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Alternative Groundwater Sustainability Plan for the Livermore Valley Groundwater Basin

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Alternative Groundwater Sustainability Plan
for the
Livermore Valley Groundwater Basin
(DWR Basin No. 2-10)

Prepared for

ZONE 7 WATER AGENCY

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APPENDICES

ELECTRONIC ATTACHMENTS

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List of Acronyms

ACEH	Alameda County Environmental Health
ACWD	Alameda County Water District
ADLLV	Arroyo De La Laguna at Verona
ADVP	Arroyo Del Valle Pleasanton
AF	Acre-feet
AFY	Acre-feet per Year
AMHAG	Arroyo Mocho Hagemann
AOC	Area of Concern
BARDP	Bay Area Regional Desalination Project
BBID	Byron-Bethany Irrigation District
bgs	Below Ground Surface
BMO	Basin Management Objective
BTEX	Benzene, Ethylbenzene, Toluene, and Xylene
CASGEM	California Ambient Statewide Groundwater Elevation Monitoring
CCWD	Contra Costa Water District
CEC	Constituent of Emerging Concern
CEQA	California Environmental Quality Act
cfs	Cubic Feet per Second
CIMIS	California Irrigation Management Information System
CIP	Capital Improvement Program
CrIII	Trivalent Chromium
CrVI	Hexavalent Chromium
CUWCC	California Urban Water Conservation Council
CY	Calendar Year
DCE	Dichloroethene
DSRSD	Dublin San Ramon Services District
DWR	Department of Water Resources
EBMUD	East Bay Municipal Utilities District
EBRPD	East Bay Regional Park District
EHD	Environmental Health Division
EIR	Environmental Impact Report
ETo	Evapotranspiration
ft	Feet
ft/yr	Feet per Year
GAMA	Groundwater Ambient Monitoring and Assessment
GIS	Geographic Information System
gpd	Gallons per Day
gpm	Gallons per Minute
GPQ	Groundwater Pumping Quota
GPS	Global Positioning System
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
GWE	Groundwater Elevation
GWMP	Groundwater Management Plan

HI	Hydrologic Inventory
HRL	Health Reference Level
InSAR	Interferometric Synthetic Aperture Radar
in/yr	Inches per Year
IRWMP	Integrated Regional Water Management Plan
LAFCO	Local Agency Formation Commission
LAMP	Local Agency Management Program
LARPD	Livermore Area Recreation and Park District
LAVWMA	Livermore-Amador Valley Water Management Agency
LDV	Lake Del Valle
LLNL	Lawrence Livermore National Laboratory
LWRP	Livermore Water Reclamation Plant
M&I	Municipal and Industrial
MCL	Maximum Contaminant Level
MGDP	Mocho Groundwater Demineralization Plant
mi	mile
µg/L	Micrograms per Liter
mg/L	Milligrams per Liter
MOU	Memorandum of Understanding
msl	Mean Sea Level
MTBE	Methyl Tertiary-butyl Ether
NOAA-NMFS	National Marine Fisheries Service
NMP	Nutrient Management Plan
NO3	Nitrate
NRCS	National Resource Conservation Service
OWTS	On-site Wastewater Treatment System
PCE	Tetrachloroethylene
RO	Reverse Osmosis
RRE	Rural-Residential-Equivalence
SBA	South Bay Aqueduct
SCVWD	Santa Clara Valley Water District
SFPUC	San Francisco Public Utilities Commission
SGMA	Sustainable Groundwater Management Act
SMP	Salt Management Plan
SWP	State Water Project
SWRCB	California State Water Resources Control Board
TAF	Thousand Acre Feet
TBA	Tertiary-butyl Alcohol
TCE	Trichloroethylene
TDS	Total Dissolved Solids
TPHd	Total Petroleum Hydrocarbons as Diesel
TPHg	Total Petroleum Hydrocarbons as Gasoline
TSS	Toxic Sites Surveillance
TWRG	Tri-Valley Water Retailers Group
USEPA	US Environmental Protection Agency
UWMP	Urban Water Management Plan

VC	Vinyl Chloride
WMP	Well Master Plan
WQO	Water Quality Objectives
WSE	Water Supply Evaluation
WWMP	Wastewater Management Plan for Unsewered, Unincorporated Area of Alameda Creek Watershed above Niles
WY	Water Year

Executive Summary

E-1. Agency Information and Plan Area

E-1.1. Introduction

For more than 50 years, Zone 7 Water Agency (Zone 7 or Agency) has managed imported and local surface and groundwater resources for beneficial uses in the Livermore Valley. In 2005, the Agency 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, 2005*). This was amended in June 2015 with the adoption of the Nutrient Management Plan.

Under the Sustainable Groundwater Management Act (SGMA), Zone 7 has been designated as the exclusive Groundwater Sustainability Agency within its service area (shown in **Figure E-1**). For the Livermore Valley Groundwater Basin, Zone 7 is required to prepare either a Groundwater Sustainability Plan (GSP) or an Alternative Plan. Such an Alternative Plan must cover the entire groundwater basin, be functionally equivalent to a GSP, and demonstrate that the entire basin has been operating within its sustainable yield[1] for at least 10 years. Given the ongoing sustainable management of the Livermore Valley Groundwater Basin over forty years, Zone 7 has prepared this Alternative Plan for compliance with SGMA and GSP regulations.

This Alternative Plan is presented in five sections:

- Agency Information and Plan Area
- Basin Setting
- Sustainable Management Criteria
- Monitoring Networks
- Projects and Management Actions

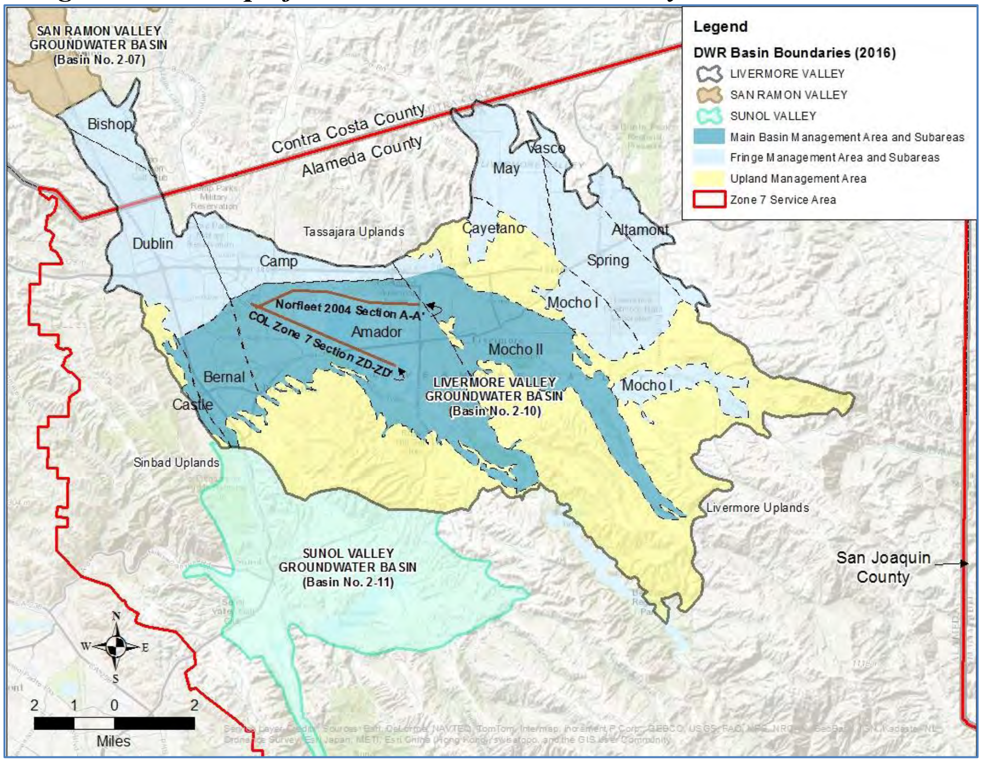
These sections are supplemented with appendices and attachments; appendices include the following:

- Appendix A: MOUs with Other Agencies
- Appendix B: Monitoring Protocols
- Appendix C: Wells in the Zone 7 Monitoring Network
- Appendix D: CEQA Documentation

Appendix E: Board Resolution

[1] SGMA defines Sustainable Yield as the maximum quantity of water (calculated over a base period representative of long-term conditions in the basin and including any temporary surplus) that can be withdrawn annually from a groundwater supply without causing an undesirable result.

Figure E-1: Map of Plan Area, Livermore Valley Groundwater Basin



Attachments include ten water resource management reports and plans that have been foundational to ongoing sustainable groundwater management by Zone 7.

- Groundwater Management Plan, 2005 (Attachment A)
- Annual Reports, 2015 WY and 2014 WY (Attachments B and C)
- Salt Management Plan, 2004 (Attachment D)
- Nutrient Management Plan, 2015 (Attachment E)
- UWMP, 2015 (Attachment F)
- Water Supply Evaluation Update, 2016 (Attachment G)
- Well Master Plan (Attachment H, *Zone 7 2005b*)
- Historical SqueeSAR ground deformation analysis over Livermore and Pleasanton (Attachment I, *TRE Altamira, 2016*)
- Report of History of Bench Marks (Attachment J, *Altamont Land Surveyors, 1994*)

E-1.2. Zone 7 Water Agency

Zone 7 Water Agency is one of ten active zones of the Alameda County Flood Control and Water Conservation District. 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 for more than 50 years. Consistent with its management responsibilities, duties, and powers, Zone 7 is designated in SGMA as the exclusive GSA within its boundaries. Electing to be the GSA for the Basin, the Agency will continue to exercise its groundwater management authority consistent with the District Act and with SGMA.

The Livermore Valley Groundwater Basin is an inland alluvial basin. It is drained by west flowing streams (including Arroyo Valle, Arroyo Mocho, and Arroyo las Positas) that join the Arroyo de la Laguna, which flows south out of the basin towards Alameda Creek. The basin has been delineated by the Department of Water Resources (DWR) in Bulletin 118 (revised 2003).

For purposes of groundwater management, the basin has been divided into three management areas based on varying geologic, hydrogeologic, and groundwater conditions. These are shown in **Figure E-1** and listed below.

Management Area	Portion of Groundwater
Main Basin	19,800 acres
Fringe Subareas	22,041 acres
Upland Areas	27,759 acres
Total	**69,600 acres**

The Main Basin produces water from a thick alluvial sequence that contains the highest yielding aquifers, best quality groundwater, and the major municipal wells. The Fringe Management Area is characterized by relatively thin alluvium overlying the Livermore Formation that has limited groundwater storage, low well yield, and poor water quality. The Upland Areas are underlain by the low-yielding Tassajara Formation, with relatively few wells. Groundwater flow is generally from Fringe and Upland Management Areas toward the Main Basin. Within the Main Basin, groundwater naturally flows from east to west.

As the water wholesaler, Zone 7 supplies treated State Water Project water to four local retail water supply agencies:

- California Water Service Company – Livermore District (Cal Water)
- Dublin San Ramon Services District (DSRSD),
- City of Livermore (Livermore), and
- City of Pleasanton (Pleasanton).

In addition to the water purchased from Zone 7, Pleasanton and Cal Water have their own municipal groundwater supply wells. Private wells in the area provide some of the water supply for industrial, agricultural, irrigation, domestic, and undifferentiated uses. DSRSD and Livermore provide recycled water for landscape irrigation.

Land uses include urban, agricultural, mining, water bodies, parks, golf courses, and open space. Current (2015) land use remains similar to that of the mid-2000s. Land use planning is implemented by various jurisdictions. Zone 7 works closely with the county and cities for regional water planning, sustainable land use planning, water recycling, and water conservation.

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:

- Monitoring groundwater using long-term well measurements coupled with a detailed groundwater basin numerical model,

- Monitoring land surface elevation changes,
- Importing, artificially recharging, and banking surface water to meet 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 Program,
- Managing groundwater pumping for sustainability,
- Maintaining sustainable long-term groundwater storage volumes with natural and imported supplies,
- Promoting sound recycled water use, and
- Identifying and planning for future supply needs and demand impacts.

Through these and other programs, Zone 7 has sustainably managed the basin to avoid undesirable results for at least 10 years since the 2005 adoption of the GWMP. The historical groundwater data shows that the basin has been operated sustainably for over 40 years including three major droughts. Most of the data sets discussed in this Alternative Plan date back to 1974 allowing a comprehensive, long-term assessment of Zone 7's basin management.

E-2. Basin Setting

The Basin Setting (**Section 2**) is organized into the following subsections:

- Physical Setting
- Hydrogeological Conceptual Model
- Groundwater Conditions
- Water Budget
- Projected Water Budget and Future Management
- Groundwater Model

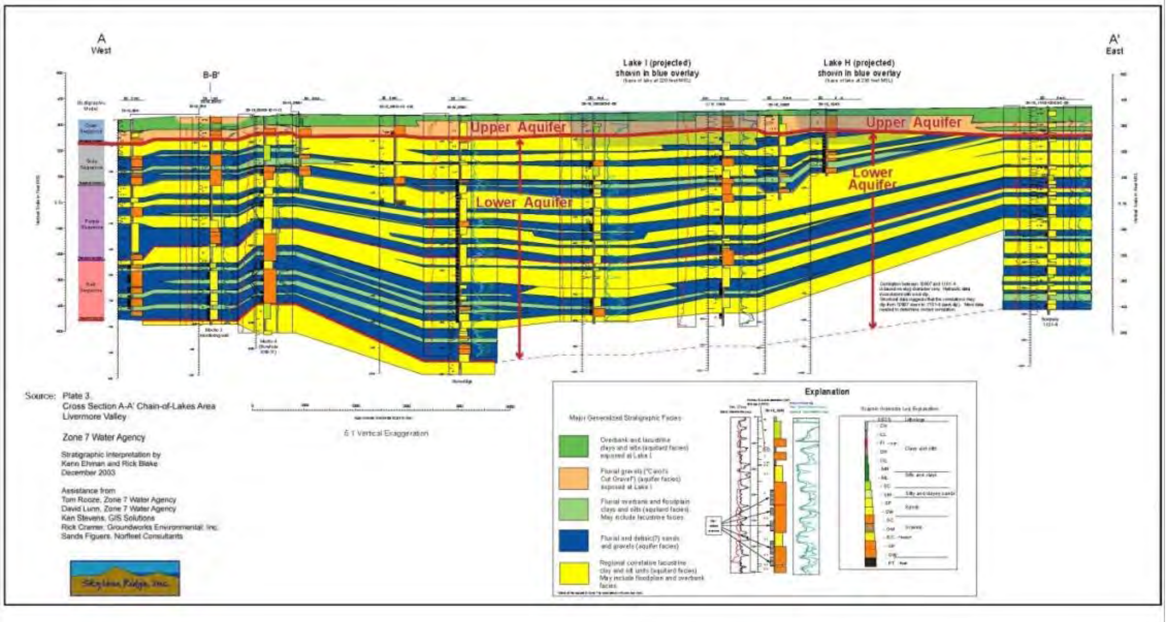
E-2.1. Physical Setting

This section documents the topography, climate, surface water drainage, and soils within the groundwater basin area. It also discusses various springs and groundwater dependent ecosystems.

E-2.2. Hydrogeological Conceptual Model

The Livermore Valley is a structural basin bound on the east and west by the northwest-southeast trending faults, the upland bedrock hills of the Diablo Range on the south, and the leading edge of the Mt. Diablo thrusts on the north. Hydrogeologic maps and cross-sections developed by DWR and Zone 7 identify groundwater basin boundaries, management areas, and subbasins (**Figure E-1**). Hydrogeologic cross-sections, such as **Figure E-2**, illustrate the alluvial stratigraphic framework of up to 1,000 feet of water-bearing sediments as well as identifying the primary aquifers in the Main Basin. Geologic and groundwater level data were used to define the Upper and Lower Aquifers. The relatively-thin Upper Aquifer consists of alluvial materials, extends continually across the Main Basin and Fringe Management Area, and contains groundwater typically under unconfined conditions. The extensive Lower Aquifer includes all aquifer zones below a confining aquitard in the central and eastern parts of the Main Basin. It generally does not extend into the Fringe Management Areas.

Figure E-2: Stratigraphic Cross Section, Main Basin



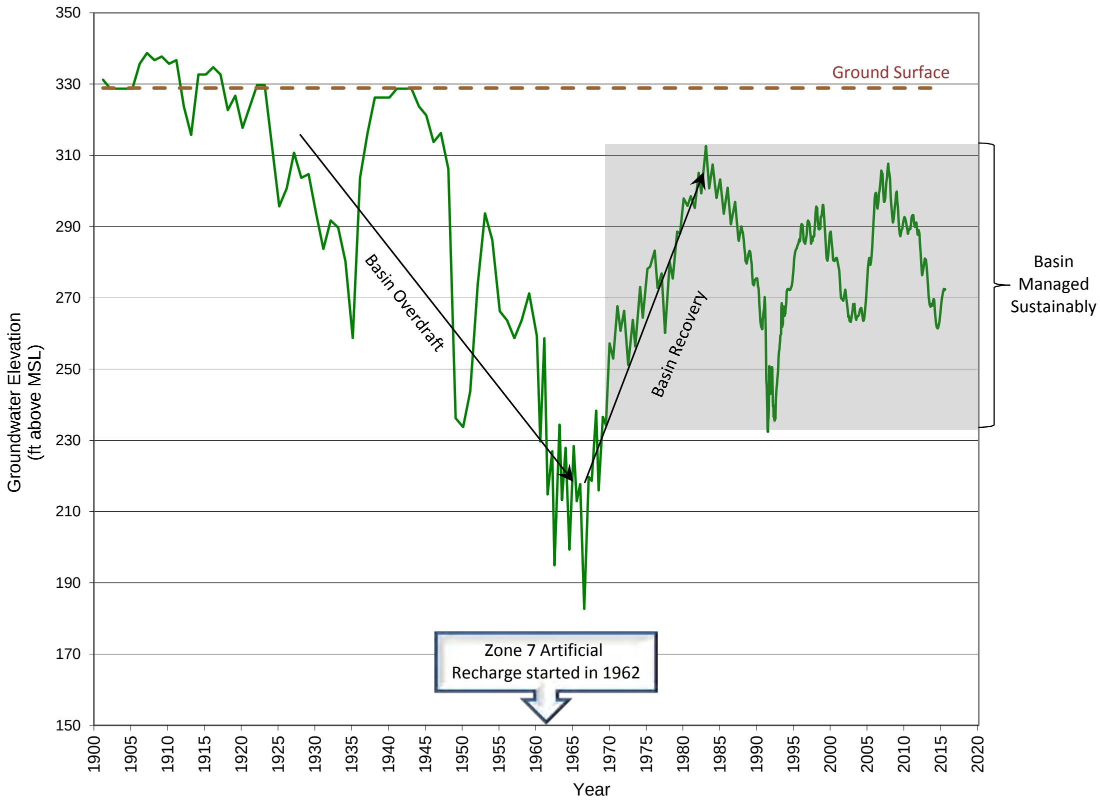
E-2.3. Groundwater Conditions

Section 2.3 of this report characterizes current and historical groundwater conditions in the basin from 1974 to 2015. Subsections address groundwater use, groundwater occurrence and flow, groundwater levels, groundwater in storage, groundwater quality, potential subsidence, and surface water-groundwater interactions. This information is basic to evaluation of sustainable management criteria. Key conditions are presented in **Section 3**, Sustainable Management Criteria.

Groundwater is used for agricultural, municipal, industrial, domestic and undifferentiated supply purposes. Supply wells are distributed throughout the basin with the major municipal wells in the Main Basin. Agricultural pumping has decreased significantly since 1974 when imported surface water became available to many irrigation customers. Municipal wells now account for the majority of pumping. Municipal pumping by retailers is contractually limited to a groundwater pumping quota (GPQ). Zone 7 pumps only groundwater that has been stored in the basin as part of its artificial recharge program. Zone 7 pumping is for municipal purposes, salt management, demand peaks, and any shortage or interruption in its surface water supply or treatment.

Figure E-3 shows historical groundwater levels at the Fairgrounds Key Well (in the westernmost Main Basin) from 1900 to present. It illustrates historical overdraft until the mid-1960s, basin recovery (due to Zone 7's management and artificial recharge), and the long-term sustainable management of the Livermore Valley Groundwater Basin.

Figure E-3: Groundwater Basin Management: Historical Groundwater Elevations at Fairgrounds Key Well



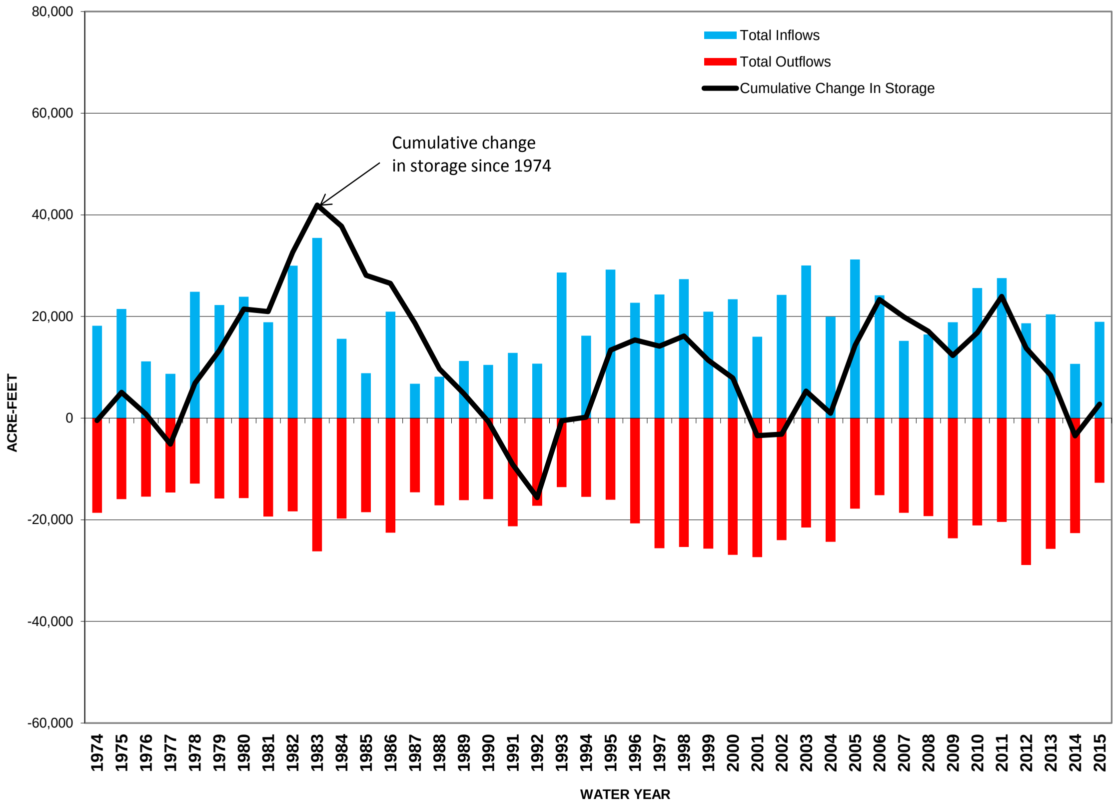
E-2.4. Water Budget

Zone 7 has used data from its ongoing monitoring programs to develop annual groundwater budgets since 1974. The Water Budget is developed using two independent methodologies. The first method, the Hydrologic Inventory, involves accounting for inflows and outflows and derivation of the change in storage as the residual of the water budget equation. This method is applied to all management areas. The second method, the Groundwater Elevation method, uses groundwater level data and storage coefficients and is applied to the Main Basin.

