655	-442	0
Evaporation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Processing Losses	-514	-364	-276	-354	-360	-440	-310	-409	-428	-371	-388	-399	-387	-364	-417
GROUNDWATER BASIN OVERFLOW	**0**	**0**	**0**	**0**	**0**	**0**	**-738**	**-1,080**	**-171**	**0**	**0**	**0**	**0**	**0**	**0**
	-15,169	**-12,630**	**-11,445**	**-12,936**	**-10,591**	**-6,261**	**-9,788**	**-11,133**	**-16,157**	**-14,110**	**-12,697**	**-19,906**	**-16,216**	**-12,848**	**-6,987**

NET SALT INFLOW (Tons)	**-2,381**	**2,448**	**5,819**	**464**	**4,964**	**6,437**	**2,817**	**2,702**	**-1,396**	**240**	**874**	**-6,116**	**-2,037**	**-1,454**	**8,013**
CUMULATIVE SALT INFLOW (Tons)*	**57,760**	**60,208**	**66,027**	**66,491**	**71,455**	**77,892**	**80,709**	**83,411**	**82,015**	**82,255**	**83,129**	**77,013**	**74,976**	**73,522**	**81,535**

TDS Concentration Calculations	1973	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Net Basin Recharge (AF)		-11,499	72	8,309	-4,560	13,193	8,790	-3,639	-3,011	-4,997	4,290	6,893	-10,438	-5,542	-12,153	6,037
Basin Storage (HI Method)(AF)	212,000	206,356	206,428	214,737	210,177	223,370	232,160	228,521	225,510	220,513	224,803	231,696	221,258	215,716	203,563	209,600
Total Salt in Main Basin (tons)	129,598	187,358	189,806	195,625	196,089	201,053	207,490	210,307	213,009	211,613	211,853	212,727	206,611	204,574	203,120	211,133
Main Basin TDS Concentration (mg/L)	**450**	**668**	**677**	**671**	**687**	**663**	**658**	**677**	**695**	**706**	**694**	**676**	**687**	**698**	**735**	**742**
Cumulative Increase in TDS Conc (mg/L)**		**218**	**227**	**221**	**237**	**213**	**208**	**227**	**245**	**256**	**244**	**226**	**237**	**248**	**285**	**292**

* Basinwide salt buildup since 1973

** Basinwide TDS concentration increase relative
to 1973 value of 450 mg/L

TABLE 13-2
HISTORICAL SALT LOADING (in tons)
1974 TO 2019 WATER YEARS

SALT INFLOW COMPONENTS YEAR	2016	2017	2018	2019	AVG	TOTAL
NATURAL STREAM RECHARGE	3,366	4,948	1,315	3,531	3,695	169,982
Total Arroyo Valle	1,620	2,392	249	1,185	1,210	55,668
Flood releases recharge	0	404	0	-53	169	7,751
Non Flood Natural Inflow	1,620	1,988	249	1,238	1,042	47,917
Arroyo Mocho	945	1,882	430	1,648	1,346	61,901
Arroyo Las Positas	801	674	636	698	1,139	52,413
AV PRIOR RIGHTS	288	91	208	249	262	12,041
ARTIFICIAL STREAM RECHARGE	2,571	2,046	1,494	558	1,618	74,425
Arroyo Valle	1,299	667	924	442	541	24,863
Arroyo Mocho	1,272	1,379	570	116	1,000	46,010
Arroyo Las Positas	0	0	0	0	77	3,552
INJECTION WELL RECHARGE	0	0	0	0	22	995
RAINFALL RECHARGE	0	0	0	0	0	0
Lake Recharge	*3,641*	*6,743*	*8,295*	*6,874*	*650*	*29,892*
LEAKAGE	651	677	703	778	287	13,217
APPLIED WATER RECHARGE	5,251	4,421	5,707	5,625	5,784	266,041
SUBSURFACE BASIN INFLOW	2,078	2,106	2,078	2,187	1,995	91,758
	14,205	14,289	11,505	12,928	13,662	628,459