Inflow components include stream recharge, rainfall recharge, applied water recharge, import water recharge (artificial recharge), subsurface groundwater inflow and pipe leakage. These total about 19,800 AF annually. Outflows include pumping by Zone 7, the municipal retailers and others, plus losses from the mining areas (mostly evaporation).

Figure E-4 presents annual inflows (blue), outflows (red) and the cumulative change in groundwater storage from 1974 through 2015. Circa 1974, the basin began to recover from the historic lows in the early 1960s in response to the Zone 7 GPQ and groundwater basin recharge programs. The Livermore Valley has experienced three droughts since the early 1980s but groundwater levels recovered after each drought due to the Zone 7 groundwater recharge/management programs. **Figure E-4** demonstrates long-term groundwater sustainability for over 40 years.

Figure E-4: Main Basin Sustainability



E-2.5. Projected Water Budget and Future Management

Zone 7's imported water supplies have decreased in reliability over the years as SWP reliability has declined. Furthermore, Zone 7 anticipates increased water demand from population growth. Zone 7 evaluated projected water supply and demand in its 2016 Water Supply Evaluation Update and 2015 Urban Water Management Plan (UWMP). The UWMP used the scenarios in the 2015 SWP Delivery Capability Report to account for climate change impacts. To meet possible future supply shortfalls, Zone 7 expects that conservation and a portfolio of alternatives will be needed, including such options as the California WaterFix, Bay Area Regional Desalination Project, and potable reuse of recycled water.

E-2.6. Groundwater Model

Zone 7 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.

E-3. Sustainable Management Criteria

SGMA establishes a specific process for groundwater management. It introduced new management criteria, including thresholds and objectives. While it is recognized that these concepts have not yet been incorporated into Zone 7 policies and actions, the Agency's current groundwater management practices are functionally equivalent to the SGMA process.

As outlined in **Section 3**, Zone 7's ongoing sustainable management goal is to continue to operate the Livermore Valley Groundwater Basin within its sustainable yield[2] and to manage the groundwater resources to prevent significant and unreasonable: (1) lowering of groundwater levels, (2) reduction in basin storage, (3) degradation of groundwater quality, (4) inelastic land subsidence, or (5) depletion of surface water supplies that may adversely impact beneficial uses. A sixth sustainability indicator, seawater intrusion, is not applicable because the Livermore Valley Groundwater Basin is not a coastal basin.

The five relevant sustainability indicators are discussed in terms of the definition of undesirable results and minimum thresholds. As demonstrated in **Section 2** of this Alternative Plan, the basin has not experienced undesirable results for at least 10 years because of sustainable groundwater management. Accordingly, potential conditions are discussed that could be considered undesirable results. Minimum thresholds are presented in **Section 3**. Although previously undefined using the specific wording and terminology of SGMA, Zone 7 already applies such minimum thresholds to track the performance of groundwater management activities and as a trigger for future management actions to avoid undesirable results. Because the basin has not experienced undesirable results for decades, quantification of minimum thresholds is conservative. In the future, these thresholds may be modified.

E-3.1. Groundwater Levels

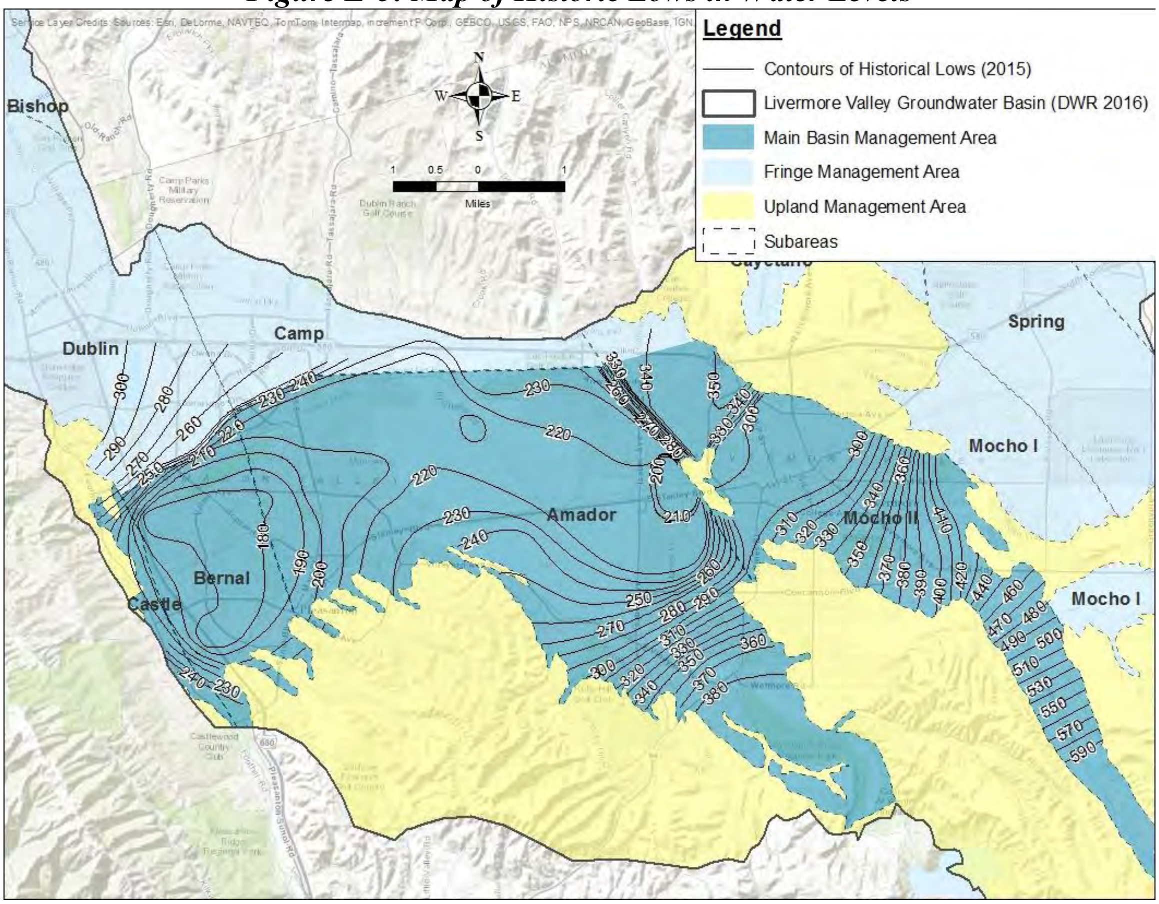
Significant and unreasonable chronic lowering of water levels is defined by SGMA as an undesirable result. Therefore, groundwater levels are utilized as a sustainability indicator. Zone 7 has numerous policies and objectives relating to the maintenance of groundwater levels and regularly measures an extensive network of monitoring wells. Zone 7 balances basin water levels for numerous objectives including minimizing impacts of high water levels on gravel mining operations, retaining storage capacity for recharge of available imported supplies, maintaining groundwater emergency reserves for worst credible drought and unplanned import outages, and keeping groundwater levels sufficiently high to support beneficial use of existing groundwater wells.

To avoid unreasonable lowering of basin groundwater levels, Zone 7 operates the basin to remain above historic low levels throughout the Main Basin Management Area. **Figure E-5** is a composite map of historic low groundwater levels representing the minimum threshold. Outside of the Main Basin Management Area where historic lows have not been determined, water level

[2] Sustainable Yield is defined by SGMA as the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result.

hydrographs indicate no historic significant fluctuations or downward trends. For these areas, an alternative minimum threshold has been developed, whereby new well construction would be evaluated for areas with a relatively high density of wells. Zone 7's role in permitting new wells in the basin allows an early assessment of proposed wells to ensure that they are constructed to account for operating water levels in local wells and do not result in over-pumping.

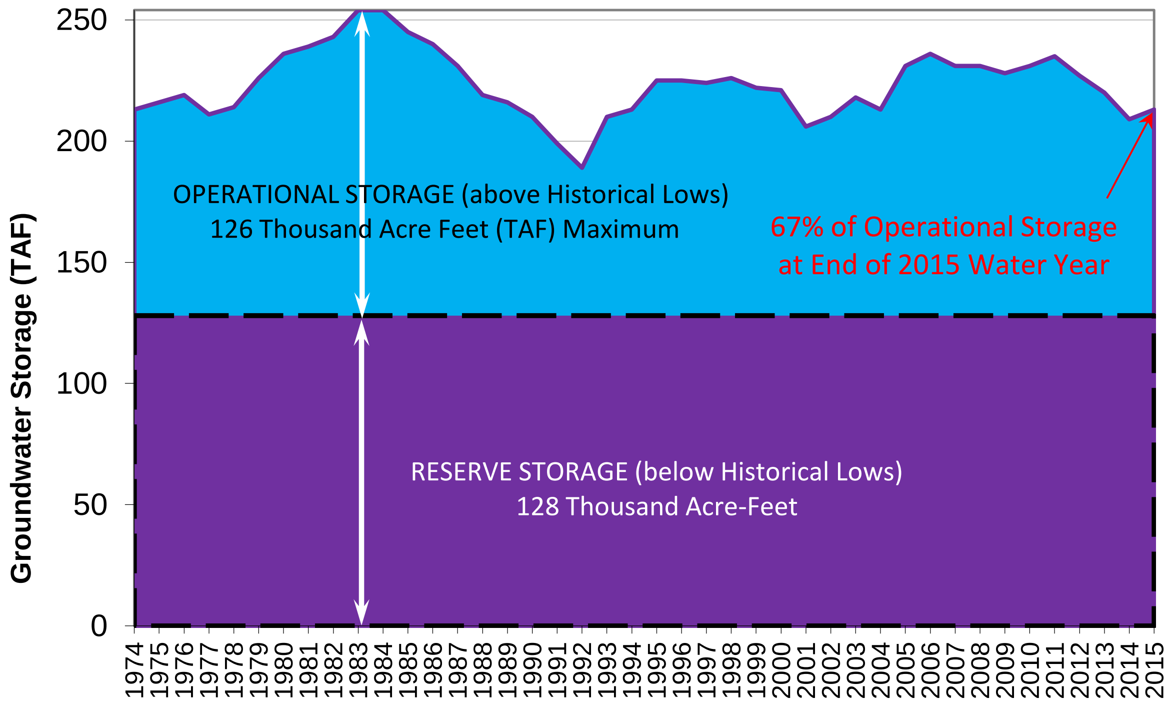
Figure E-5: Map of Historic Lows in Water Levels



E-3.2. Groundwater Storage

Significant and unreasonable depletion of groundwater storage is defined by SGMA as an undesirable result. This depletion occurs when the loss of storage is chronic and cannot be recovered over time with available cyclical replenishing supplies. To avoid this undesirable result, Zone 7 operates the Livermore basin such that groundwater in storage remains between a "full basin" volume (254,000 AF) and the historic low water levels, which represent about one-half of the total storage volume. This 126,000 AF referred to as Operational Storage. As illustrated in **Figure E-6,** the minimum threshold for basin storage is 128,000 AF, which represents the remaining emergency basin storage when water levels throughout the Main Basin are at historic lows. Groundwater below the threshold is regarded as Reserve Storage that is unavailable during non-emergency conditions.

Figure E-6: Operational Storage in Main Basin Management Area



E-3.3. Groundwater Quality

Although groundwater quality challenges have arisen since 1974, Zone 7 addressed each issue, preventing or reducing significant and unreasonable degradation of groundwater quality. The Alternative Plan discusses undesirable results and minimum thresholds in terms of the following groundwater quality issues:

- Total Dissolved Solids (TDS) and Salt Loading
- Nitrate and Nutrient Loading
- Additional Inorganic Constituents of Concern (Boron and Chromium VI)
- Toxic Sites

While elevated concentrations for these constituents may exist in localized parts of the basin (nitrate for example), they may be elevated due to ambient sources, historical conditions, or geologic factors. These are actively managed so they do not affect beneficial use of primary drinking water wells (municipal wells). In addition, Zone 7 evaluates new and proposed land uses to prevent undesirable results that might be created by those activities.

Two criteria are used to identify undesirable results.

- For the Main Basin Management Area, an undesirable result is defined as the loss of beneficial uses as measured in basin municipal wells that provide drinking water supply. This result would be caused by degradation of the Lower Aquifer with TDS, key inorganic constituents, and/or toxic substances such that levels in municipal wellfields cannot be blended, treated, or managed to provide drinking water supply.

- For the Fringe and Upland Management Areas, undesirable results are defined as the loss of beneficial uses due to contamination when treatment is not possible or practicable. Many of the subareas outside of the Main Basin Management Area already have poor water quality, so the focus is directed towards preventing contamination spread that would further limit beneficial uses.

Sustainability criteria are based on water quality BMOs adopted by Zone 7 in its GWMP and affirmed in subsequent documents. Key criteria for defining minimum thresholds include the RWQCB Basin Plan water quality objectives, federal and state drinking water standards (primary or secondary MCLs) and, in the case of boron, an EPA health advisory plus crop sensitivities.

Minerals and salts, using Total Dissolved Solids (TDS) as a surrogate, is an important factor in Zone 7's ongoing water quality management effort. Salt loading to the Main Basin is quantified through Zone 7's salt loading calculations. This provides an annual estimate of salt loading to the groundwater volume of the Main Basin in tons. Recognizing that salt addition and removal changes from year to year, Zone 7 strives for no long-term net loading. In addition, Zone 7 recognizes the potential for basin groundwater conditions to cause undesirable results in terms of TDS at specific municipal wells and wellfields. The recommended secondary MCL/RWQCB Basin Plan water quality objective (500 mg/L TDS) serves as a minimum threshold for potential undesirable results. Trends toward that threshold or exceedances trigger management responses by Zone 7 in collaboration with the Retailers. The responses can involve short-term actions such as further investigation and reduction of pumping of the affected well. Longer-term actions include the salt management strategies identified in the Zone 7 Salt Management Plan (SMP), such as artificially recharging the Basin with low TDS imported water, pumping and delivering additional groundwater to customers so more salts are exported as wastewater, and operating the Mocho Groundwater Demineralization Plant.

Boron also is addressed by SMP strategies. Similarly, a single detection of CrVI in a municipal well would prompt Zone 7 (with approval of the Division of Drinking Water) to blend water produced from the affected well with other sources of water to minimize any potential risk of MCL exceedance in delivered water. For the Fringe and Upland Management Areas, the TDS water quality objective is 1,000 mg/L (or ambient, whichever is lower).

Primary responsibility for toxic site regulation lies with Federal and State regulatory agencies. Zone 7 provides collaborative support (e.g., through its TSS Program) that successfully aids in remediation of priority contamination sites and prevention of the spread of contaminant plumes that would negatively impact beneficial uses.

E-3.4. Subsidence

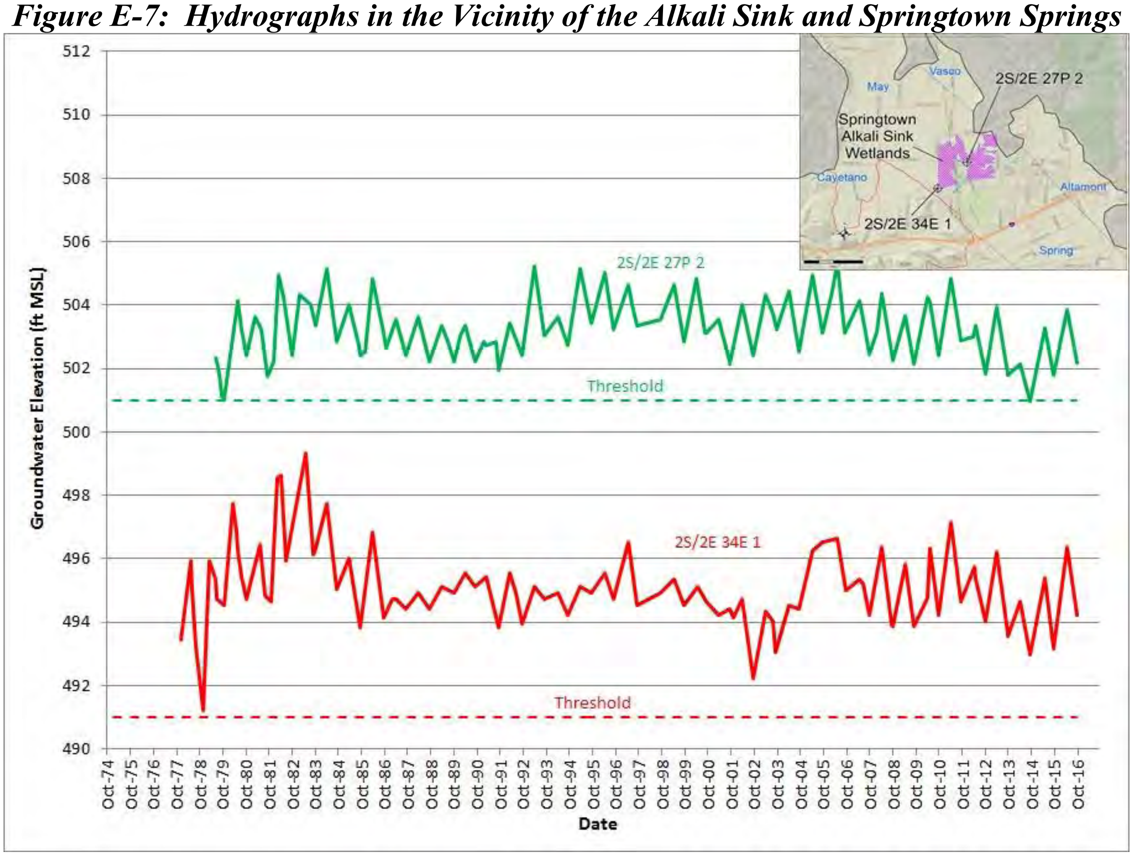
Zone 7 has recognized subsidence as a potential undesirable result and has responded through its 2005 GWMP and its on-going land surface elevation monitoring program. This program has demonstrated that no inelastic land subsidence has occurred during the monitoring period. In addition, Zone 7 conducted two historical research efforts (addressing 1992-2016 and 1947-1980). These studies documented no *inelastic* subsidence, however *elastic* surface elevation changes of up to 0.4 feet were observed during wet and dry hydrologic cycles.

Within this dynamic context, Zone 7's objective is prevention. Because there has been no observed inelastic subsidence, the minimum thresholds are set as the historical low groundwater elevation (see **Figure E-5**) and a decrease of 0.4 feet of land surface in any given groundwater level cycle. If these thresholds are triggered, the factors influencing the ground surface elevation will be analyzed. Other actions may include shifting groundwater extraction to other wells and/or placing a moratorium on new well construction in the area of concern.

E-3.5. Surface Water – Groundwater Interaction

The Springtown Alkali Sink may be considered a groundwater-dependent ecosystem, although the contribution of groundwater is limited and effects are seasonal. The sink supports an alkali-saline wetland habitat with seasonal surface ponding and shallow, seasonal high-salinity groundwater. The undesirable result would be depletion of surface water in the Alkali Sink and resulting potential adverse effects on the Alkali Sink ecosystem and protected species. The cause of undesirable results might result from a sequence of processes: increased pumping in the up-gradient area due to intensification of land uses, interception of groundwater flow, groundwater level declines near the sink, and resulting depletion of surface water. Ongoing monitoring and management by Zone 7 has supported the maintenance of steady groundwater levels near the Alkali Sink, with no increase in surface water depletion since the late 1970s. The minimum threshold is to avoid surface water depletion spatially and temporally in the Alkali Sink, and to use groundwater level measurements in two monitored wells in proximity to the sink. Specified minimum levels are used as the threshold: namely 491 feet in Well 2S/2E 34E 1 and 501 feet in Well 2S/2E 27P 2 (see **Figure E-7**).

Figure E-7: Hydrographs in the Vicinity of the Alkali Sink and Springtown Springs



E-4. Monitoring Networks

Zone 7 has developed and implemented an extensive basin-wide monitoring network that has expanded and improved over time as described in **Section 4**. The overall objective of the monitoring networks 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. Major features of the monitoring networks are provided below.

E-4.1. Climate Monitoring

The climate monitoring network provides high quality data for basin recharge calculations used in the water budget analyses. The network includes seven rainfall stations, two pan evaporation stations and one CIMIS station, including semi-continuous readings.

E-4.2. Surface Water Monitoring

Zone 7 monitors streamflow in arroyos that cross the basin, the surface area and water levels of quarry ponds, and the flow from the upper Arroyo Valle watershed into Lake Del Valle. This program utilizes a network of 15 recorder stream gage stations (including 1 low-flow-only and 3 high-flow-only gages) focused on but not limited to Arroyo Valle, Arroyo Mocho, Arroyo Las Positas, and Arroyo De La Laguna. Water quality is sampled and analyzed at least annually.

The Chain of Lakes/Mining Area Monitoring Program includes water level measurements and water quality analysis for mining area ponds. It also tracks mining activities, locations of discharge lines, circulation and conveyance of water between pits, and the locations of flow barriers created by clay-lined or backfilled pits. These data factor into both groundwater budget analyses and groundwater quality tracking/management.

E-4.3. Groundwater Elevation Monitoring

As shown in **Figure E-8**, about 240 wells are included in the Zone 7 groundwater elevation monitoring program in order to: track groundwater levels and flow, identify short- and long-term trends, estimate subsurface flows between Management Areas, and support water budget and storage analyses. Some of the data collected is submitted to the California Statewide Groundwater Elevation Monitoring (CASGEM) program.

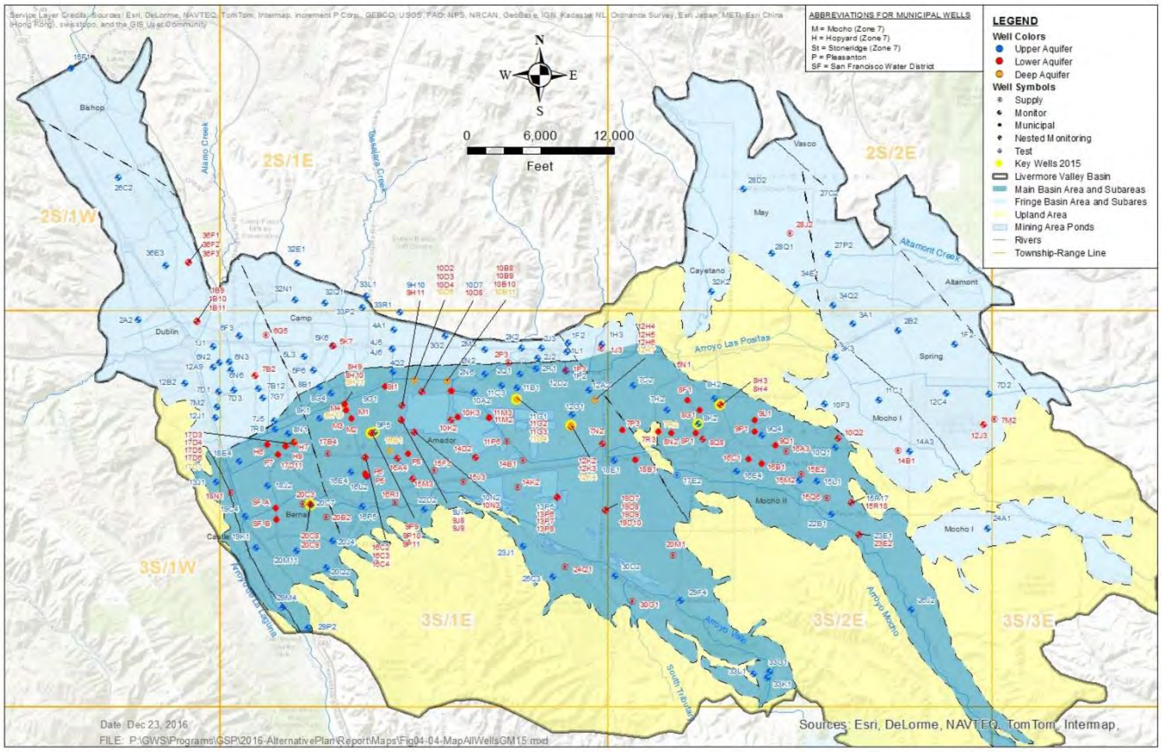
E-4.4. Groundwater Quality Monitoring

The groundwater quality monitoring program supports prevention of water quality degradation and mitigation of past degradation. The program includes 223 wells and analyses for 44 constituents and physical parameters. It focuses primarily on four inorganic constituents of concern in the Main Basin: TDS, nitrate, boron, and hexavalent chromium (CrVI).

E-4.5. Land Surface Elevation Monitoring

The Land Surface Elevation Monitoring Program, involving high precision surveys across the Bernal and Amador Subareas, tracks ground surface elevation changes across the groundwater basin to identify short- and long-term trends. To date, only small (<0.4 feet) elastic fluctuations in land surface elevation have been noted.

Figure E-8: Monitoring Program Wells in Livermore Valley Groundwater Basin



E-4.6. Wastewater and Recycled Water Monitoring

Zone 7 monitors the quality and quantity of wastewater and recycled water as they apply to the Livermore Valley groundwater budget (recharge supply and quality). Recycled water is mostly used for landscape irrigation. However, a minor amount is used for dust suppression, grading projects, and crop irrigation.

E-4.7. Data Management System

Zone 7 stores its data on groundwater levels, water quality, geology, and well construction in GIS/Key, a proprietary database management system. The program includes a detailed QA/QC checking module that confirms data integrity during import. Once imported, Zone 7 uses the reporting and mapping tools within GIS/Key to view and report the datasets. Zone 7 also exports datasets from GIS/Key for use in other programs such as Microsoft Excel, Microsoft Access, and ArcGIS to generate tables and figures in reports and other work products. Zone 7 uses a proprietary program called Aquarius Time-Series for managing time series datasets, such as recorded 15-minute rainfall, stream flow and groundwater elevation data.

E-4.8. Evaluation of the Monitoring Networks and Data Gaps

The Zone 7 monitoring program, developed over decades, provides tracking across the basin, with focus on areas of maximum groundwater use and on key sustainability metrics. This program, coupled with Zone 7's well permitting program and other collaborative efforts, provides effective early warning before triggers such as minimum thresholds are reached. The network is evaluated annually and improved as needed.

E-5. Projects and Management Actions

As described in **Section 5**, Zone 7 has been sustainably managing the Livermore Valley's groundwater basin for over 50 years. This adaptive management—involving ongoing plans and programs, plus specific projects—is responsive to Zone 7 goals and basin measurable objectives and assures sustainability out to the planning horizon.

E-5.1. Groundwater Supply

Consistent with planning documents (such as the GWMP, Urban Water Management Plan, Well Master Plan, and Nutrient Management Plan) that were developed with agency collaboration and public outreach, Zone 7 manages its available water supplies—imported surface water, local surface water, groundwater, and recycled water—with conjunctive use principles and ongoing adaptive management. Key projects and programs are summarized below.

- Import of Surface Water: The availability of State Water Project (SWP) supplies plus local sources is fundamental to Zone 7 maintenance of its basin objectives with regard to sustainable groundwater levels and storage, protection of beneficial uses, and avoidance of undesirable results. Zone 7 ensures that local water supplies (including groundwater) are not depleted by importing approximately 75% of the Valley's water supply (mostly SWP) and by recharging the Main Basin with surplus surface water when available (artificial recharge).

- Conjunctive Use: A key component of Zone 7's conjunctive use program has been its artificial recharge program, which consists of releases of surface water to dry arroyos and former quarry pits to recharge the groundwater basin. The timing and quantity of artificial recharge are typically dependent upon available supply, available recharge capacities, source water quality, and regulatory requirements. Nonetheless, the location and timing of artificial recharge operations is used as a water quality management tool as well as a water storage activity.

- Well Master Plan: The Well Master Plan provides a road map to guide construction of new Zone 7 wells in accordance with the water supply reliability goals for normal and drought years and for supply interruptions.

- Chain of Lakes Recharge Projects: Zone 7 worked closely with local aggregate mining companies to develop a mining area reclamation plan whereby ownership of ten quarry lakes—the Chain of Lakes—will be transferred to Zone 7 for water resources management purposes, including storage and groundwater replenishment, when quarry operations are complete.

- Existing and Future Recycled Water Use: Currently the City of Livermore and DSRSD produce about 5,600 AFY of tertiary-treated recycled water mostly for landscape irrigation, under a General Recycled Water Order. Both programs began under a Master Water Recycling Permit held jointly with Zone 7. Water quality concerns related to salt and nutrient loading from recycled water use are addressed in Zone 7's Salt Management Plan and Nutrient Management Plan, both incorporated into the Groundwater Management Plan.

- Water Conservation: Zone 7 is a member of the California Urban Water Conservation Council (CUWCC) and is in full compliance with the CUWCC Memorandum of Understanding. As a wholesaler, Zone 7 retains a Conservation Coordinator and provides regional coordination of conservation programs. Zone 7 is also up-to-date on its UWMP preparation and submittals.

E-5.2. Groundwater Quality

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 to basin measurable objectives to maintain groundwater quality and are indirectly supportive of groundwater supply objectives.

- Well Ordinance Program: Zone 7 administers the well permitting program within its service area and the three cities (Dublin, Livermore, and Pleasanton). This program helps protect local groundwater from negative impacts associated with poorly-constructed wells. It also allows identification and compilation of data on all pumping wells in the basin. This supports the monitoring program and management of groundwater pumping, with potential future benefits to management of groundwater levels, storage, and subsidence.

- Toxic Site Surveillance Program: Zone 7 tracks polluted sites that pose a potential threat to drinking water, gathering and compiling information from state, county, and local agencies. This helps protect groundwater quality and thereby supports conjunctive use of the groundwater basin.

- Salt Management Plan: Zone 7 prepared a SMP in 2004 to protect the long-term water quality of the Main Basin while expanding the area's use of recycled water. The SMP includes identification and screening of multiple strategies (including application of numerical modeling), cost allocation, and an implementation plan.

- Salt Management Strategy: Zone 7's water supply operations use an adaptive management approach to select the combination of salt management strategies to be implemented in a given year. These include artificial recharge with low TDS imported water, pumping and delivering additional groundwater to customers so more salts are exported as wastewater, and operating groundwater demineralization facilities that export salts as part of the waste concentrate (brine).

- Groundwater Demineralization Program: The Mocho Groundwater Demineralization Plant is a reverse osmosis membrane-based treatment system producing product water with extremely low TDS. The demineralized water is blended with other groundwater or system water to achieve the desired overall delivered water TDS and hardness. The concentrate is exported by the regional wastewater export pipeline (Livermore-Amador Valley Water Management Agency's pipeline to East Bay Dischargers Authority's pipeline to San Francisco Bay).

- Nutrient Management: Zone 7 tracks nutrient concentrations in groundwater annually as part of its routine groundwater quality monitoring program.

- Nutrient Management Plan: Zone 7 adopted a Nutrient Management Plan (NMP) in 2015 to assess the existing and projected future groundwater nutrient concentrations relative to the current and planned expansion of recycled water projects and future development. While concluding that overall basin groundwater quality is not expected to degrade with respect to nitrate, the NMP presents planned actions for addressing positive nutrient loads and high groundwater nitrate concentrations in localized Areas of Concern and calls for the continued use of Best Management Practices.

- Onsite Wastewater Treatment Systems (OWTS) Management: Zone 7 works collaboratively with Alameda County in permitting onsite wastewater treatment systems. Zone 7 approval is required for OWTS projects located within the Upper Alameda Creek Watershed.

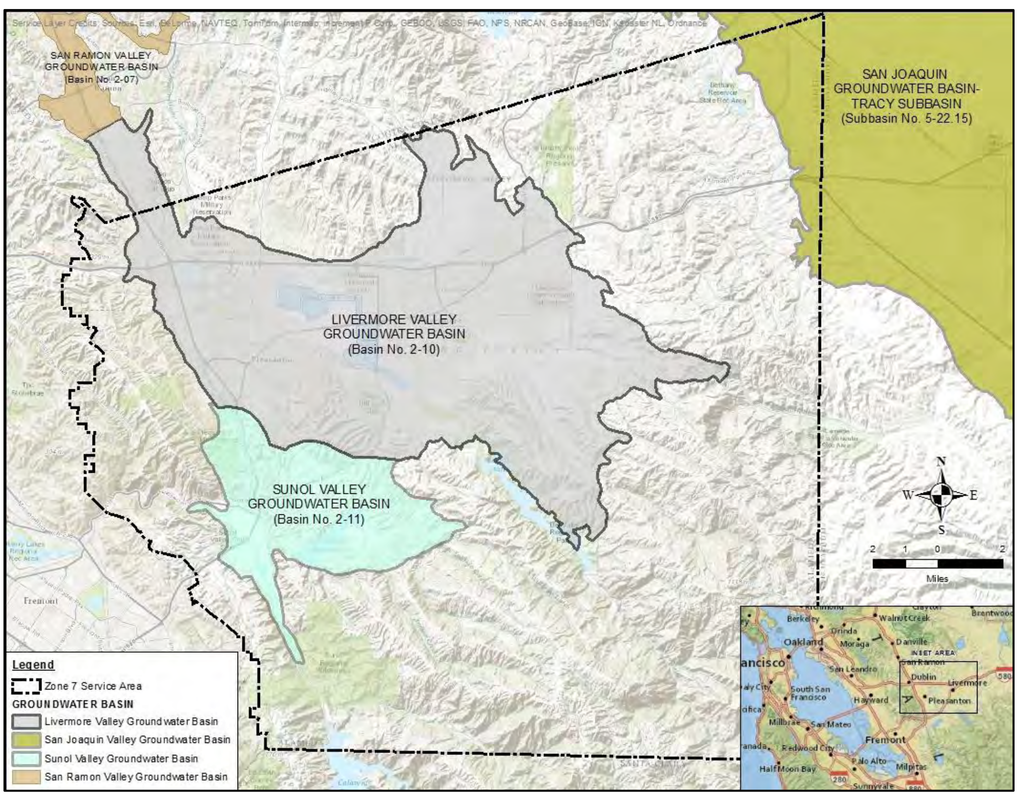
1 Agency Information and Plan Area

1.1 Introduction

For more than 50 years, Zone 7 Water Agency (Zone 7 or Agency) has managed imported and local surface and groundwater resources for beneficial uses in the Livermore Valley Groundwater Basin. In 2005, the Agency 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, 2005*). The GWMP followed requirements set forth in the California Groundwater Management Planning Act (Water Code Sections 10750, et seq.). That plan is incorporated into this Alternative Plan; a copy of the GWMP is provided with other key documents as attachments.

In 2014, the State of California passed the Sustainable Groundwater Management Act (SGMA) to empower local agencies to adopt groundwater management plans that are tailored to the resources and needs of their communities. SGMA also empowers local agencies to form Groundwater Sustainability Agencies (GSA) for managing groundwater resources in a sustainable manner. Recognizing the Agency's legal authority to implement SGMA for its service area, SGMA specifically designates Zone 7 as the exclusive GSA within its statutory boundaries (*Water Code §10723*). As shown on **Figure 1-1,** the Zone 7 Service Area includes almost all of the Livermore Valley Groundwater Basin, all of the Sunol Valley Groundwater Basin, and a small section of the Tracy Subbasin in the adjacent San Joaquin Valley Groundwater Basin.

Figure 1-1: Map of Groundwater Basins within Zone 7 Service Area



As a requirement of SGMA, the Department of Water Resources (DWR) has ranked all of California's groundwater basins as having a high-, medium-, low-, or very low-priority based on groundwater use, population, and other factors. DWR designated the Livermore Valley Groundwater Basin and the Tracy Subbasin as medium-priority basins and the Sunol Groundwater Basin as a very low-priority basin. Under SGMA, high- and medium-priority groundwater basins are required to be managed under a Groundwater Sustainability Plan (GSP) by January 31, 2022. Regulations for GSP development were approved by the California Water Commission in May 2016.

The regulations also allow a GSA to submit an Alternative Plan instead of a GSP if the entire basin has been operating within its sustainable yield[1] for at least 10 years. Such an Alternative Plan must cover the entire groundwater basin and be functionally equivalent to a GSP. Given the ongoing sustainable management of the Livermore Valley Groundwater Basin, Zone 7 Water Agency has prepared this Alternative Plan for compliance with SGMA and GSP regulations.

With regard to the Tracy Subbasin, Zone 7 Water Agency has executed a memorandum of understanding (MOU) with the San Luis & Delta-Mendota Water Authority to support SGMA compliance. Accordingly, this Alternative Plan does not cover the Tracy Subbasin. As mentioned above, the Sunol Groundwater Basin does not require a GSP, given its current very-low priority status.

1.2 Zone 7 Water Agency

Zone 7 of the Alameda County Flood Control and Water Conservation District is one of ten active zones of the Alameda County Flood Control and Water Conservation District (District). Zone 7 is the only zone in the District that provides water services in addition to flood protection, and has a long history of managing imported and local surface and groundwater resources for beneficial uses in the Livermore Valley Groundwater Basin. Consistent with its management responsibilities, duties, and powers, Zone 7 Water Agency is designated in SGMA as the exclusive GSA within its boundaries. Electing to be a GSA, the Agency will exercise its groundwater management authority consistent with its principal act and with SGMA.

The history of Zone 7 Water Agency, including its statutory responsibilities and its ongoing coordination with other local agencies in the basin, is described briefly below.

1.2.1 Alameda County Flood Control and Water Conservation District

The Alameda County Flood Control and Water Conservation District was created in 1949 by the California State Legislature through passage of the Alameda County Flood Control and Water

[1] SGMA defines Sustainable Yield as the maximum quantity of water (calculated over a base period representative of long-term conditions in the basin and including any temporary surplus) that can be withdrawn annually from a groundwater supply without causing an undesirable result.

Conservation District Act (*1949 ch1275, published as Act 205 of the California Uncodified Water Code*) (District Act). The District was authorized by the District Act to provide control of flood and storm waters and to conserve water for beneficial uses. District authority also includes the powers to:

- store water in surface or underground reservoirs for the benefit of the District;
- conserve and reclaim water for present and future use within the District;
- appropriate and acquire water and water rights, and import water into the District;
- prevent interference with or diminution of, or to declare rights in the natural flow of any stream or surface or subterranean supply of waters used or useful for any purpose of the District;
- prevent contamination, pollution or otherwise rendering unfit for beneficial use subsurface water used or useful in the District; and
- levy replenishment assessments upon the production of groundwater from all water-producing facilities, whether public or private, within the District.

The full text of District Act (Act 205 of the Uncodified Water Code) can be viewed here: http://www.acfloodcontrol.org/resources/district-act-205/

1.2.2 Zone 7 Water Agency Responsibilities

The history of Zone 7 as a separate water resource management agency can be traced to the mid-1950s, when the Livermore-Amador Valley was primarily rural in character, with a population of approximately 30,000 people. The area faced a number of challenges, including groundwater overdraft - from both groundwater export by the San Francisco Public Utilities Commission (SFPUC), local use, and flood hazards - as evidenced by the flood of record in 1955, and uncertainty over future water supplies. It was against this backdrop that the residents of the Livermore Valley voted, in 1957, to create Zone 7 Water Agency.

In 2003, the legislature passed Assembly Bill 1125 and gave the Zone 7 Board of Directors full authority and autonomy to govern matters solely affecting Zone 7 independently of the Alameda County Board of Supervisors. The Alameda County Board of Supervisors governs the other nine zones of the District. Zone 7's key water resource responsibilities include:

- serve as the contractor with DWR for the State Water Project,
- manage the local water right on Arroyo Valle,
- procure other water supplies as necessary to meet demands,
- provide wholesale treated water supply,
- provide untreated water for agriculture,
- operate and maintain water treatment and transmission systems,
- manage regional stormwater for public safety and protection of property, and
- sustainably manage the Livermore Valley Groundwater Basin.

Zone 7's mission statement concisely defines the overarching goals of the agency to provide ~~a~~ reliable supply of high quality water and an effective flood control system to the Livermore-Amador Valley. In fulfilling our present and future commitments to the community, we will develop and manage the water resources in a fiscally responsible, innovative, proactive, and environmentally sensitive way." Under Zone 7's Groundwater Management Program, Zone 7 administers management of the Livermore Valley Groundwater Basin and prevents groundwater overdraft. The primary groundwater basin management objectives of Zone 7 are to provide for the control and conservation of waters for beneficial future uses, the conjunctive use of groundwater and surface water, the importation of additional surface water, and the use of the groundwater basin to store imported surface water for later recovery during drought periods. The basin is not adjudicated.

1.2.3 Zone 7 Retailers

As the water wholesaler for the Livermore-Amador Valley, also commonly referred to as the Tri-Valley[2], Zone 7 supplies treated water to four retail water supply agencies (Retailers):

- California Water Service Company – Livermore District (Cal Water)
- Dublin San Ramon Services District (DSRSD),
- City of Livermore (Livermore), and
- City of Pleasanton (Pleasanton).

These Retailers deliver water for municipal and industrial (M&I) purposes within their individual service areas, which include the cities of Livermore, Pleasanton, Dublin, and a portion of San Ramon (Dougherty Valley).

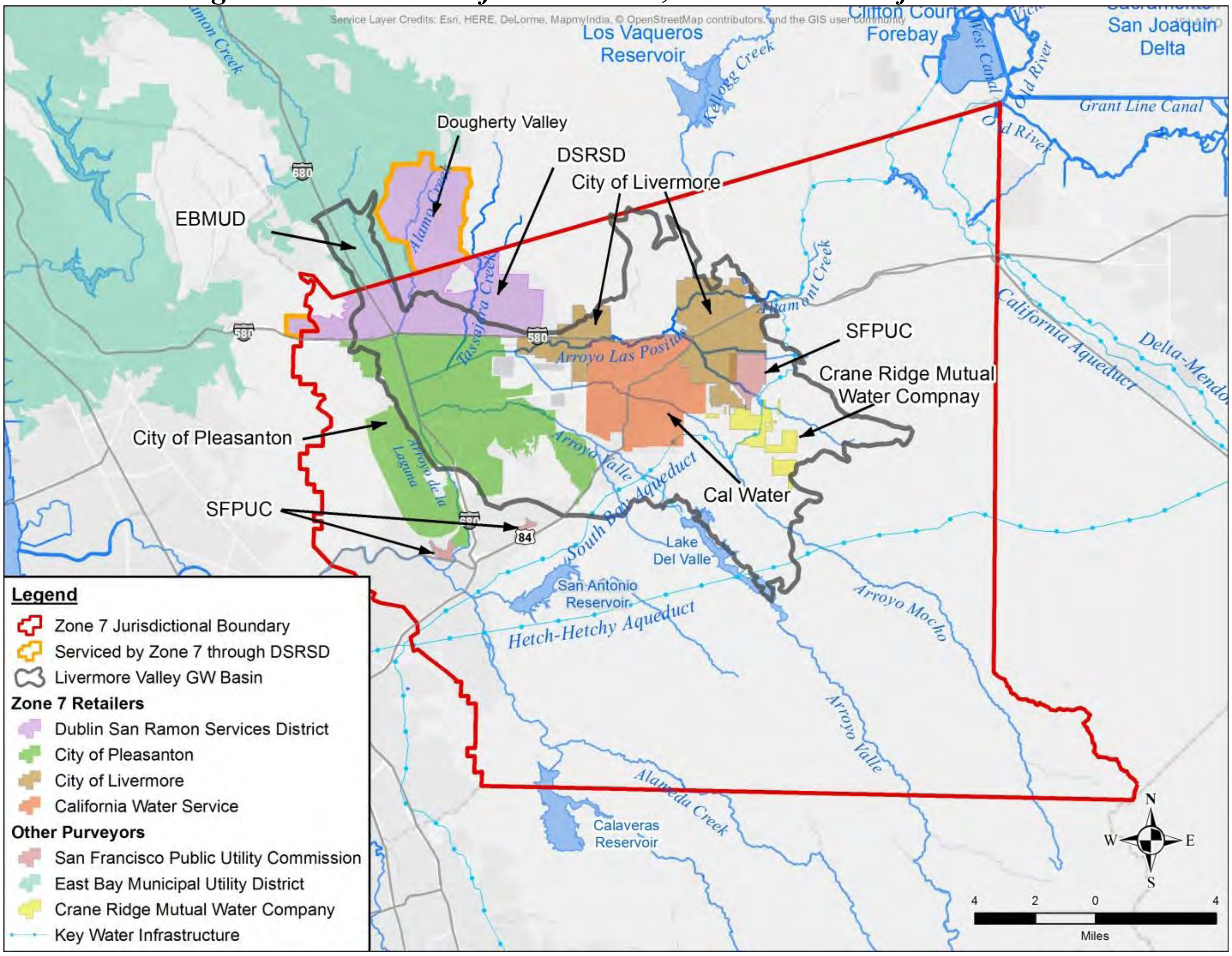
The Retailers and Zone 7 work together through various means of communication including the Tri-Valley Water Retailers Group (TWRG), consisting of staff from each retailer, and Liaison Committee meetings, consisting of both elected officials and staff. In addition to these formal meetings, the staff from operations and planning regularly meet to discuss annual operations, safety and emergency response, and long-term water supply planning.