OUTFLOW COMPONENTS YEAR	2016	2017	2018	2019	AVERAGE	TOTAL
MUNICIPAL PUMPAGE	-6,194	-7,635	-8,700	-10,427	-10,012	-326,541
Zone 7 Wells - Hop, Stone, COL	-750	-1,107	-1,938	-1,982	-2,376	-49,899
Zone 7 Wells - Mocho	-666	-2,200	-2,642	-4,895	-2,985	-62,686
Demin Salts Exported from Valley	*-183*	*-949*	*-1,168*	*-1,871*	*-378*	*-17,400*
Other Pumpage	-4,779	-4,326	-4,120	-3,549	-4,651	-213,956
AGRICULTURAL PUMPAGE	-92	-84	-87	-101	-679	-31,237
MINING USE	-378	-364	-388	-372	-3,388	-155,834
Stream Export	0	0	0	0	-2,259	-103,914
Evaporation	0	0	0	0	0	0
Processing Losses	-378	-364	-388	-372	-416	-19,122
GROUNDWATER BASIN OVERFLOW	0	0	-506	-758	-442	-20,337
	-6,664	-8,083	-9,681	-11,658	-11,524	-530,083

	2016	2017	2018	2019	AVERAGE	TOTAL
NET SALT INFLOW (Tons)	7,541	6,206	1,824	1,270	2,139	98,376
CUMULATIVE SALT INFLOW (Tons)*	89,076	95,282	97,106	98,376		

TDS Concentration Calculations	1973	2016	2017	2018	2019
Net Basin Recharge (AF)		15,405	25,259	285	4,447
Basin Storage (HI Method)(AF)	212,000	225,005	250,264	250,549	254,996
Total Salt in Main Basin (tons)	129,598	218,674	224,880	226,704	227,974
Main Basin TDS Concentration (mg/L)	450	715	661	666	658
Cumulative Increase in TDS Conc (mg/L)**		265	211	216	208