1.2.4 Zone 7 Service Area

The Zone 7 water service area (**Figure 1-2**) is located about 40 miles south-east 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 DSRSD.

[2] The Tri-Valley Area, as defined here, includes the City of Dublin, City of Livermore, City of Pleasanton, and part of the City of San Ramon.

Figure 1-2: Location of Service Area, Retailers and Major Streams

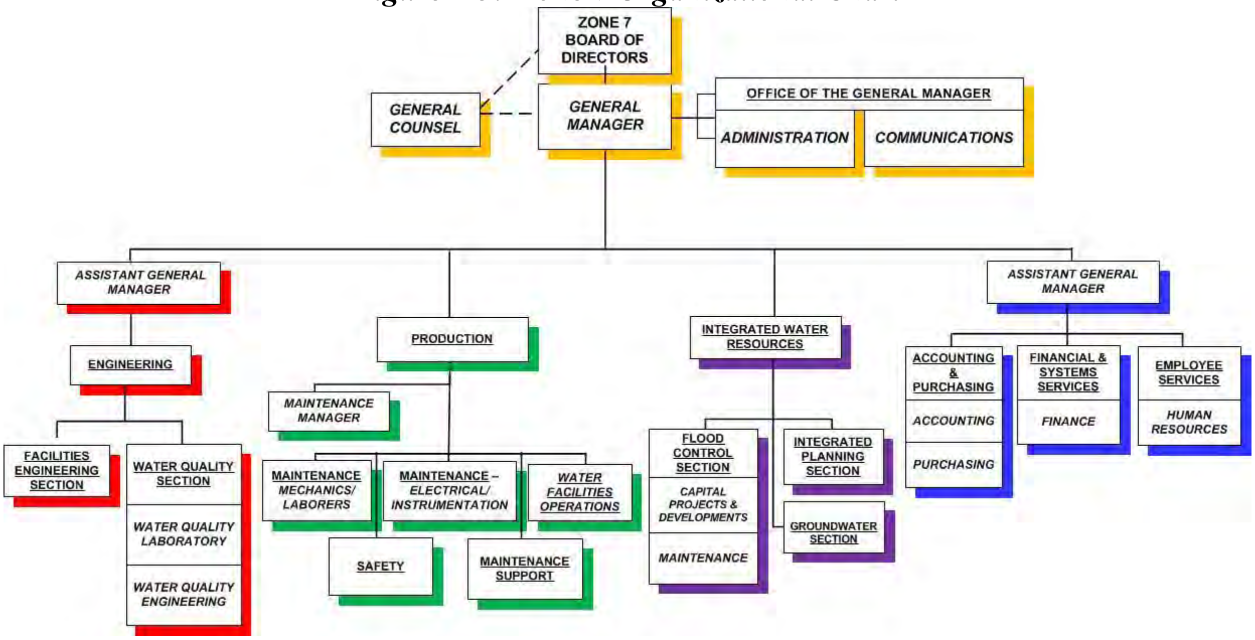


1.2.5 Zone 7 Organization and Management Structure

As described in Section 1.2.1, the 1949 Alameda County Flood Control and Water Conservation District was created with authority to provide control of flood and stormwater and to conserve and manage local water for beneficial uses. The District comprises 10 active zones, of which Zone 7 covers the eastern portion of Alameda County (**Figure 1-2**). Pursuant to Section 36 of the District Act, Zone 7 Water Agency was established in 1957 to address regional and water supply issues. Zone 7 is governed by a seven-member Board of Directors (Zone 7 Board). Each director is elected at-large by residents within Zone 7's service area to a four-year term. The Zone 7 Board of Directors have full authority and autonomy to govern matters solely affecting Zone 7, independent of the Alameda County Board of Supervisors who govern the other nine zones of the District. The Zone 7 Board has played an active role in groundwater management and has adopted numerous policies and programs for sustainable management of local groundwater resources.

The Zone 7 Board also provides direction to Zone 7 management and staff through the Zone 7 General Manager and general counsel. Zone 7's organizational chart is included below as **Figure 1-**3.

Figure 1-3: Zone 7 Organizational Chart



The General Manager is assisted by two Assistant General Managers with respective responsibility for two divisions: Engineering and Finance. Three other Core Managers oversee the core functions of the Agency: Engineering, Operations and Maintenance, and Integrated Water Resources. Groundwater management falls under the Integrated Water Resources function and coordinates within the group to also achieve stream management and flood protection, long-term planning, watershed and water quality protection, environmental planning, Asset Management and Capital Improvement Program planning.

Because the local streams are used for both flood protection and artificial recharge, Zone 7's climatology and stream monitoring programs are coordinated between the Flood Control and Groundwater sections. Zone 7 serves as the area's flood control agency and owns and/or maintains 37 miles of flood protection stream/channel corridors within a 425 square mile area. Zone 7 manages is flood protection program through its Stream Management Master Plan.

Regarding water operations and long-term planning, Zone 7 became an early importer of water (1962) for artificial groundwater recharge as one of the 29 contractors for the State Water Project (SWP). As the water wholesaler for the Tri-Valley Area, Zone 7 imports surface water from the SWP through the South Bay Aqueduct (SBA) for treatment, storage, and groundwater recharge. Zone 7 supplies treated drinking water to the four Retailers (see **Figure 1-2**), which deliver water to customers in their specific service areas. Zone 7 also supplies untreated water for local industry and agriculture. Thus, Zone 7 indirectly serves water to an area with a population of approximately 238,600 (*Zone 7's 2015 Urban Water Management Plan*, UWMP).

Although the Livermore Valley Groundwater Basin is not adjudicated, by agreement with the local Retailers, Zone 7 manages regional water supplies, through the interrelated programs described above where previously agreed groundwater extraction quotas are tracked and annual water management accounting is conducted. Zone 7 also operates recharge facilities to augment instream and mining pond aquifer recharge. Zone 7's groundwater extraction is managed as to not exceed the previously recharged amounts. Water quality is also closely monitored and environmental cleanup sites are tracked. In addition, Zone 7 works closely with DWR, which manages Lake Del Valle and dam, to augment imported water supplies with local surface water runoff.

In summary, Zone 7 Water Agency imports surface water via the SWP's SBA, stores local runoff in Lake Del Valle, operates recharge facilities in the area, manages local and import surface water and groundwater supplies to maximize conjunctive use of the supplies, treats and wholesales potable water to local retail water supply agencies (who in turn retail it to residents and other customers), delivers imported untreated water for irrigation to its agricultural customers, and provides protection of groundwater quality through the implementation of its Groundwater Management Plan, Salt and Nutrient Management Plan, and operation of its Mocho Groundwater Demineralization Facility.

Continuing almost 60 years of active water resource management and over 50 years of active groundwater basin management, this Alternative Plan will be implemented by the Zone 7 General Manager, assisted specifically by staff of the Agency's Integrated Water Resources Division.

1.2.6 GSA and Coordinating Agreements

SGMA designates Zone 7 as the exclusive GSA for groundwater basins within its service area. A small portion of the northwestern Livermore Valley basin extends into Contra Costa County (see **Figure 1-1**) beyond the Zone 7 service area and into the service areas of East Bay Municipal Utilities District (EBMUD), City of San Ramon, and DSRSD. To provide management of this portion of the basin, Zone 7 and the local agencies have developed and adopted a MOU under which Zone 7 will serve as the GSA for the Contra Costa portion of the Livermore Valley Groundwater Basin. For this portion of the basin, the MOU delegates to Zone 7 the administrative functions, powers and duties assigned by SGMA to a GSA to manage and monitor groundwater supplies and use, and report data. The MOU also reserves EBMUD's rights to continue to provide water service in the area, retains Contra Costa County's authority as the well permitting agency for the area, and recognizes the City of San Ramon as the primary land use agency. A copy of the MOU is provided in **Appendix A**.

1.2.7 Alternative Plan Implementation Costs

Within Zone 7's Integrated Water Resources Division, the Groundwater Section is primarily responsible for the implementation of Zone 7's Groundwater Management Plan. The Groundwater Section employs a staff of seven including four hydrogeologists and three Water Resource Technicians. One of the Water Resources Technician positions is funded, in part, through fees collected under the Alameda County Well Ordinance program. Section budgets are set every two years, or adjusted as needed to address emergencies and critical need. The annual

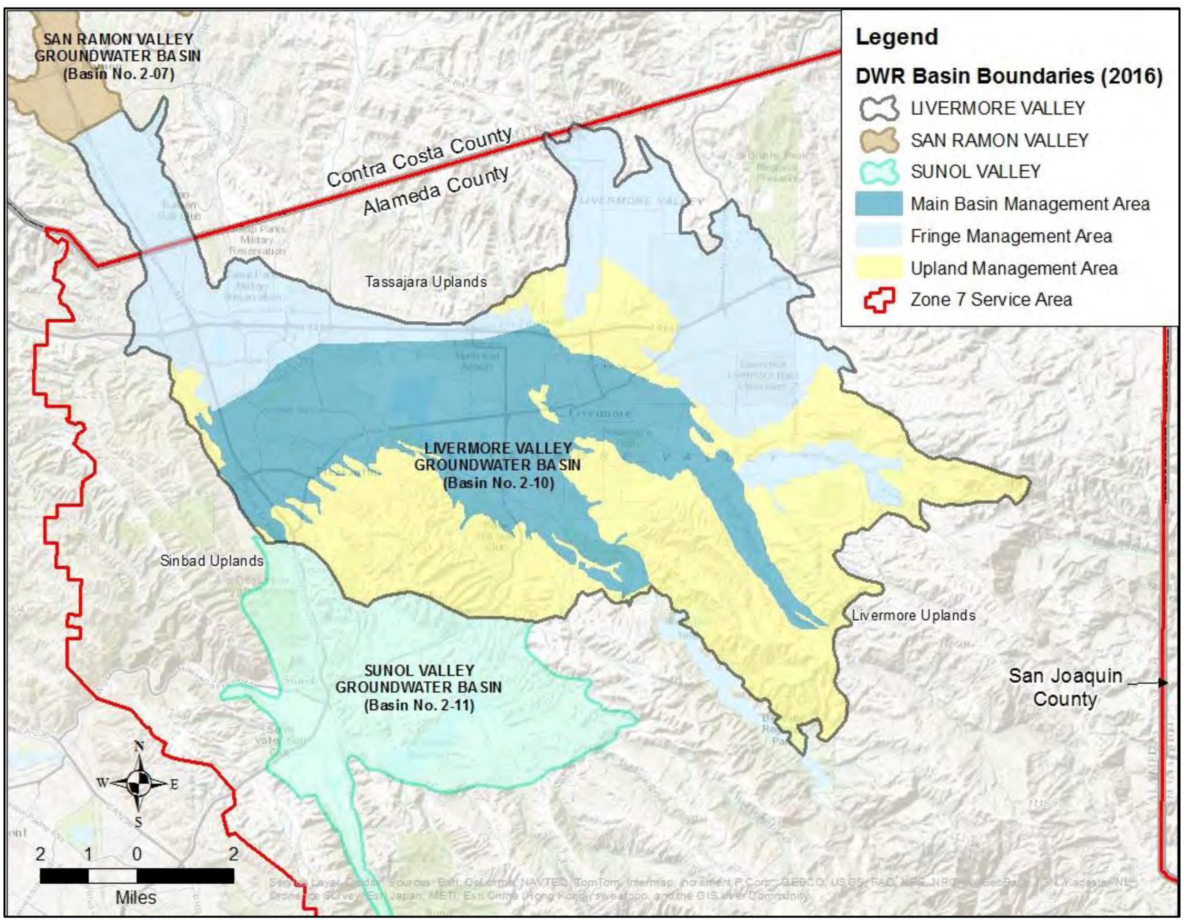
Groundwater Section budgets for the 2016-17 and 2017-18 fiscal years are approximately $1.5M and $1.6M respectively. About 98% of the funding for these budgets will come from water sales and well permit revenues. The balance of the Section's funding will be from new water connection fees and property taxes.

1.3 Plan Area

1.3.1 Description and Maps

The Plan Area (**Figure 1-4**) is the entire Livermore Valley Groundwater Basin, designated in DWR Bulletin 118 as Basin No. 2-10 and encompassing approximately 69,600 acres (109 square miles) in Alameda and Contra Costa counties. The area is referred to as the ―Plan Area," ―groundwater basin" or simply ―basin" in this document. 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 (No. 2-11), which is a very-low priority basin to the southwest of the Livermore Valley Groundwater Basin.

Figure 1-4: Map of Plan Area, Livermore Valley Groundwater Basin



The Livermore Valley Groundwater Basin is an inland alluvial basin underlying the east-west trending Livermore-Amador Valley (Valley). The Valley floor covers about 42,000 acres and is mostly surrounded by hills of the Diablo Range. The Livermore Valley Groundwater Basin covers the alluvial-filled Valley and extends into the uplands generally south of Pleasanton and Livermore. Surface drainage features include Arroyo Valle, Arroyo Mocho, and Arroyo las Positas as principal streams (see **Figure 1-2**), with Alamo Creek, South San Ramon Creek, and Tassajara Creek as minor streams draining from the north. All streams converge on the west side of the basin to form Arroyo de la Laguna, which flows south, exiting the Livermore Valley and joining Alameda Creek in Sunol Valley.

The basin was first delineated by DWR in its *Bulletin No. 118-2, Evaluation of Ground Water Resources, Livermore and Sunol Valleys, Appendix A:Geology* (*August 1966*). The basin was defined as including the Livermore Valley underlain by alluvium and the uplands underlain by the Livermore Formation. Uplands to the north, underlain by the Tassajara Formation, were not included given its low yield of groundwater. The northern boundary is the limit of alluvium except the northwestern boundary with the San Ramon Valley Groundwater Basin, which was defined as the surface water divide. Narrow strips of alluvium along Alamo and Tassajara creeks were deemed to have insignificant thickness overlying relatively non-water bearing rocks and were not included in the basin. The southern and southwestern boundaries are the limit of the Livermore Formation except the southwestern boundary with the Sunol Valley Groundwater Basin where the surface water divide between the Livermore and Sunol uplands was selected with a narrow extension to the west across Arroyo de la Laguna.

Subsequently, the basin boundaries were modified somewhat by DWR in *Bulletin No. 118-2 (Evaluation of Ground Water Resources: Livermore and Sunol Valleys, June 1974)* and during a 2003 update. In 1974, the northwestern boundary with the San Ramon Valley Groundwater Basin was shifted northward, still defined by the subtle surface water divide. The basin also was extended to include additional areas of alluvium associated with some of the smaller streams along the western and northern boundary. North of Livermore, the boundary was simplified to consolidate and exclude some areas of Tassajara Formation. The southern boundary of the Livermore Uplands with the Sunol Valley Groundwater Basin also was adjusted to account for the Verona Fault. During the 2003 update, some additional modifications were made to the basin boundaries; overall the modified boundary was generalized and more inclusive. As an exception, the boundary with San Ramon Valley Groundwater Basin is shifted back southward. North of Livermore, some previously-excluded areas of Tassajara Formation were encompassed. The easternmost Livermore Upland corner of the basin was also extended eastward and the southern boundary simplified.

For purposes of groundwater management, the basin has been divided into three management areas (and additional subareas) on the basis of varying geologic, hydrogeologic, and groundwater conditions.

Table 1-1: Groundwater Basin Management Areas

Management Area	Size (acres)
Main Basin	19,800
Fringe Subareas	22,041
Upland Areas	27,759
Total	**69,600**

The Main Basin is the portion of the Livermore Valley Groundwater Basin that contains the highest yielding aquifers and generally the best quality groundwater. The Fringe Management Area encompasses northern and eastern portions of the Valley that are characterized by relatively limited groundwater storage, low well yield, and poor water quality. The Upland Areas (mostly situated along the southern portion of the basin) are underlain by the relatively low-yielding Livermore Formation. Groundwater flow is generally from Fringe and Upland Management Areas toward the Main Basin; within the Main Basin, groundwater flows from southeast and east to the west, toward municipal wells.

Figure 1-5 shows the Livermore Valley Groundwater Basin as defined in the 2003 Bulletin 118 update. As noted previously, the boundaries were initially delineated by DWR in 1966, modified in 1974 and 2003.

Figure 1-5: Delineation of Livermore Valley Groundwater Basin Boundary

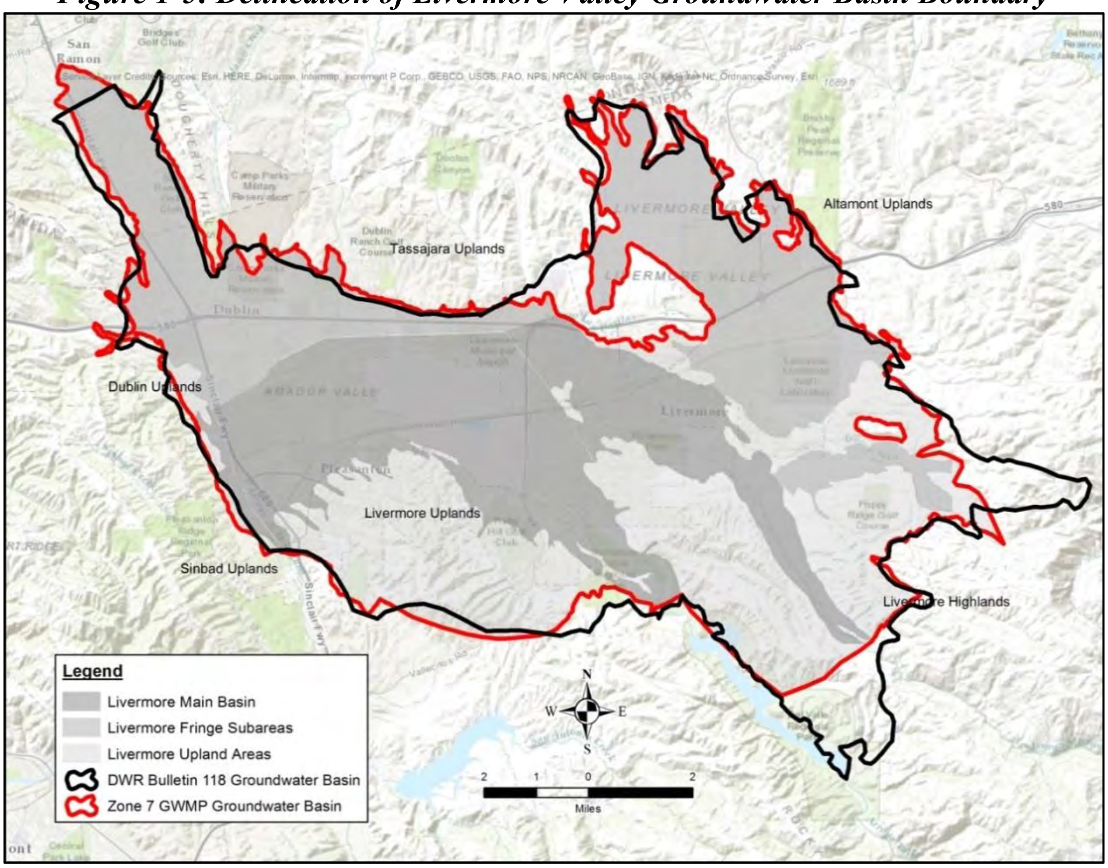


Figure 1-5 also shows the basin boundary as depicted in the 2005 Zone 7 Water Agency Groundwater Management Plan (**Attachment A**); the two basin areas are substantially the same. Areas of difference between the two maps include the boundary with San Ramon Valley Groundwater Basin and small extensions up alluvial stream valleys, where the Zone 7 boundary has been more detailed than the current DWR boundary. In addition, the Zone 7 boundary had not been revised to include areas of Tassajara Formation north of Livermore or extension of the Livermore Upland to the east. The Zone 7 boundary also is somewhat different and less extensive to the southeast where the Livermore Upland areas are quite rugged.

While recognizing that the boundary has varied over the years with interpretation both by DWR and Zone 7, no modifications are planned for the 2016 review of Bulletin 118 basin boundaries. More recent geologic mapping (e.g., *Wagner et. al., 1991*) and more extensive hydrogeologic information developed by Zone 7 may warrant review and refinement of the boundaries in the future. In the meantime, the boundaries are comparable. The areas outside of the GWMP basin are predominantly upland areas with relatively limited groundwater development. Inclusion of these areas will not impact the hydrogeological conceptual model or hydrologic inventory, which already accounts for subsurface inflows. In addition, Zone 7 management activities will not be affected materially. While not dismissing likely future changes to the monitoring program, current monitoring programs provide effective tracking of relevant groundwater sustainability indicators including groundwater levels, storage, quality, and surface water/groundwater interactions. This Alternative Plan addresses the entire area of the Livermore Valley Groundwater Basin as currently defined by DWR.

1.3.2 Water Supply

1.3.2.1 Water Purveyors

Zone 7 supplies the majority of the water for the Valley; primarily through its four Retailers (see **Section 1.2.3** and **Figure 1-2)**. Three of these Retailers (DSRSD, Pleasanton, and Livermore) are public water supply agencies. Cal Water is a private water company providing water supply to portions of the City of Livermore. In addition to the treated water supplied by Zone 7, two of the Retailers (Pleasanton and Cal Water) have their own municipal groundwater supply wells. DSRSD and Livermore also provide recycled water for landscape irrigation to supplement treated water supply.

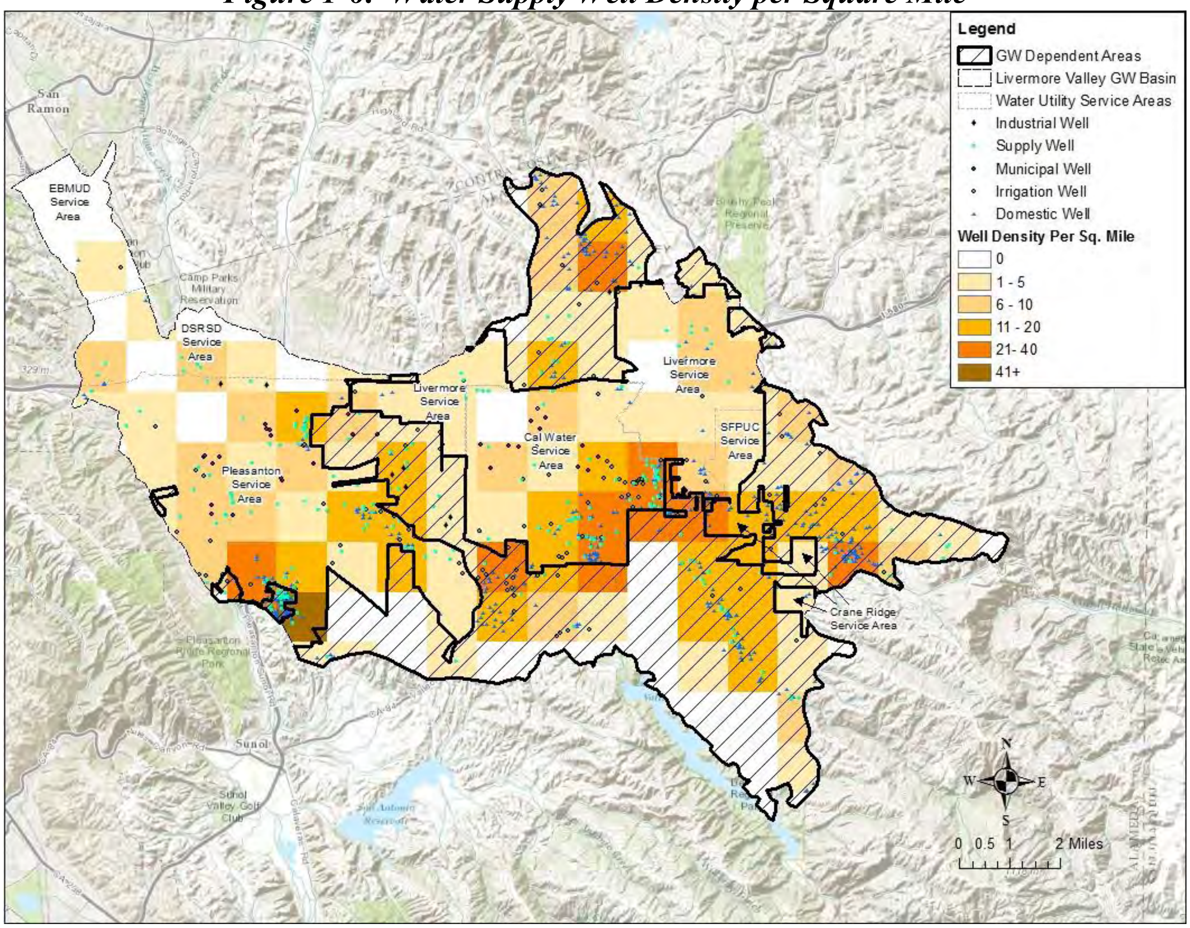
SFPUC supplies groundwater to the Castlewood Development in the western portion of Pleasanton. The Crane Ridge Mutual Water Company, a small private water purveyor, distributes potable water supplied by Cal Water to various domestic users in South Livermore. Alameda County Fairgrounds, in Pleasanton, is a small water system using groundwater.

1.3.2.2 Water Supply Wells

Figure 1-6 shows the distribution and density per square mile of water supply wells in the basin, including industrial, municipal, agricultural, irrigation, domestic, and undifferentiated supply wells. The last two categories include de minimis extractors. Well information was derived from Zone 7's database, which relies on permit records, field inspections, and property owner and driller reporting. All known active supply wells in the Livermore Valley Groundwater Basin are included on the map. Selection of the one-mile grid was performed automatically using geographic information system (GIS) software.

Figures 1-2 and 1-6 also show the service areas of the major water providers in the basin, including EBMUD, DSRSD, Pleasanton, Livermore, and Cal Water. While these providers may use groundwater supply, none are dependent on groundwater. Beyond their respective service areas, other entities rely on groundwater. For the purposes of this map, an area in the groundwater basin that is outside of the water utilities service areas is considered a groundwater dependent community. As shown on the map, groundwater dependent communities are present in the north-central and southeastern portions of the basin, as well as a small pocket in the southwestern portion of the basin (referred to as Happy Valley).

Figure 1-6: Water Supply Well Density per Square Mile



1.3.3 Land Use

1.3.3.1 Land Use Designations

Zone 7 monitors land use changes in the Valley as part of its long-range flood and water supply planning, which includes its groundwater basin management program. The purpose of the program is to map and quantify Main Basin land use for areal recharge calculations (e.g., rainfall recharge, applied water recharge, and unmetered groundwater pumping for agriculture) and consideration as part of water quality sustainability.

The Land Use Monitoring Program identifies significant changes in land use over time with an emphasis on changes in pervious areas and the volume and quality of irrigation water that could impact the volume or quality of water recharging the Main Basin. Land use data are derived from aerial photography (most recent available from June 2014), well permit applications, field observations, and City and County planning documents. New development plans and associated California Environmental Quality Act (CEQA) documentation are reviewed by Zone 7 staff to evaluate potential impacts to groundwater supply and quality.

For the purpose of Zone 7's Groundwater Management Program, primary land uses are mapped as polygons having one of the following designations:

- Residential (rural)
- Residential (low density)
- Residential (medium density)
- Residential (high density)
- Commercial and Business
- Public
- Public (Irrigated Park)
- Agriculture (vineyard)
- Agriculture (non-vineyard)
- Mining Area – Pit
- Water Body (including Chain of Lakes)
- Golf Course
- Open Space

Each individual land use polygon is also assigned one of the following sources of irrigation water based on Zone 7's understanding of the primary irrigation water source used for that particular area:

- Delivered (municipal) water
- Groundwater (non-municipal supply wells)
- Recycled water
- None

Land use categories and source water type are then assigned spatially to the groundwater model cells (500 feet by 500 feet), which are also the spatial units used for the areal recharge calculations.

The 2015 Water Year (WY) land use areas are shown on **Figure 1-7**. For the 2015 WY, land use remained relatively unchanged from 2014 WY, and in fact still remains quite similar to the land use of the mid-2000s.

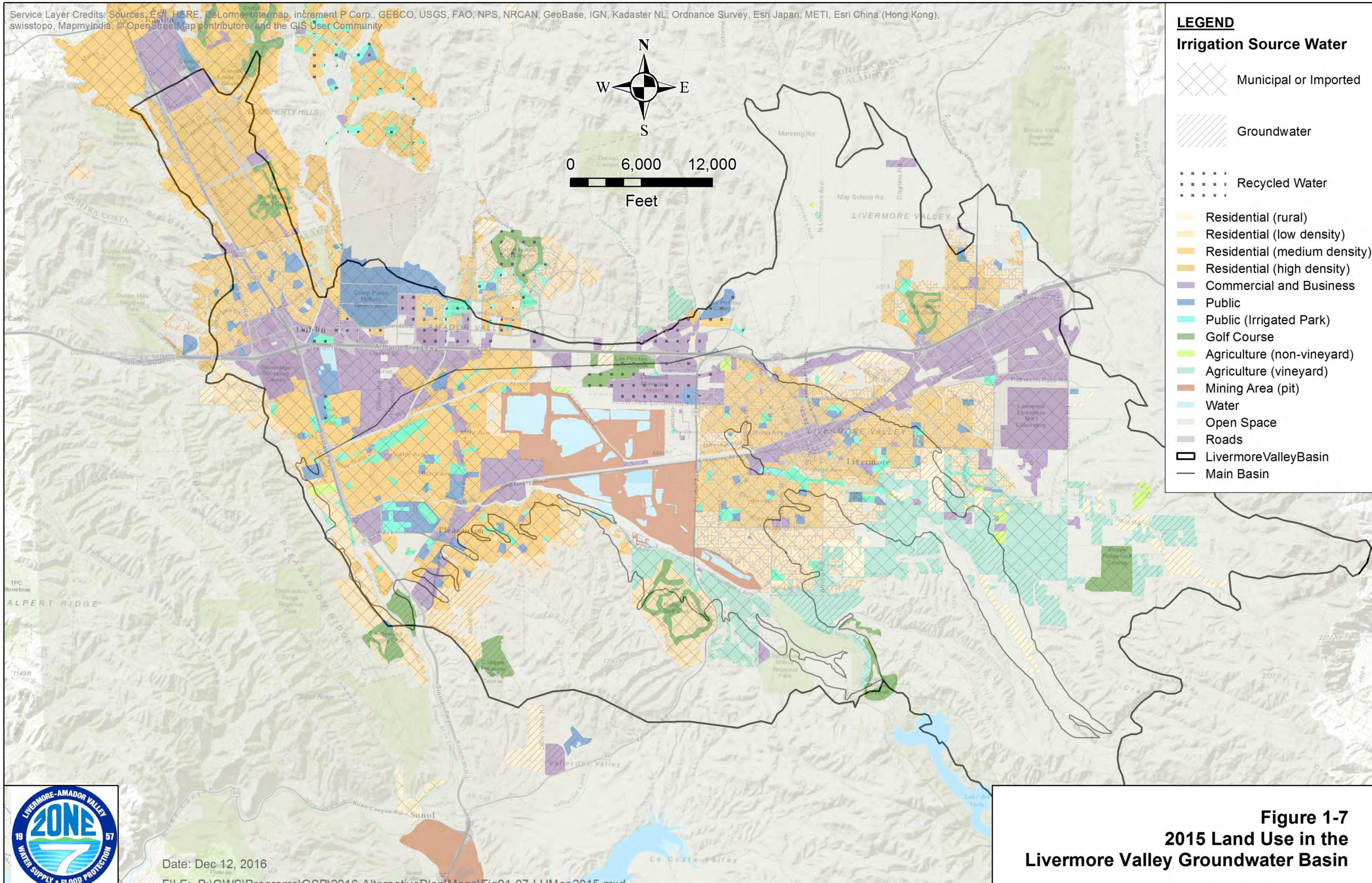


Figure 1-7
2015 Land Use in the Livermore Valley Groundwater Basin

1.3.3.2 Land Use Planning

Implementation of existing land use plans by various jurisdictions has important ramifications for water supply sustainability. Urban, rural, and agricultural growth tends to increase water demand, but land use policies and programs can support sustainable water supply planning including water conservation, conjunctive use of surface water and groundwater supplies, water recycling, and stormwater management.

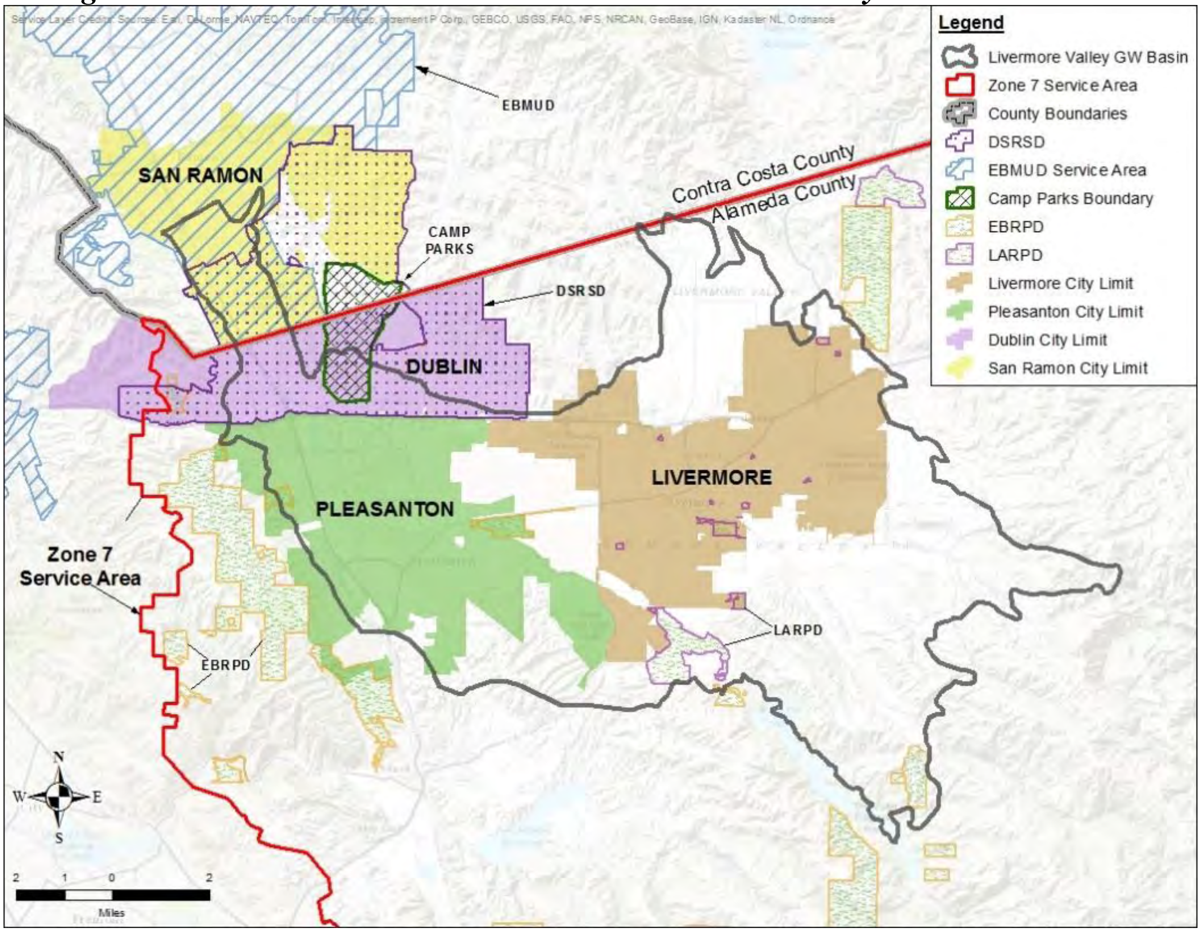
1.3.3.3 Jurisdictions

The Livermore Valley Groundwater Basin is located mostly in Alameda County, with a northern extension into Contra Costa County. Cities overlying portions of the basin include San Ramon, Dublin, Pleasanton, and Livermore (**Figure 1-8)**. There are two Park Districts in the Valley: the East Bay Regional Park District (EBRPD) and the Livermore Area Recreation and Park District (LARPD).

Other jurisdictions in the basin include Camp Parks Military Reservation/Reserve Forces Training Area, located on the northern boundary of the basin and operated by the Department of Defense/ United States Army. The facility is a semi-active mobilization and training center for army reserve personnel to be used in case of war or natural disaster. The site also includes a federal correctional institution. On the southern side, the Lake Del Valle State Recreation Area and Shadow Cliffs Regional Recreation Area are operated by EBRPD. No tribal land is known in the basin.

Agencies with public water supply responsibility in the basin include Zone 7 Water Agency, EBMUD, DSRSD, Pleasanton, Livermore, and SFPUC. Zone 7's jurisdictional area is only in Alameda County. Across the county line, Contra Costa County, Contra Costa County Water Agency, City of San Ramon and EBMUD have jurisdictions in the northwestern portion of the basin. Pursuant to the MOU with Zone 7 (**Section 1.2.6** and **Appendix A**), the Contra Costa authorities have delegated to Zone 7 the administrative functions, powers and duties assigned by SGMA to a GSA. Contra Costa County retains its authority as the well permitting agency for that area. Likewise, EBMUD retains its rights to continue to provide water service and the City of San Ramon remains as the primary land use agency.

Figure 1-8: Jurisdictional boundaries in the Livermore Valley Groundwater Basin



1.3.3.4 General Plans

General plans affecting the Livermore Valley Groundwater Basin have been developed by Alameda and Contra Costa Counties and the cities of Dublin, Livermore, Pleasanton, and San Ramon.

The Alameda County General Plan consists of several documents. These include countywide elements that apply to the entire unincorporated area; of these relevant elements include the Community Climate Action Plan (2000), Conservation Element (1994), and Open Space Element (1994). In addition, the General Plan includes three area plans; of these, the East County plan is relevant. The County also developed a South Livermore Specific Plan in 1993 primarily to promote and maintain the South Livermore Valley as a wine region.

The policies and programs of the East County Area Plan, approved by voter initiative in 2000, reflect close collaboration with Zone 7 Water Agency in regional water planning, sustainable land use planning, water recycling, and water conservation. Key policies are listed below.

- Policy 251: The County shall work with the Alameda County Flood Control and Conservation District (Zone 7), local water retailers, and cities to develop a comprehensive water plan to assure effective management and long-term allocation of water resources, to develop a contingency plan for potential short-term water shortages, and to develop uniform water conservation programs. The water plan should include a groundwater pump monitoring and cost allocation system in order to facilitate groundwater management and to recover the cost of purchased water stored in the groundwater basin. In developing this plan, EBRPD shall be consulted regarding potential direct or indirect effects of water use on EBRPD recreation facilities.

- Policy 252: The County shall encourage Zone 7 to pursue new water supply sources and storage facilities only to the extent necessary to serve the rates and levels of growth established by the Initiative and by the general plans of the cities within its service area.
- Policy 253: The County shall approve new development only upon verification that an adequate, long-term, sustainable, clearly identified water supply will be provided to serve the development, including in times of drought.
- Policy 254: The County shall encourage Zone 7 and local water retailers to require new development to pay the full cost of securing, conveying, and storing new sources of water.
- Policy 255: The County shall encourage Zone 7 to maximize use of the Chain of Lakes for water supply development and groundwater management. Zone 7 is encouraged to stage implementation of the system so that each component may be utilized as it becomes available.
- Policy 256: The County shall discourage water service retailers from constructing new water distribution infrastructure which exceeds future water needs based on a level of development consistent with the Initiative.
- Policy 257: The County shall support more efficient use of water through such means as conservation and recycling, and shall encourage the development of water recycling facilities to help meet the growing needs of East County.
- Policy 258: The County shall encourage Zone 7, water retailers, and cities to sign the California Urban Water Conservation Council's (CUWCC) MOU which binds parties to implement Best Management Practices where feasible.
- Policy 259: The County shall include water conservation measures as conditions of approval for subdivisions and other new development.
- Policy 260: The County shall require major projects to mitigate projected water consumption by applying one or more Best Management Practices that reduce water consumption off-site.
- Policy 261: The County shall encourage the efficient use of water for landscape irrigation, vineyards and other cultivated agriculture. To this end, the County shall encourage the use of recycled water, treated by the reverse osmosis or other process and meeting groundwater basin standards set forth by the Regional Water Quality Control Board, for agricultural irrigation.
- Policy 262: The County shall encourage Zone 7 and the water retailers to require separate service connections and meters where large quantities of water are used for special purposes such as golf courses and landscape irrigation so that consumption of water for these uses can be managed in times of drought. To this end, the County shall, if feasible, require the use of recycled water for golf courses and shall encourage use of recycled

water for non-residential landscaping, irrigated agriculture, and groundwater recharge in accordance with Regional Water Quality Control Board adopted standards.

- Policy 263: The County shall continue to seek alternative methods for economic reuse of wastewater in addition to those already considered.

Implementation programs of the East County Plan include adoption by the County Board of Supervisors of the CUWCC's MOU to implement Best Management Practices; collaborative efforts by the County with appropriate agencies (e.g., County Agricultural Commission, Soil Conservation Service, and the University of California Experimental Station) to provide farmers with information about water conserving agricultural practices; and preparation and adoption of a water supply ordinance that provides for the distribution of recycled water in designated areas, including South Livermore Valley.

The County's Community Climate Action Plan, approved 2014, contains water conservation measures, including measures to require new landscaping projects to reduce outdoor use of potable water, to allow grey water use for subsurface irrigation, and to work with EBMUD and Zone 7 to redesign water bills to encourage water conservation.

The City of Dublin (Dublin) does not control the supply or the delivery of water to customers, control cost and pricing mechanisms related to water supply, or manage regional flood control facilities. However, the City of Dublin General Plan recognizes that Dublin works in collaboration with other agencies, notably Zone 7 and DSRSD, which provide these services, and therefore includes a Water Resources Element that reflects this reality. The scope of Dublin's influence extends mainly to promoting and encouraging water conservation among business and residential users, implementing Low Impact Development measures to help treat stormwater, and managing the stormwater runoff and pipelines that lead to flood control facilities. With regard to land use and growth, Dublin historically expanded to the west and east; currently, Dublin has established its Western Extended Planning Area, consisting of steep terrain and oak woodlands, as open space. On the east, Dublin has established Urban Limit Lines along its eastern boundary to protect approximately 3,828 acres of land known as the Doolan-Collier Canyons from development. Dublin also has a Development Elevation Cap, defined as the 770-foot elevation that represents the highest serviceable elevation for water service and urban development. This cap represents a limit on urban development potential.

The City of Livermore General Plan, first adopted in 2004 and subsequently amended, addresses water resource issues in its Infrastructure and Public Services element. Potable water and raw water for agricultural irrigation is provided to the City of Livermore (Livermore) from a variety of sources. Zone 7 is the water wholesaler, while Cal Water and Livermore Municipal Water provide retail service, and the San Francisco Hetch Hetchy water supply system provides water directly to Lawrence Livermore National Laboratory and Sandia National Laboratory. The City of Livermore General Plan presents an overall goal to provide sufficient water supplies and facilities to serve Livermore in the most efficient and financially sound manner, while maintaining the highest standards required to enhance the quality of life for existing and future residents. Objectives are to:

- Plan, manage and develop the public water treatment, storage and distribution systems in a logical, timely and appropriate manner;
- Require coordination between land use planning and water facilities and service to ensure that adequate water supplies are available for proposed development; and
- Identify potential water conservation and recycling opportunities that could be served by Livermore's existing recycled water system.

With regard to land use, Livermore is completely surrounded by an Urban Growth Boundary. This boundary is intended to protect existing agricultural uses and natural resources outside Livermore from future urban development. Livermore has had an evolving residential growth policy in place since 1976.

The City of Pleasanton (Pleasanton) General Plan, adopted in 2009, contains two overarching goals: to preserve Pleasanton's character and encourage sustainable development. This builds on the 1996 General Plan, which envisioned managed growth of Pleasanton consistent with a 29,000 unit residential cap and an Urban Growth Boundary. Consequently, residential and commercial development has been focused on infill sites. The 2009 General Plan includes a water element, which provides a regional overview of the watershed, water systems, wastewater systems, flood control, and stormwater management. Pleasanton receives water from Zone 7 and from its own wells. General Plan goals are to:

- Preserve and protect water resources and supply for long-term sustainability;
- Provide healthy water courses, riparian functions, and wetlands for humans, wildlife, and plants;
- Ensure a high level of water quality and quantity at a reasonable cost, and improve water quality through production and conservation practices which do not negatively impact the environment;
- Provide sufficient water supply and promote water safety and security;
- Provide adequate sewage treatment and minimize wastewater export;
- Minimize stormwater runoff and provide adequate stormwater facilities to protect property from flooding; and
- Reduce stormwater runoff and maximize infiltration of naturally-occurring rainwater so as to improve surface and subsurface water quality.