* Basinwide salt buildup since 1973

** Basinwide TDS concentration increase relative to 1973 value of 450 mg/L

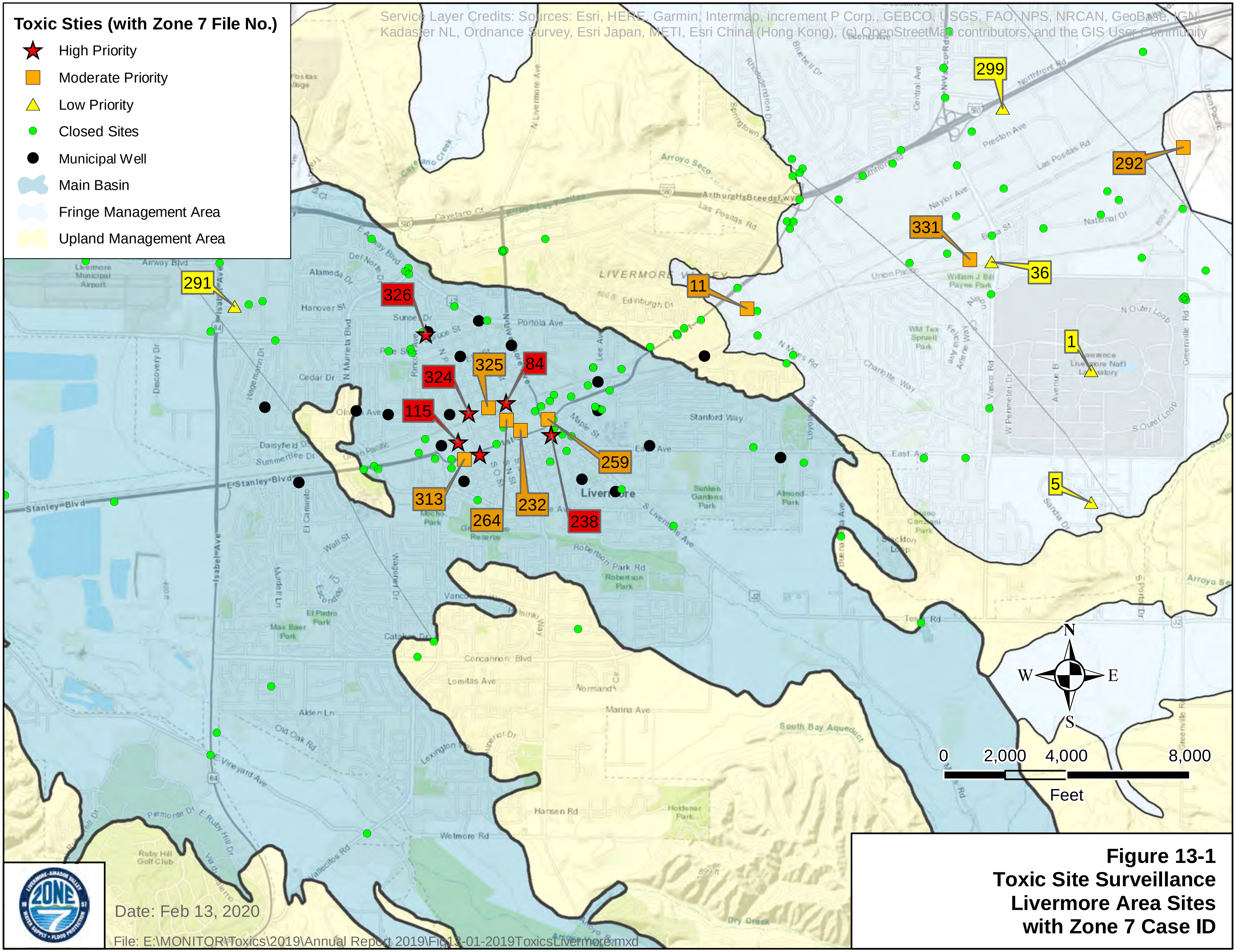

Figure 13-1
Toxic Site Surveillance
Livermore Area Sites
with Zone 7 Case ID

Date: Feb 13, 2020

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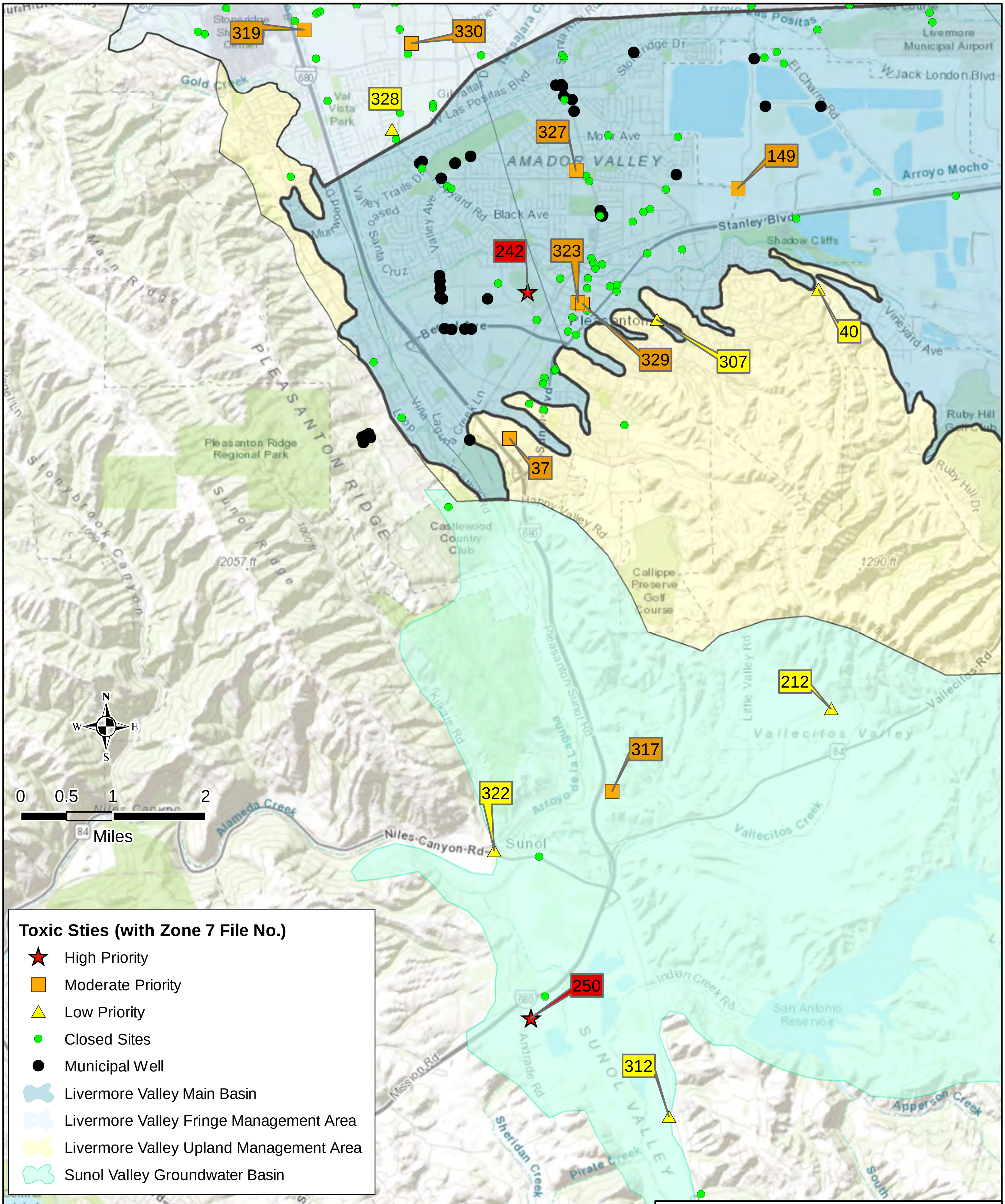

Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c)

Date: Feb 13, 2020

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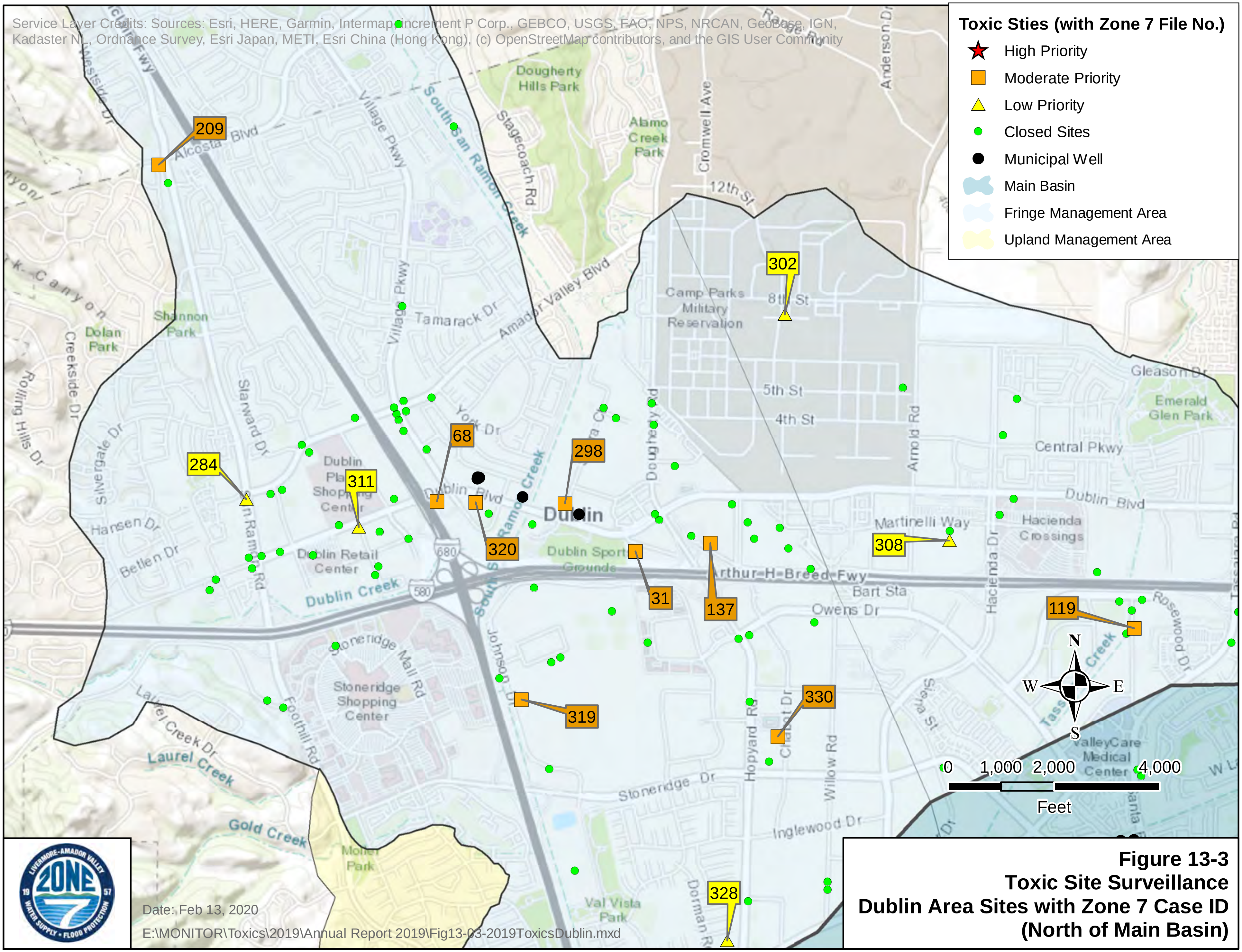
Figure 13-2
Toxic Site Surveillance
Pleasanton and Sunol Area Sites
with Zone 7 Case ID