The City of San Ramon (San Ramon) includes a northwestern portion of the Livermore Valley Groundwater Basin, but water supply is provided by EBMUD from non-groundwater sources. The San Ramon General Plan, adopted in 2015, includes a Growth Management Element that establishes San Ramon's first Urban Growth Boundary and encourages smart growth by promoting infill development and discouraging urban sprawl. Low Impact Development is promoted by San Ramon for its infill development; otherwise, San Ramon's General Plan has very little influence on the Livermore Valley Groundwater basin.

1.3.3.5 Well Permitting

The construction, repair, reconstruction, destruction or abandonment of wells within Zone 7's service area is currently regulated by *Alameda County General Ordinance Code, Chapter 6.88*. Pursuant to an MOU with Alameda County, Zone 7 administers the associated well permit program within its service area including within the three incorporated cities: Dublin, Livermore, and Pleasanton. 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. This program allows Zone 7 to protect the groundwater basin from any negative impacts that would be threatened by poorly-constructed wells.

A copy of the current Zone 7 drilling permit application is available to the public for download from the Zone 7 website (http://www.zone7water.com/business/permits-fees/36-public/content/64-well-drilling-and-destruction-permits). Well construction and destruction permit requirements are determined on a case-by-case basis, but generally follow DWR's *California Well Standards* (Bulletins 74-81 and 74-90, *DWR 1990*).

In April 2015, Alameda County amended its Water Wells Ordinance to: 1) be more compliant with the State standards, 2) clarify the County's role and procedure for well permitting, 3) provide for additional protection of groundwater quality by incorporating local hydrogeologic considerations into the regulations, and 4) establish a means for the County to delegate administrative authority to regulate well construction work to others in certain service areas. In June 2015, Alameda County and Zone 7 entered into a MOU that delegates the administrative authority for issuing of water well permits to Zone 7 for all wells within Zone 7's service area. An Appeals Process for permit complaints for approval and adoption by the Zone 7 Board was started in the 2016 WY. The implementation of the County fee program for permits also started in the 2016 WY. This fee program offsets a portion of the cost for program administration and field inspections by Zone 7 personnel.

As provided in the Water Wells Ordinance, Special Requirement Areas have been defined within Zone 7's jurisdiction where:

- soil boring permits are required for boreholes at 10 feet or greater depth, regardless of groundwater depth;
- supply wells are prohibited; and
- special well construction techniques are required for boreholes and monitoring wells to prevent vertical spreading of contamination.

In addition, five Special Requirement Areas are clearly identified on the Zone 7 website; these are contamination sites where additional protection measures are required.

Well permitting in the Contra Costa County portion of the basin is regulated by the *Contra Costa County Ordinance Code, Title 4, Article 414-4.8* and administered by the Environmental Health Division (EHD) of Contra Costa Health Services. EHD's Land Use Program reviews plans for well designs, issues construction permits and conducts inspections during the drilling to make sure wells will be installed or destroyed in a way that doesn't contaminate the county's groundwater. A permit from the EDH is required to construct, reconstruct or destroy a well, including water wells, monitoring wells, cathodic protection wells and soil borings.

1.3.3.6 Implementation of Land Use Plans and Water Supply Management

Land use planning and water resource management are regularly and closely coordinated across the Livermore Valley Groundwater Basin. This ensures that implementation of land use plans, which can change water demands or affect sustainable groundwater management, is occurring in a context of open collaboration among land use planners and water agencies. Moreover, development of various water management plans, including the Zone 7 GWMP and this Alternative Plan, also has occurred through open collaboration. Such dynamic and interactive planning has been fundamental to sustainable groundwater management in the basin.

As documented above, all of the cities overlying the basin have developed General Plans that address water supply issues (as appropriate to their respective responsibilities) and all of the cities have established urban growth boundaries or urban limit lines. Alameda County's East County Area Plan provides numerous policies that indicate commitment to work with Zone 7, local water retailers, and cities toward comprehensive water planning.

All of the urban retailers in the basin (Cal Water, DSRSD, EBMUD, Livermore, and Pleasanton) have prepared at least 2010 and 2015 Urban Water Management Plans. Zone 7 adopted its first UWMP in 1985, and then prepared an updated UWMP in 1991 in cooperation with Livermore, Pleasanton, and DSRSD. Zone 7 has prepared and adopted UWMPs for 1995, 2000, 2005, 2010, and 2015. Agency outreach and coordination is manifest in each of these documents.

In 2011, Zone 7 completed an evaluation of its long-term water supply in order to provide background for and facilitate preparation of the Zone 7 UWMP and other agency planning efforts. This evaluation included discussion of key assumptions, approach, analysis, and results with the local water supply retailers; and many of the projects and recommendations from that report are actively being implemented by Zone 7 and the retailers. Again in 2016, working closely with the water retailers, Zone 7 has prepared a Water Supply Evaluation Update (*Zone 7, 2016*) with re-examination and update of projected water demands and development of potential water supply options.

Zone 7 regularly tracks changes in land use through its Land Use Monitoring Program, which identifies significant changes in land use that could impact the quantity or quality of water recharging the Main Basin. Land use data are derived from aerial photography (most recent available from June 2014), permit applications, field observations, and City and County planning documents. The Livermore Valley Land Use Report is generated annually to display, review, and discuss the data that were gathered. This report tracks all new land use changes and is used to coordinate Zone 7 with the land use planning agencies.

On an as-needed basis, and consistent with its GWMP, Zone 7 regularly reviews CEQA documents for all new developments and coordinates with cities and counties to ensure accurate planning. Continuation of such activities among Zone 7, water supply retailers, and land use planning agencies ensures that implementation of land use plans and the Alternative Plan will be coordinated effectively over the respective planning and implementation horizons.

1.3.4 Water Resource Management Programs

Zone 7 Water Agency regulates more than half of the inflow and outflow from the basin, managing the groundwater resources to provide a sustainable supply of high quality water for residents of the Tri-Valley. The Agency serves as the lead for many of the water resource management programs and coordinates with groundwater resource programs of others in the basin. A summary of such programs by others is provided in the following section. Key programs implemented by Zone 7 are also summarized herein and incorporated into the Alternative Plan.

Zone 7's groundwater management policies and programs are described in the 2005 Groundwater Management Plan (**Attachment A,** *Zone 7, 2005a*). These policies and programs are also updated in the Groundwater Management Program annual reports, the most recent of which is located on the Zone 7 website at http://www.zone7water.com/36-public/content/76-groundwater-management-program-annual-report.

1.3.4.1 Summary of Zone 7 Programs

Zone 7 is sustainably managing the Livermore Valley Groundwater Basin through numerous interrelated programs to assess, manage, monitor, and protect the groundwater supply. In 2005, Zone 7 compiled and documented its groundwater management objectives, policies, and programs in its GWMP for Livermore Valley Groundwater Basin. Since then, Zone 7 has been generating detailed annual reports that appraise the conditions of the basin and update the objectives, policies and programs first outlined in the GWMP. The annual reports for the 2014 and 2015 Water Years are provided in **Attachments B** and **C** (*Zone 7, 2014b* and *Zone 7, 2015b*). Other important planning documents included as attachments include the UWMPs (**Attachment F**, *Zone 7, 2015a*, prepared every five years) and the recent Water Supply Evaluation Update (**Attachment G,** *Zone 7, 2016*). All of these documents are also provided to the public on the Zone 7 website and can be accessed at http://www.zone7water.com/publications-reports/reports-planning-documents.

Zone 7 adaptively manages its groundwater supply with regard for current hydrologic conditions, water demands, water quality conditions, and future water supply/demand forecasts. As described in later sections and listed here, Zone 7 maintains the sustainability of the groundwater basin through the following programs:

- Monitoring the long-term natural groundwater budget (described in **Section 2.4**),
- Monitoring of land surface elevation (described in **Section 2.3.9**),
- Importing, artificially recharging, and banking surface water to meet future demands (described in **Section 5.2.1**),

- Implementing a conjunctive use program that maximizes use of the storage capacity of the groundwater basin (described in **Section 5.2.2**), including long-term implementation of the Chain of Lakes,
- Managing groundwater pumping for sustainability (described in **Section 2.3.2**),
- Maintaining sustainable long-term groundwater storage volumes, even when total outflows exceed the natural sustainable supply (see **Section 2.4.4**),
- Promoting increased and sound recycled water use (see **Section 5.2.5**), and
- Identifying and planning for future supply needs and demand impacts (**Section 1.3.3.6**); this is often analyzed using Zone 7's numerical groundwater model of the basin (**Section 2.6**).

Zone 7 also prepares plans and conducts programs that are more directed toward protection and improvement of groundwater quality, including wastewater monitoring and plans that support water recycling.

- Zone 7 administers the Well Ordinance Program, which requires permitting for the construction, repair, reconstruction, destruction or abandonment of wells. Inspections are also completed as a part of the program.

- Zone 7 administers the Toxic Sites Surveillance (TSS) Program, which documents and tracks polluted sites across the groundwater basin that pose a potential threat to drinking water and interfaces with lead agencies to ensure the Main Basin is protected. Information is gathered from state, county, and local agencies, as well as from Zone 7's well permitting program and the SWRCB's GeoTracker website, and compiled in a GIS database.

- The 2004 Salt Management Plan (SMP) is a substantial 450-page document reflecting a cooperative effort to address the increase in total dissolved solids (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), which began operating in 2009 to strip salts from the produced groundwater and discharge them to the wastewater export pipeline that discharges treated wastewater to San Francisco Bay.

- The 2015 Nutrient Management Plan (NMP, *Zone 7 2015c*) was conceived as an addendum to the SMP. Together, the NMP and SMP fulfill requirements of a joint Master Water Recycling Permit and the General Water Reuse Order adopted by the Regional Water Board, and are consistent with the provisions of the State's Recycled Water Policy. 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 Alameda County Environmental Health (ACEH) for development of a Local Agency Management Program (LAMP) for onsite wastewater treatment systems (OWTS) that addresses certain high nitrate areas-of-concern (see next section).

1.3.4.2 Zone 7 Coordination with Water Resources Programs by Others

As a water supply wholesaler, Zone 7 maintains close relationships with other groundwater users in the basin, and coordinates their actions with the groundwater monitoring and management activities of others. **Table 1-2** provides a summary of key cooperative programs; in addition, recent achievements of two programs are described in greater detail.

Table 1-2: Summary of Cooperative Water Resource Management Programs

Water Resources Management Program	Other Local Agency	Zone 7 Cooperative Role
Onsite Wastewater Treatment System (OWTS)	Alameda County Environmental Health (ACEH)	Reviews permit applications; Zone 7 approval is required in some cases
Toxic Sites Surveillance (TSS) Program	Regional Water Quality Control Board - San Francisco Bay Region (RWQCB) and ACEH	Tracks progress of site investigation/cleanup and provides input to lead agencies
Surface Mining Permits	Alameda County Community Development Agency (ACCDA)	Reviews permit changes and provides input as a future owner
CASGEM	DWR	Monitors and reports groundwater elevations in Tracy Subbasin, San Joaquin Valley Basin
Water Quality/Groundwater Elevation Monitoring	Retailers (City of Pleasanton, City of Livermore, DSRSD, Cal Water Service); LLNL	Data sharing of water quality and elevation data
Referral Process (Development Reviews/CEQA Reviews)	Cities of Pleasanton, Livermore, and Dublin, and Alameda Co.	Review proposed site plans and comment on existing infrastructure as well as potential impacts
South Bay Contractors	Alameda County Water District (ACWD) and Santa Clara Valley Water District (SCVWD)	Work with other water agencies on allocating water supply available for recharge
Integrated Regional Water Management	San Francisco Bay Area water agencies	Local representative
Liaison Committee	Cities, Retailers, DSRSD, Elected Officials	Local representative to provide input and information
Tri-Valley Potable Reuse Feasibility Study	Retailers	Evaluating feasibility of potable reuse for the Valley

Tri-Valley Potable Reuse Feasibility Study

This recently-initiated study is a joint effort by the Tri-Valley Water Agencies, including Zone 7 and the four Retailers (Cal Water, DSRSD, Livermore and Pleasanton). Zone 7's February 2016 Water Supply Evaluation Update underscored the need to pursue water supply options to enhance long-term water supply reliability for the Livermore-Amador Valley. Potential future water supply options identified in the Update included the California WaterFix, desalination, and potable reuse. In February 2016, participants in the Tri-Valley Water Policy Roundtable—which included elected representatives from Dublin, Livermore, Pleasanton, San Ramon, DSRSD, and Zone 7—agreed to proceed with a detailed study of potable reuse.

The primary goals of the study are to evaluate the feasibility of potable reuse for the Valley; to identify the most promising options based on technical, financial, and regulatory considerations; and, assuming that potable reuse is found to be feasible, to recommend next steps for the agencies. The options to be evaluated include groundwater recharge/injection, surface water augmentation, and connection upstream of the Zone 7 water treatment plants. The findings and recommendations from the study will be presented to the governing bodies of the Tri-Valley Water Agencies for their consideration and potential actions.

OWTS Program

ACEH and Zone 7 cooperate on the approval and permitting process for OWTS. ACEH issues permits for the operation, installation, alteration, and repair of OWTS throughout Alameda County. However, for certain OWTS projects in Upper Alameda Creek Watershed, Zone 7 review and approval is required. Zone 7 approval is required for the following types of OWTS projects:

- New septic systems constructed partially or fully for a commercial or industrial use;
- Conversion or expansion of existing septic systems to a commercial or industrial use; or
- New residential septic systems that discharge greater than one rural-residential-equivalence (RRE) of wastewater per five acres (and one RRE per 10 acres inside the NMP nitrate areas-of-concern, **Section 2.3.8.4**).

In 1982, the Zone 7 Board of Directors adopted the ―Wastewater Management Plan for the Unsewered, Unincorporated Area of Alameda Creek Watershed above Niles (WWMP, *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 No. 1165*). This prohibition can be waived by the Zone 7 Board if ―…it can be satisfactorily demonstrated to the Board that the wastewater loading will be no more than the loading from an equivalent rural residential unit (on a five-acre lot) and said septic tank(s) will be in compliance with all other conditions and provisions."

Currently Zone 7 is cooperating with ACEH in its development of a LAMP for OWTS and anticipates that all of Zone 7's wastewater policies will be incorporated or otherwise satisfactorily addressed in the LAMP. To date, ACEH has completed a draft of the LAMP and submitted it to the Regional Water Quality Control Board (RWQCB) for consideration. ACEH and RWQCB anticipate the LAMP being finalized and implemented by 2018.

1.3.5 Cooperation with Other Agencies and Stakeholders

Zone 7 has developed objectives that support a basic philosophy of working cooperatively with groundwater stakeholders in the Livermore Valley Groundwater Basin including the public, irrigation and domestic well owners, gravel mining companies, Tri-Valley Retail Group, water purveyors, and planning agencies. These objectives include:

- develop information, policies, and procedures for the effective long-term management of the groundwater basin;
- inform the public and relevant governmental agencies of the Zone's water supply potential and management policies and to solicit their input and cooperation; and
- work cooperatively with the gravel mining industry to implement the Chain of Lakes reclamation plan.

Zone 7 actively involves the public, stakeholders and local agencies in its planning and programs through meetings, data sharing, and online media. This approach was memorialized by Zone 7 as an explicit operational policy in the 1987 Statement on Groundwater Management. This statement, along with numerous examples of public involvement in the Zone 7 groundwater management program are provided in the GWMP (see *Section 4.3* and *Appendix E* of the GWMP), which is included with this Alternative Plan as **Attachment A**.

Consistent with this approach, Zone 7 has established positive ongoing working relationships with numerous other agencies involved in the basin including, but not limited to DWR, RWQCB, Alameda County, Contra Costa County, California Department of Fish and Wildlife, U.S. Fish and Wildlife Service, National Marine Fisheries Service (NOAA-NMFS), and the U.S. Army Corps of Engineers. Additional information on Zone 7's relationships and cooperation with other agencies in the basin are also described in the GWMP (e.g., see *Section 4.4* of the GWMP). Zone 7 was an early signatory to a Statement of Understanding for the development of NOAA-NMFS Multispecies Recovery Plan that explores responsible water management for the preservation of Oncorhynchus mykiss (steelhead trout) within the Alameda Creek watershed.

For development of the 2004 Salt Management Plan, Zone 7 assembled a Groundwater Management Advisory Committee including citizens and stakeholders and an independent Technical Advisory Group (including key stakeholders and water retailers). Similarly, the 2015 Nutrient Management Plan was developed with support and input from the RWQCB, ACEH, Alameda County Community Development Agency, Zone 7 Retailers, and other stakeholders and interested public. Most recently, the Tri-Valley Potable Reuse Feasibility Study was developed through a process involving a series of public Round Table discussions among representatives of Zone 7 and the Retailers, along with extensive outreach to the public, including a survey.

A major land use in the Valley is aggregate mining (see **Figure 1-7**), conducted by various mining companies. Groundwater is used for industrial mining purposes such as gravel washing and dust control (see locations of industrial wells in **Figure 1-6**). Most importantly, Zone 7 has worked closely with the mining companies in developing a quarry reclamation plan that recognized the importance of groundwater recharge and conveyance through the mining area. This resulted in the Chain of Lakes reclamation plan, wherein the mining area reclamation is being implemented to include a series of wet pits that will be owned and operated by Zone 7 for flood control and managed aquifer recharge. Zone 7 and the mining companies collaborate in groundwater and surface water (level and quality) monitoring (see **Section 4.4**).

Groundwater is also used for private domestic, golf course irrigation, and agricultural purposes (see **Figures 1-6** and **1-7**). Individual groundwater users have been active participants in Zone 7 GWMP, SMP, and NMP efforts; numerous private well owners participate in Zone 7 groundwater monitoring programs.

Currently, Zone 7 is working actively with other local agencies in its designated role as the exclusive GSA for the basin. As mentioned previously, Zone 7, EBMUD, San Ramon, DSRSD and Contra Costa County have an MOU under which Zone 7 will serve as the GSA for the Contra Costa portion of the Livermore Basin.

1.3.6 Beneficial Uses

Zone 7 cooperates with the RWQCB, San Francisco Bay Region in implementation of the Water Quality Control Plan (Basin Plan, *RWQCB, 2015*). In the Basin Plan, the RWQCB identifies beneficial uses and water quality objectives for surface water and groundwater in the Livermore Valley. A summary of the existing (labeled –X”) and potential (labeled –P”) beneficial uses for those water bodies is provided in **Table 1-3** below.

The Basin Plan includes specific groundwater quality objectives developed by the Water Board for the Alameda Creek watershed above Niles, which includes the Livermore Valley Groundwater Basin. These groundwater quality objectives are provided in *Table 3-7* of the Basin Plan and are summarized below.

The specific groundwater quality objectives include thresholds for both TDS and nitrate (NO3). In the Central Basin, the water quality objective (WQO) for TDS is ambient or 500 milligrams per liter (mg/L), whichever is lower, and for nitrate is 45 mg/L. In the Fringe Subareas, the WQO for TDS is ambient or 1,000 mg/l, whichever is lower, and for nitrate is 45 mg/L. In the upland and highland areas, the WQOs are the California domestic water quality standards set forth in California Code of Regulations, Title 22 and current count standards. Concentrations are not to be exceeded more than 10 percent of the time during the year. Ambient water quality conditions at a proposed project will be determined by Zone 7 at the time the project is proposed. Ambient conditions apply to the water bearing zone with the highest quality water. Water designated as domestic or municipal water supply shall not contain concentrations of chemicals in excess of natural concentrations or the limits specified in *California Code of Regulations, Title 22, Chapter 15*, particularly *Tables 64431-A* and *64431-B* of *Section 64431*, *Table 64444-A* of *Section 64444*, and *Table 4* of *Section 64443*.

Table 1-3: Beneficial Uses for Surface Water and Groundwater

WATERBODY	MUN	AGR	IND	PROC	GWR	COMM	COLD	MGR	RARE	SPWN	WARM	WILD	REC-1 & -2
Arroyo del Valle	X				X		X	P	X	X	X	X	X
Shadow Cliffs Reservoir					X	X	X			X	X	X	X
Del Valle Reservoir	X					X	X			X	X	X	X
Arroyo Mocho					X		X	X		X	X	X	X
Tassajara Creek					X		P	X	X	X	X	X	X
Arroyo las Positas					X		X	X	X	X	X	X	X
Alamo Canal					X		P	X		X	X	X	X
South San Ramon Creek											X	X	X
Arroyo de la Laguna					X		X	X		X	X	X	X
Livermore Valley Groundwater Basin	X	X	X	X									

MUN – Municipal and domestic water supply
AGR – Agricultural water supply
IND – Industrial service water supply
PROC – Industrial process water supply
GWR – Groundwater recharge
COMM – Commercial and sport fishing
COLD – Cold freshwater habitat
MGR – Fish migration
RARE – Preservation of rare and endangered species
SPWN – Fish Spawning
WARM – Warm freshwater habitat
WILD – Wildlife habitat
REC-1 and REC-2 – Water contact and noncontact water recreation

Zone 7 conducts surface water and groundwater quality sampling programs to ensure that water quality is adequate for beneficial uses. Groundwater quality is described in **Section 2**. Surface water and groundwater monitoring programs are described in **Section 4**.

1.4 Alternative Plan Approach and Organization

1.4.1 Approach to the Alternative Plan

Our approach to this Alternative Plan is to develop a focused document that follows the GSP regulations to demonstrate sustainable management for at least 10 years as required by the regulations. The Alternative Plan compiles primarily existing information from the numerous planning and reporting documents developed by Zone 7; key documents used in the development of this Alternative Plan include:

- Groundwater Management Plan, 2005 (Attachment A)
- Annual Reports, 2015 WY and 2014 WY (Attachments B and C)
- Salt Management Plan, 2004 (Attachment D)
- Nutrient Management Plan, 2015 (Attachment E)
- UWMP, 2015 (Attachment F)
- Water Supply Evaluation Update, 2016 (Attachment G)
- Well Master Plan (Attachment H, *Zone 7 2005b*)
- Historical SqueeSAR ground deformation analysis over Livermore and Pleasanton (Attachment I, *TRE Altamira, 2016*)
- Report of History of Bench Marks (Attachment J, *Altamont Land Surveyors, 1994*)

For reference, these documents are provided electronically with this Alternative Plan as attachments, but can also be accessed on the Zone 7 website at http://www.zone7water.com/publications-reports/reports-planning-documents.

Although the Alternative Plan is derived mostly from existing material, the information has been re-arranged and revised to meet the regulatory requirement that an Alternative Plan be *functionally equivalent* to a GSP. In addition to these documents, several new maps and technical analyses have been developed to meet some specific GSP requirements.