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Date: Feb 13, 2020

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Figure 13-3
Toxic Site Surveillance
Dublin Area Sites with Zone 7 Case ID
(North of Main Basin)

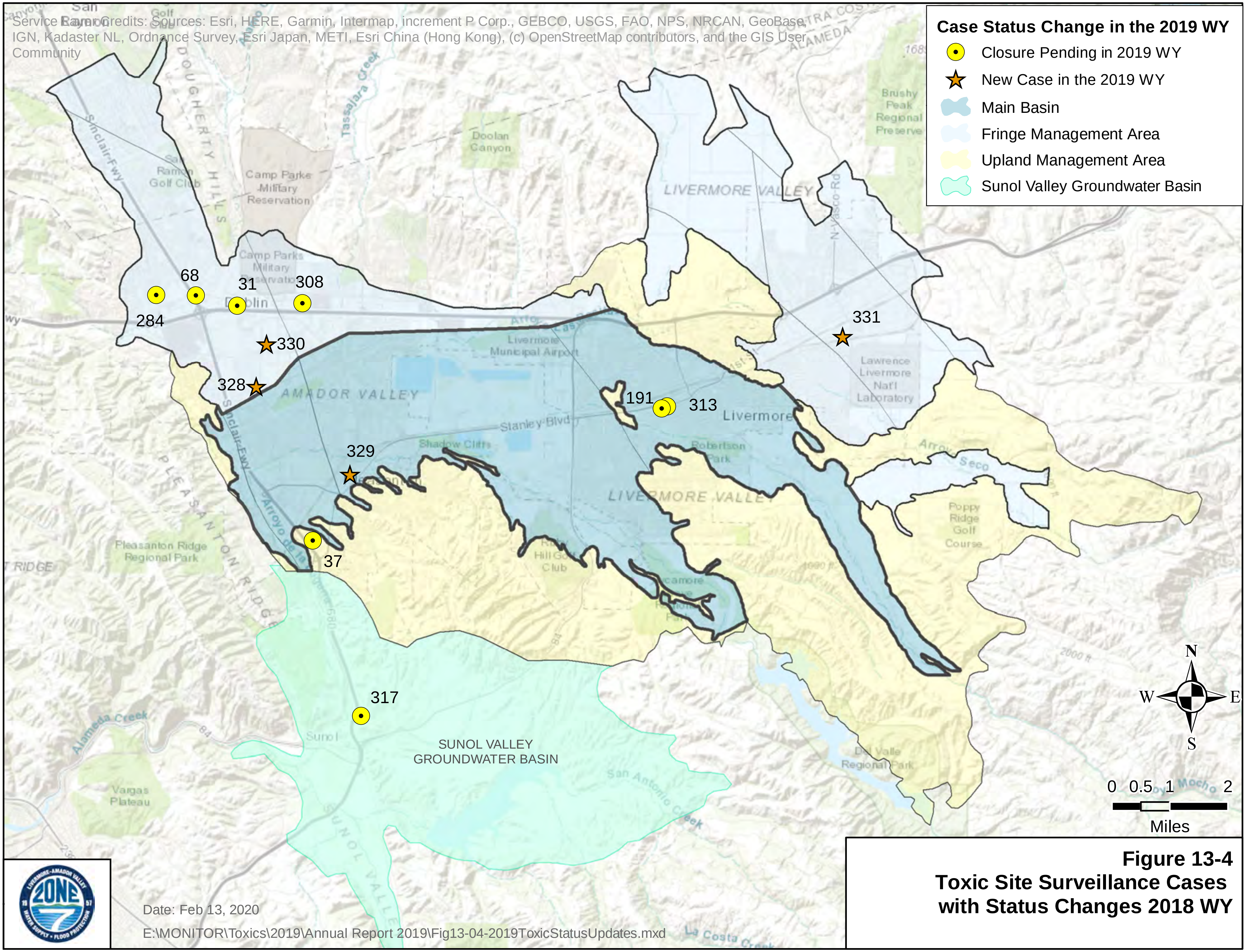

Figure 13-4