As required by the GSP regulations for an Alternative Plan, available information demonstrates that the Livermore Valley Groundwater Basin has not experienced undesirable results for any of the sustainability indicators during at least a 10-year period dating back to WY 2006, the year in which the Zone 7 Groundwater Management Plan was adopted (adoption date September 21, 2005). Moreover, Zone 7 has sustainably managed the basin to avoid undesirable results for more than 40 years, adapting its management program to any changing conditions in the valley. Since its inception, Zone 7 has incorporated the basic principles of sustainable management into its activities. As previously described, the Agency was formed, in part, to alleviate overdraft conditions in the groundwater basin. The benefits of the initial conjunctive use program were evident beginning in the early 1970s. DWR Bulletin 118-2, published in June 1974, noted that:

> In the late 1940's and during the 1950's, water demand exceeded supply and ground water levels declined. This trend has been stopped by the availability of a new water supply to the area as a result of the construction of Del Valle Reservoir on the southern edge of Livermore Valley as a unit of the State Water Project.

As another example, when trends of increasing TDS were evident in some portions of the basin, Zone 7 implemented numerous plans and programs to manage this issue including a 1992 valley-wide study of recycled water, a 1999 SMP (finalized in 2004, *Zone 7, 2004*), and implementation of numerous projects to benefit the local groundwater quality including a 2009 project that involves demineralization of shallow groundwater in the Mocho well field (among other activities). Since start-up in 2009, the MGDP has been responsible for the export of more than 13,000 tons of salt from the groundwater basin.

Collectively, valley-wide data indicate that the basin has been operated sustainably since at least 1974. Accordingly, many of the data sets presented in this Alternative Plan date back to 1974 to provide a comprehensive assessment of Zone 7's basin management.

1.4.2 Organization of the Alternative Plan

Because this Alternative Plan is being prepared as one of the first in the State under the new GSP regulations, we are organizing the plan to follow the organization of the GSP guidelines to facilitate DWR review of the Plan. Accordingly, the major sections of this Alternative Plan are:

1. Agency Information and Plan Area
2. Basin Setting
3. Sustainable Management Criteria
4. Monitoring Networks
5. Projects and Management Actions

2 Basin Setting

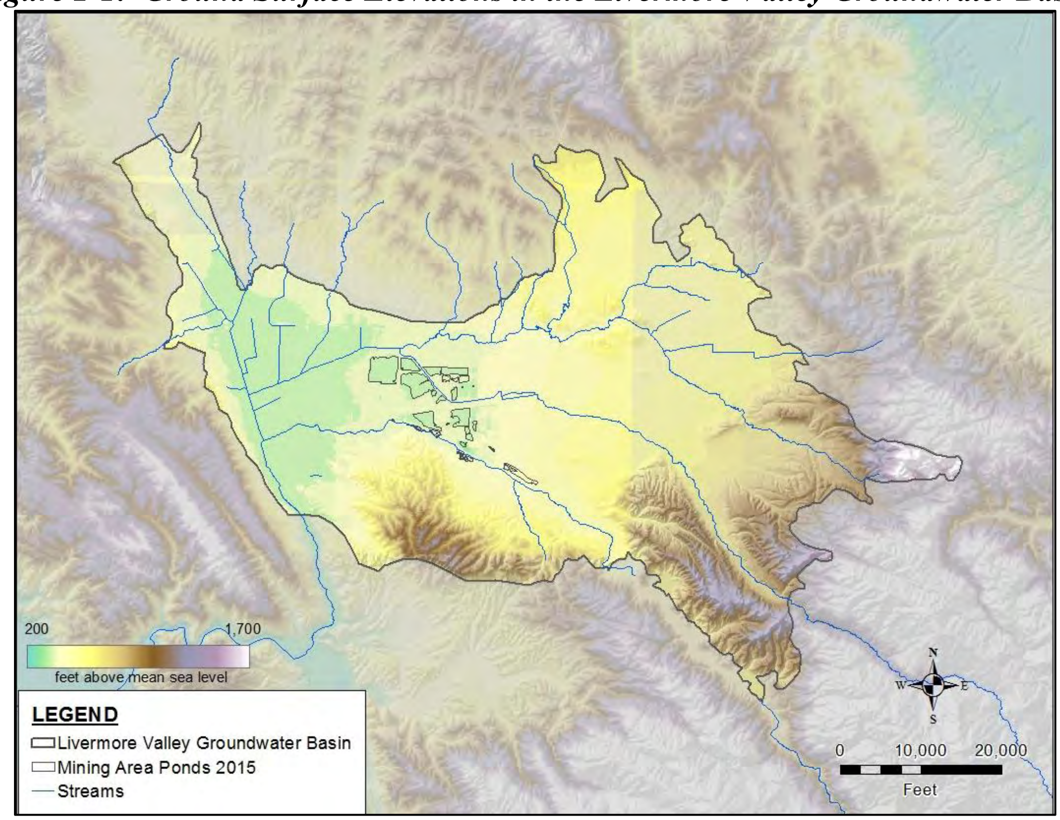
2.1 Physical Setting

2.1.1 General Setting

The Livermore Valley Groundwater Basin (DWR No. 2-10) covers 69,600 acres and includes the Livermore Valley (41,841 acres) and the hills south of Pleasanton and Livermore (27,759 acres). The valley has been divided into the Main Basin (19,800 acres) and Fringe Subareas (22,041 acres) for purposes of groundwater management.

The valley floor slopes gently west and southwest from an elevation of approximately 700 feet (ft) above mean sea level (msl) in the east to approximately 300 ft msl in the southwestern corner, which is the location of the basin‘s surface and subsurface outflow. The highest elevations in the groundwater basin are in the east-southeastern uplands where the ground surface is above 2,000 ft msl. In the southern uplands, ground surface elevations are above 1,100 ft msl. The highest elevations in the Main Basin are also in the southeast, along the upper reach of Arroyo Mocho, where elevations are around 1,000 ft msl. Ground surface elevations across the central Main Basin average about 400 ft msl. The overall topography across the groundwater basin is shown on **Figure 2-1** as represented from a digital elevation model (± 3 meters) covering Alameda and Contra Costa counties.

Figure 2-1: Ground Surface Elevations in the Livermore Valley Groundwater Basin



2.1.2 Livermore Valley Climate

The climate within Zone 7's service area is described as Mediterranean, characterized by hot, dry summers and cool, moist winters. **Figure 2-2** shows isohyets of average annual rainfall across the Livermore Valley Groundwater Basin, throughout the Zone 7 service area and extending into the Alameda Creek watershed. Overall average annual rainfall ranges from more than 28 inches in the watershed to the south to less than 13 inches in the eastern portion of the Zone 7 service area. Within the Livermore Valley Groundwater Basin, average annual rainfall varies from less than 14 inches per year in the eastern basin to 23 inches per year on the western edge of the basin.

Figure 2-2: Average Rainfall Isohyets and Alameda Creek Watershed

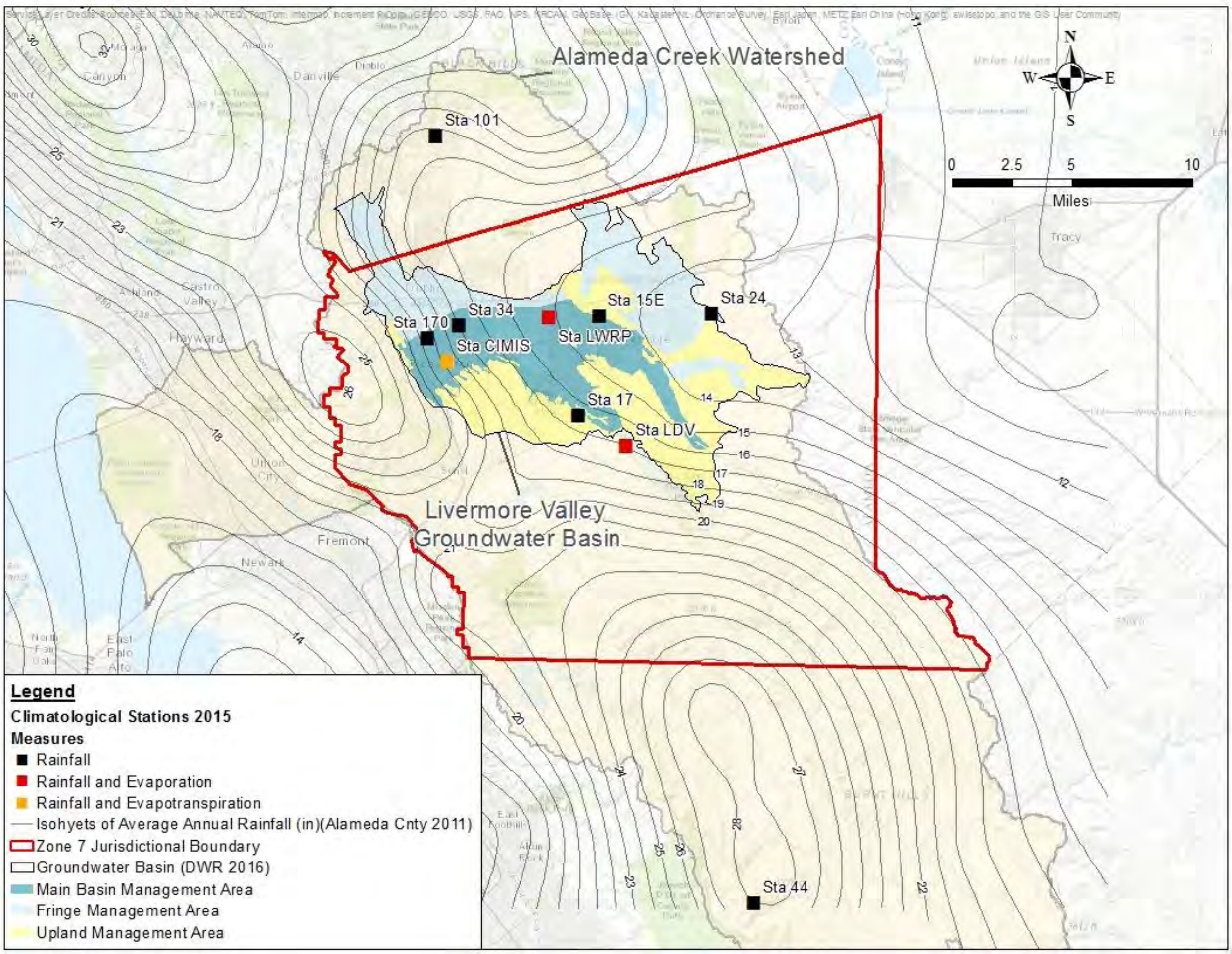
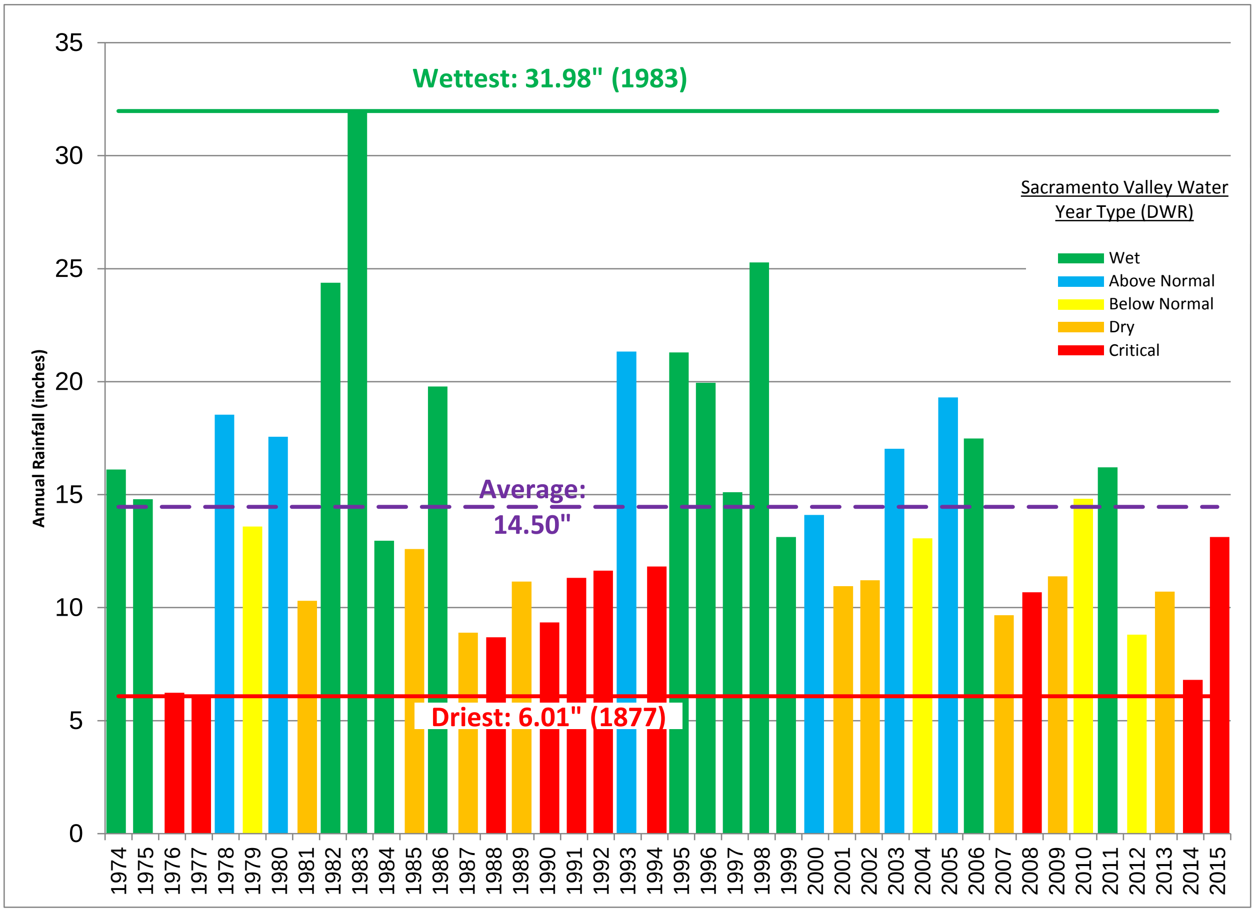


Figure 2-3 shows a graph of annual rainfall from a long-term climate station (Livermore STA 15E, see **Figure 2-2**) in the east-central portion of the basin with rainfall records dating back to 1871. Annual rainfall at this station has averaged about 14.5 inches per year. Data for each water year are color-coded to indicate the water year type as designated by DWR for the Sacramento Valley. Although the water year type does not always correlate precisely to the precipitation in the Livermore Valley, the Sacramento Valley data incorporate the precipitation

and runoff conditions that more closely controls the availability of SWP water, the largest water supply in the basin.

The graph in **Figure 2-3** includes data from 1974 Water Year (WY) through 2015 WY, but also highlights the wettest year in the 144-year record (1983) with 31.98 inches of rainfall and the driest year on record (1877) with 6.01 inches. Note that 1977 had an annual rainfall of 6.02 inches, essentially tying the record dry year of 1877. Therefore, the time period demonstrating Zone 7's sustainable management in this Alternative Plan (1974 – 2015) includes both the wettest and driest years on record.

Figure 2-3: Sta. 15E Rainfall (inches), 1974-2015 WYs



For the 2015 WY, rainfall in the Livermore-Amador Valley was 93% of average, after three water years in a row with well below-average rainfall. The total rainfall for Monitoring Station 15E was 13.13 inches for the 2015 WY. This station had the fifth wettest December on record with 8.23 inches and that was followed by the first January with zero rainfall in the station's 144 year record. The aquifer replenishment from percolating rainfall was estimated to be 3,735 acre-ft (AF) which is about 87% of normal (discussed in more detail in **Section 2.4**).

Table 2-1 provides a summary of climate conditions within Zone 7's service area (using the California Irrigation Management Information System [CIMIS] station in Pleasanton as an example), including average evapotranspiration (ETo), precipitation, and temperature over a recent five-year period from 2010 to 2014. As shown in **Table 2-1**, the average annual precipitation of 16.3 inches of rainfall was associated with an average annual evapotranspiration of 51.6 inches and average monthly temperatures (in Fahrenheit) that varied throughout the year from 36 to 87 degrees.

Table 2-1: Climate Data for Zone 7 Service Area (2010 – 2014)

Month	Standard Monthly Average ETo (inches)*	Average Total Rainfall (inches)	Average Temperature (degrees Fahrenheit)	
			Max	Min
January	1.6	1.8	61	36
February	2.2	2.2	62	39
March	3.5	2.9	66	42
April	5.0	1.3	70	45
May	6.2	0.3	74	48
June	7.0	0.3	81	53
July	7.5	0.0	87	56
August	6.5	0.0	86	54
September	5.1	0.2	85	53
October	3.5	0.6	78	48
November	2.0	2.3	67	41
December	1.5	4.1	60	36
TOTAL	**51.6**	**16.0**		

*Data from CIMIS Station 191 (Pleasanton) from January 2010 to December 2014, downloaded September 2015 from www.cimis.water.ca.gov. Reference evapotranspiration based on standard grass as reference (ET_0).

The Zone 7 network average evapotranspiration (ETo) was approximately 46.98 inches in the 2015 WY, which is about 101% of the historical network average.

2.1.3 Livermore-Amador Valley Streams

The groundwater basin lies within the Alameda Creek Watershed, which covers almost 700 square miles and extends from Altamont Pass to the east, San Francisco Bay to the west, Mt. Diablo to the north, and Mt. Hamilton to the south (see **Figure 2-2**). Six major streams flow into and/or through the valley and merge in the southwest where Arroyo de la Laguna flows out of the valley. The other six arroyos include the Arroyo Valle, Arroyo Mocho, Arroyo Las Positas, Alamo Canal, South San Ramon Creek, and Tassajara Creek (**Figure 2-4**).

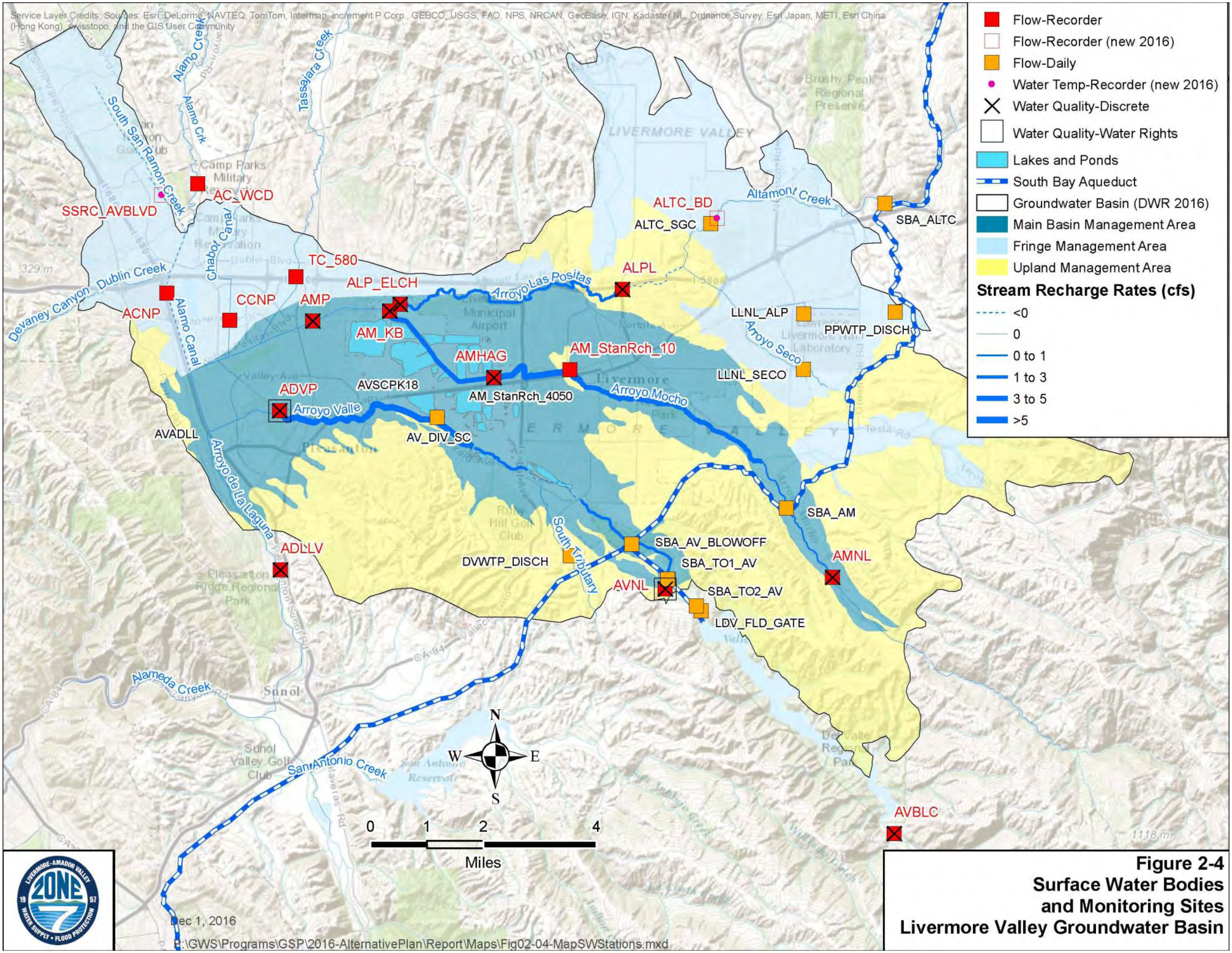


Figure 2-4
Surface Water Bodies and Monitoring Sites
Livermore Valley Groundwater Basin

Both the Arroyo Valle and Arroyo Mocho originate in the woodland forests of the Burnt Hills region in Santa Clara County, in the sub-watershed above Lake Del Valle. The two streams and their tributaries cover the largest drainage areas within the Zone 7 service area. The Arroyo Valle flows into Lake Del Valle above Lang Canyon, and then continues below the Del Valle Dam, flowing westerly through a regional park on the southern border of Livermore before reaching Pleasanton. Flowing southwesterly through the historic downtown area of Pleasanton, the Arroyo Valle ultimately joins the Arroyo de la Laguna at the southwestern outflow from the groundwater basin. Arroyo de la Laguna is a tributary to Alameda Creek.