Toxic Site Surveillance Cases with Status Changes 2018 WY

Date: Feb 13, 2020

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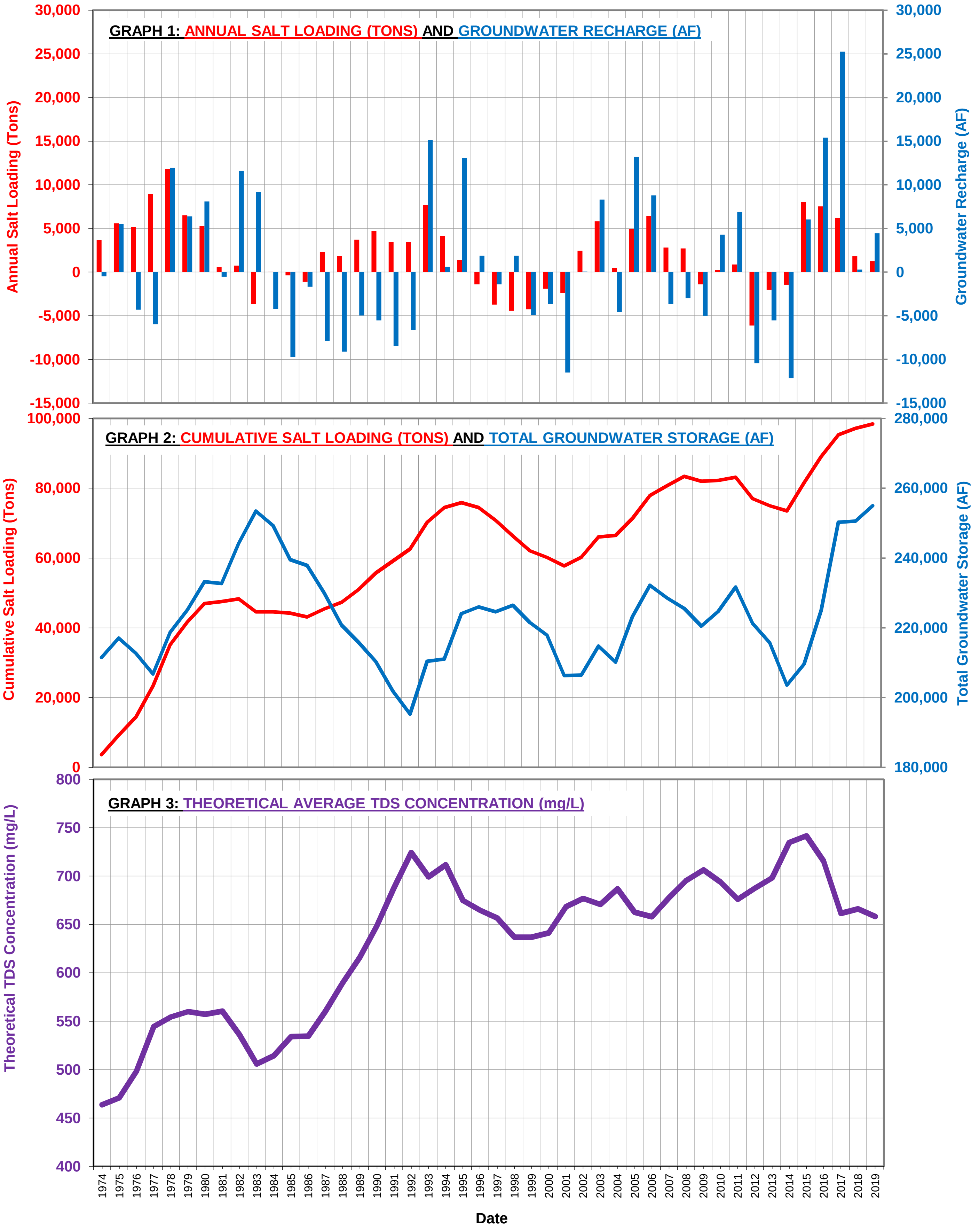
FIGURE 13-5
MAIN BASIN SALT LOADING AND TDS CONCENTRATION
1974 to 2019 WATER YEARS



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