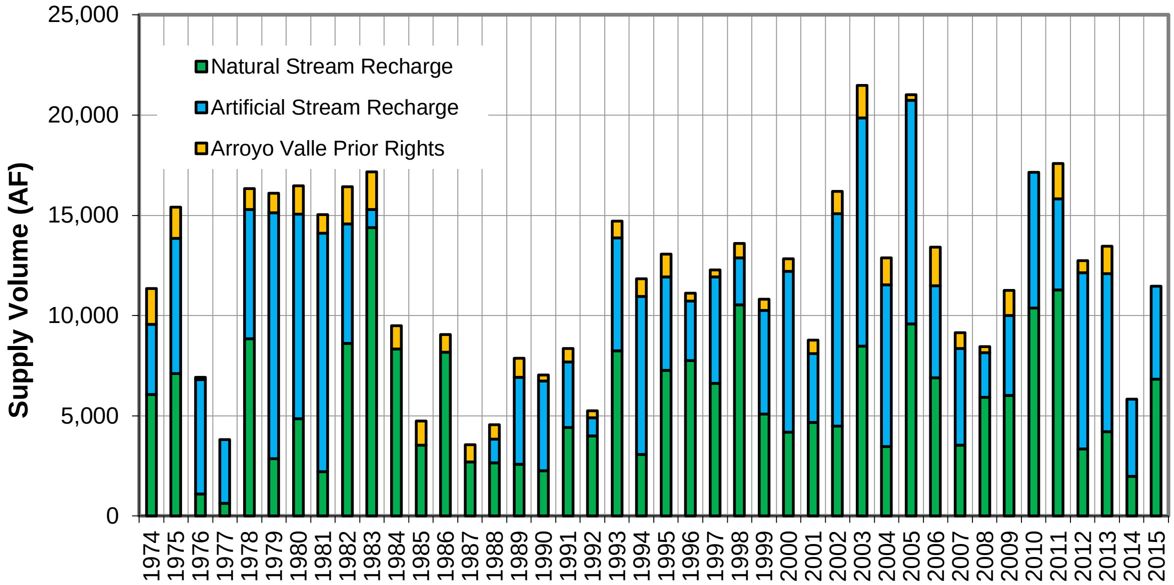
The Arroyo Mocho remains a natural waterway as it flows southwest through the oak woodlands east of Livermore, then continues through the southern portion of Livermore. Northwest from Livermore, the Arroyo Mocho has a graded and engineered channel, which proceeds through the gravel mining area and merges with the Arroyo Las Positas in northwest Livermore. The Arroyo Las Positas mainly flows westerly along Interstate 580 and is fed by the Arroyo Seco, Altamont Creek, Cayetano Creek, Collier Canyon Creek, and Cottonwood Creek. At its confluence with the Arroyo Mocho in Livermore, the streambed becomes a wide, trapezoidal-shaped flood control channel. The Arroyo Mocho then flows into the Arroyo de la Laguna at the surface and subsurface outflow from the groundwater basin.

Both the Arroyo Valle and the Arroyo Mocho serve vital roles in Zone 7‘s groundwater recharge program, as does the Arroyo Las Positas but to a lesser extent. At the request of Zone 7, DWR releases water into these arroyos to supplement the natural recharge of the Main Basin, while providing secondary aesthetic and environmental benefits. In addition to the managed (artificial) stream recharge conducted in these arroyos, the stream channels also serve to recharge the groundwater basin with natural rainfall and runoff. Both natural and artificial recharge volumes occurring in the basin stream channels are summarized by the graph on **Figure 2-5**, which shows annual recharge from 1974 WY to 2015 WY. As shown in the figure, basin recharge varies from less than 5,000 AF per year (AFY) to more than 20,000 AFY depending on local hydrologic conditions and availability of SWP water.

Due to the continuing drought throughout Northern California during 2014 and 2015, natural and artificial streamflows in the Valley‘s arroyos were significantly below normal. Releases of SWP water to the Arroyo Mocho and Arroyo Del Valle for Zone 7‘s artificial aquifer recharge operations were not made between March 28, 2014 and December 29, 2015 due to the 5% allocation. For the 2015 calendar year, the SWP allocations were increased to 20% and releases resumed at an average of 9.8 cubic ft per second (cfs) for the remainder of the 2015 WY. Arroyo Mocho was dry at Arroyo Mocho Hagemann (AMHAG) for 94% of the water year (up from only 77% in the 2014 WY), and due to the drought ―live stream" conditions were not able to be maintained at Arroyo Del Valle Pleasanton (ADVP) for the entire 2015 WY. As a result, ADVP was dry for 116 days of the 2015 WY. The total stream recharge (natural and artificial) for the water year was 4,648 AF, which is 42% of average.

A total of 26,714 AF flowed past Arroyo De La Laguna at Verona (ADLLV) and out of the Valley in the 2015 WY. This is about 51% of the average outflow between 1970 and 2014.

Figure 2-5: Stream Recharge Volumes (AF), 1974 to 2015 WYs



2.1.4 Springs and Groundwater Dependent Ecosystems

Numerous saline springs have been observed east of the Livermore Valley Groundwater Basin associated with upwelling along faults, especially those in the Greenville fault zone. One such seasonal spring, Springtown Alkali Sink, has been documented and monitored in the northeastern Fringe Management Area of the groundwater basin. Springtown Alkali Sink is located along Altamont Creek in the vicinity of Springtown golf course and is close to stream gages on Altamont Creek monitored by Zone 7. The sink is located in the watershed near stream gages ALTC_BD and ALTC_SGC on **Figure 2-4**. Groundwater discharge in this area flows into Arroyo Las Positas, ultimately providing recharge to the north-central areas of the groundwater basin.

The sink is characterized by gently sloping lowland underlain by alluvium and confined in part by shallow bedrock. Groundwater within the Alkali Sink originates as recharge from precipitation and surface runoff, and also as underflow from the Altamont Uplands east of the groundwater basin. The Altamont Uplands are composed of marine shales and sandstone and produce groundwater with elevated concentrations of salts, especially sodium chloride and boron. Bedrock has been uplifted along the Tesla Fault southwest of the Alkali Sink, creating a shallow constriction for groundwater outflow. When water levels are sufficiently high, groundwater discharges to Altamont Creek, exiting the sink as surface water. Much of this discharge is lost to evapotranspiration.

A Hydrologic Analysis of the Springtown Alkali Sink was prepared for the City of Livermore by Questa Engineering Corporation (Questa) and Weiss Associates in November 1998 (*Questa et. al, 1998*). In that report, localized aquifers and groundwater conditions were analyzed. In summary, there are three water bearing zones in the Alkali Sink area: a shallow unconfined zone (shallow zone) up to about 10 ft deep, a semi-confined zone (middle zone) approximately 10 to 60 ft deep, and deep confined zone (deep zone) from 60 ft up to 200 ft deep.

The shallow zone is a seasonal water-bearing zone with water levels near ground surface during the wet season to completely dry at the end of the dry season. Recharge to the shallow zone is from precipitation, runoff, and upwards groundwater flow through the semi-confining layer. The underlying semi-confined zone appears to be separated from the overlying shallow zone by a valley-wide hardpan/claypan semi-confined layer. The semi-confined zone contains groundwater under pressure which flows upwards into the shallow zone through breaks in the hardpan/claypan. Recharge to the semi-confined zone occurs from precipitation and runoff at the basin margins. Groundwater discharges into the overlying shallow zone and ultimately into Altamont Creek. The semi-confined zone remains saturated throughout the year, with groundwater elevations fluctuating between two and five feet. The deep zone is separated from the overlying semi-confined by a local confining layer and the deeper groundwater does not appear to influence the Alkali Sink.

Historical springs within the Alkali Sink were caused by high groundwater levels in the shallow zone. Development occurred in the area in the late 1960s when Altamont Creek was deepened into the shallow zone (up to 15 feet below ground surface [bgs]) and possibly penetrated the hardpan/claypan layer below the shallow zone. The deepening of the creek is thought to create a local drain for shallow groundwater and significant springs no longer occur in the Alkali Sink. As a result, groundwater elevations are lower than they once were, causing the wetlands to be more seasonal. Currently, less-prominent springs occur in various areas of the sink only during wet periods when the water table is high.

Groundwater in the Alkali Sink is characterized by high concentrations of sodium chloride from the marine sedimentary rocks in the Altamont upland area. Buried stream channels in the shallow groundwater zone are thought to be conduits for salt transport to the Alkali Sink. Groundwater in the shallow zone is lost primarily to evapotranspiration, leaving salts behind in the soil. During the rainy season, low-salinity precipitation and surface runoff recharges groundwater, but salinity increases as the groundwater moves through the salt residue in the soil.

The Alkali Sink may be considered a groundwater dependent ecosystem for the purposes of SGMA, although effects are clearly seasonal. The sink supports an alkali-saline wetland habitat with seasonal surface ponding and shallow, seasonal high-salinity groundwater. The Alkali Sink has a mound and swale topography allowing alkali scalds to form in surface water ponds where groundwater is shallow. These scalds support salt-tolerant plants. In areas with better drainage, water accumulates in pools supporting vernal pool biota. The Alkali Sink also contains several protected species including the Palmate-Bracted Bird‘s Beak, burrowing owl, tiger salamander, and the fairy shrimp.

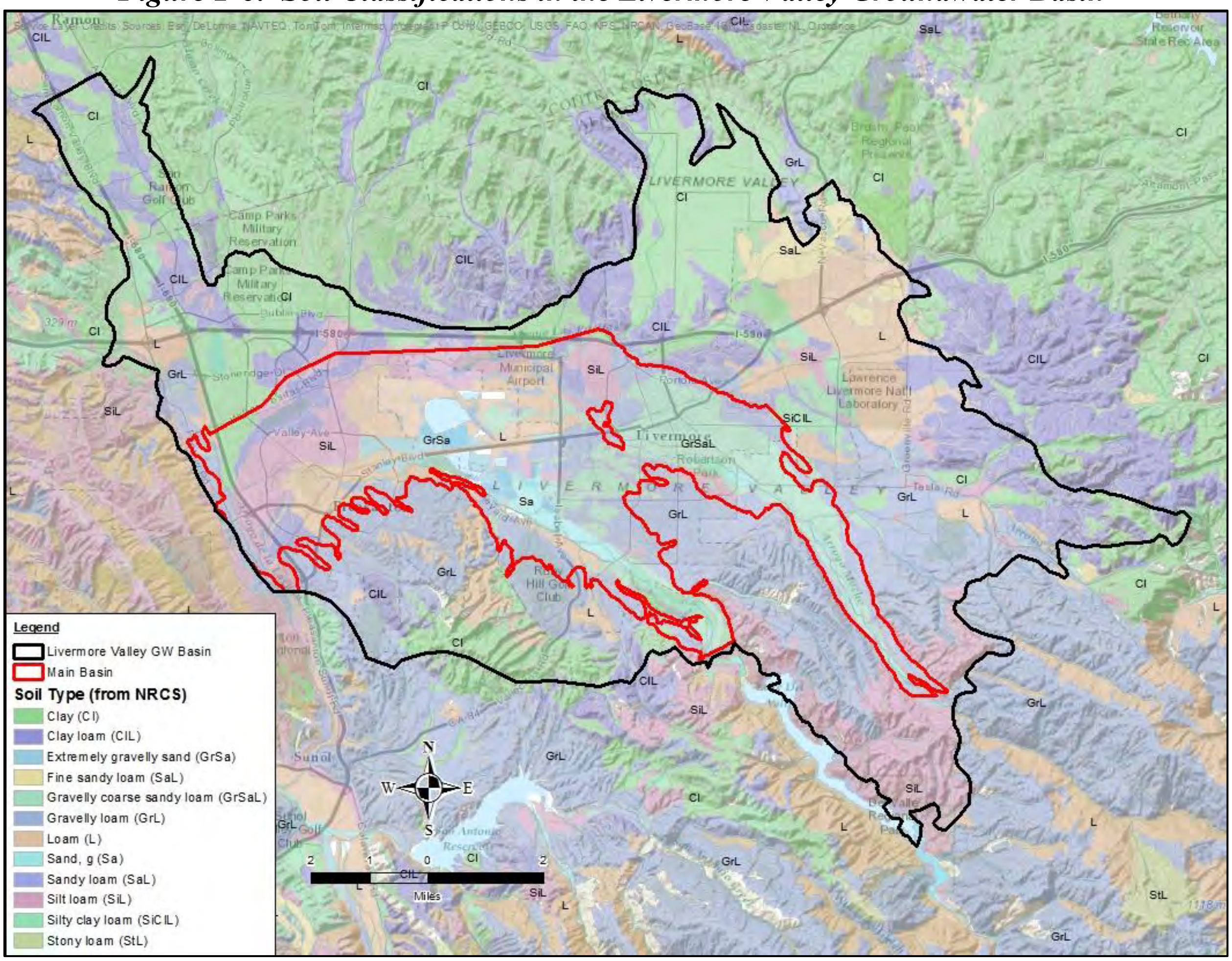
The occurrence of shallow groundwater in the vicinity of the Alkali Sink can be seen on maps showing depth to water as discussed in **Section 2.3.5** of this Alternative Plan. Additional information on the Springtown Alkali Sink and the groundwater dependent ecosystem is discussed in more detail in the section on Surface Water-Groundwater Interaction (**Section 2.3.10**) of this Alternative Plan.

Although minor springs contribute to the upper reaches of the Arroyo Mocho and Arroyo Valle above Lang Canyon, none of these springs contribute sufficient runoff to the arroyos to cause continuous flow in the streams. Most are isolated and are subject to tectonic shifts and climatic conditions that impact the amount of flow emanating. During the 2014 dry year, many springs were dry in this area and did not flow again until early 2016 (per communication with landowners).

2.1.5 Basin Soils

Figure 2-6 shows the surficial soils throughout the Livermore Valley Groundwater Basin as mapped by the National Resource Conservation Service (NRCS).

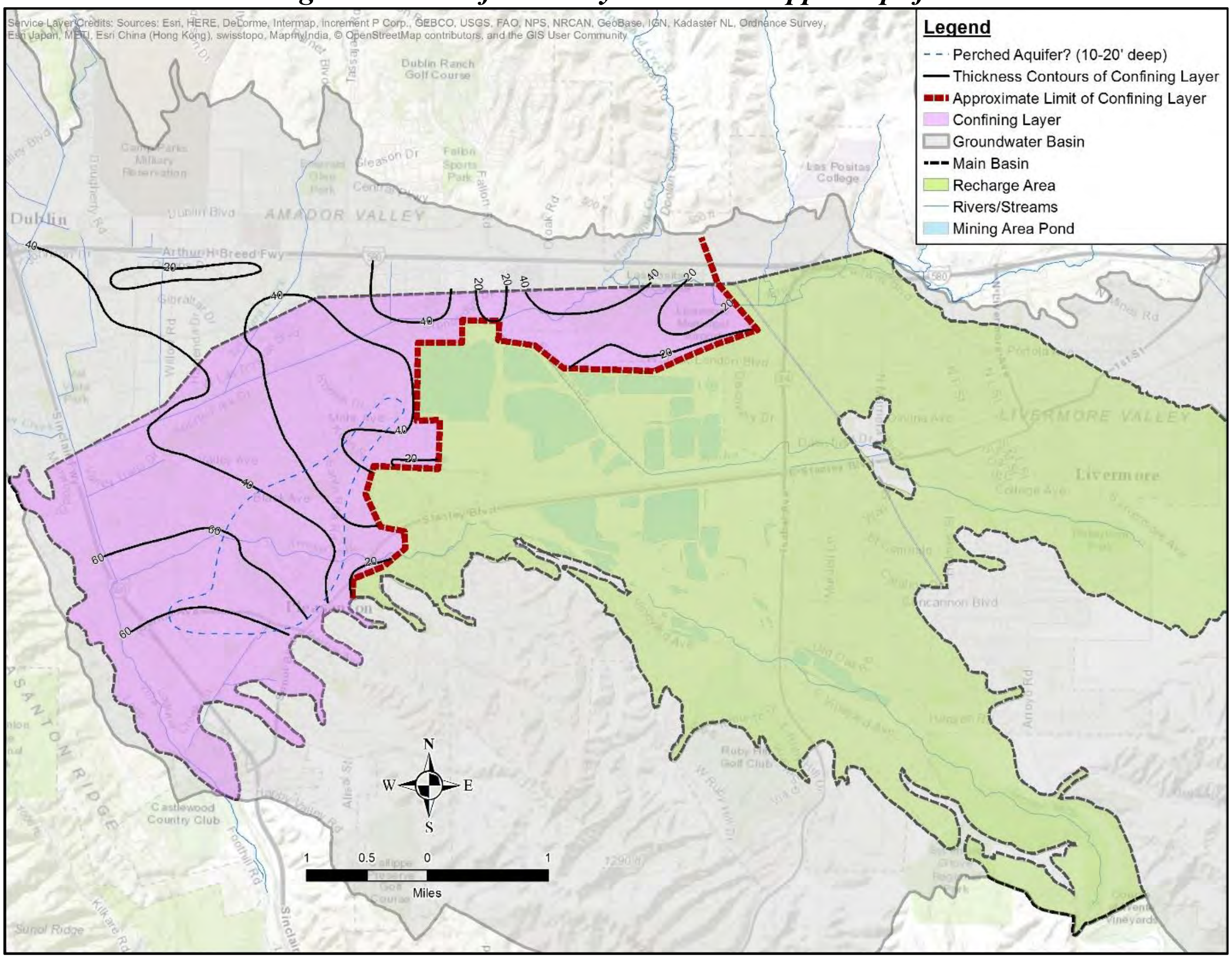
Figure 2-6: Soil Classifications in the Livermore Valley Groundwater Basin



In general, the soils reflect the lithology of the upland source rocks. The predominant soils in the northern Fringe Management Areas of the basin are low-permeability clay (Cl) and clay loams (ClL), associated with the Tassajara Uplands. Soils in the southern basin consist of more permeable soils including gravelly loams (GrL) associated with the Livermore Uplands. Across the Main Basin, soils are also more permeable than northern soils and include gravelly coarse sandy loams (GrSaL), extremely gravelly sand (GrSa), sand (Sa), silt loam (SiL) and loam (L). The lower permeability soils in the Main Basin occur along the northern and western portions.

The low permeability soils along the northern and western areas of the Main Basin are also underlain by shallow clay deposits that overlie the Upper Aquifer. These shallow clay layers have been mapped by Zone 7 to identify areas where shallow clays may be impeding surface recharge (see **Figure 2-7**).

Figure 2-7: Surficial Clays above the Upper Aquifer



2.2 Hydrogeological Conceptual Model

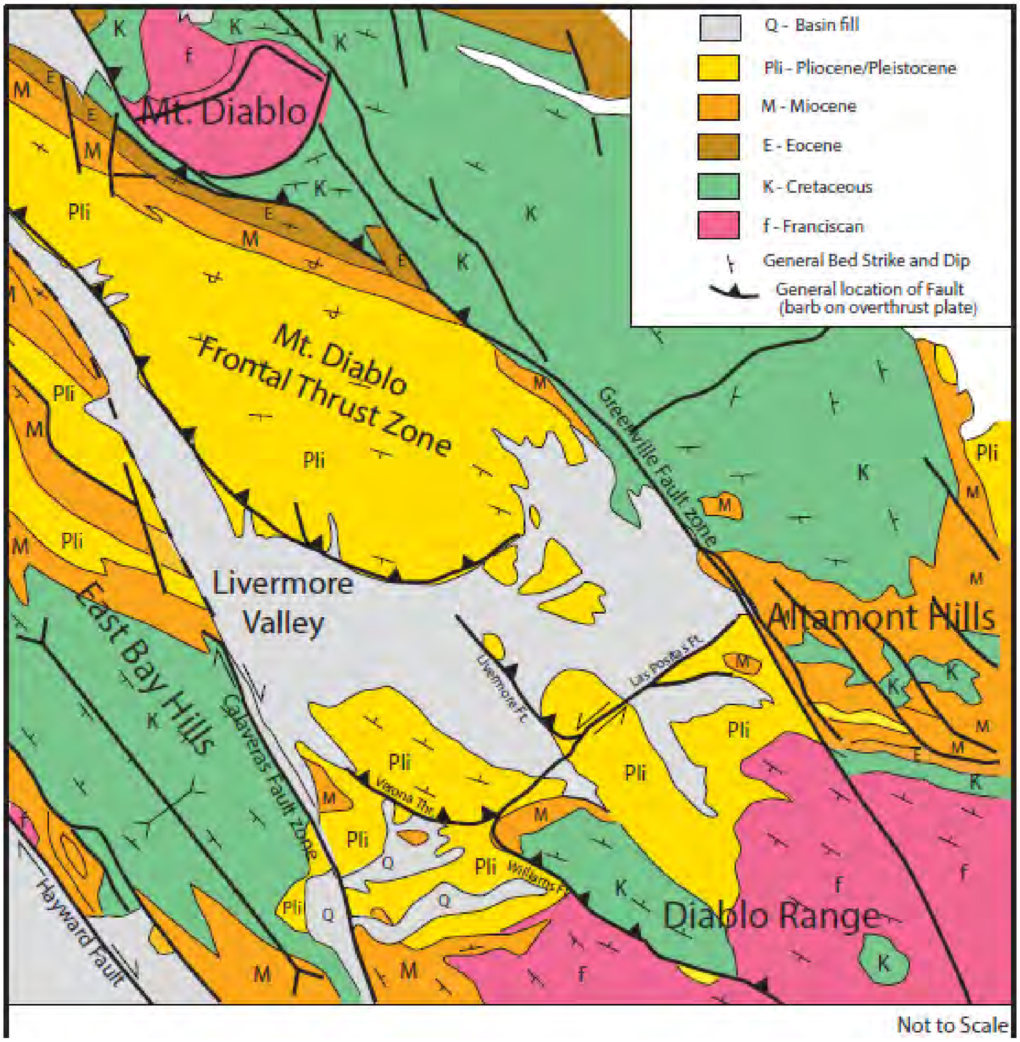
2.2.1 Geology and Structure

The Livermore Valley is an east-west trending, inland structural basin located in northeastern Alameda County. The Valley is defined primarily by northwest-southeast trending faults and upland bedrock hills of the Diablo Range. The valley covers about 42,000 acres and extends approximately 14 miles in an east-west direction with a width of between 3 and 6 miles. It is separated from San Francisco Bay by several northwesterly trending ridges of the California Coast Ranges, including the Pleasanton Ridge.

Structural uplift of the Coast Range during the late middle Pliocene and Pleistocene created extensive folding and faulting of the region, which formed the Livermore Valley. The Valley is an asymmetrical syncline of Miocene-Pliocene sandstones and conglomerates generally bounded by the Calaveras Fault on the west and the Greenville Fault on the east, as shown on **Figure 2-8** (from *Norfleet Consultants, 2004)*.

Figure 2-8 presents a schematic geologic/tectonic map that illustrates the tectonic history and formation of the Valley. As indicated on the map, the Livermore Valley is the result of deformation between the southward movement of the Mt. Diablo thrust sheets north of the Valley and the Diablo Range uplift south of the Valley. The tectonic history of the Valley began with the uplift of the Diablo Range, which created ancestral streams (including ancestral Arroyo Mocho) that initially flowed north toward San Ramon (and continuing northwest to the Concord area). Up to 12,000 ft of Pliocene-age sediments (including the Livermore Gravels and equivalent formations) were deposited in this Proto-Livermore Basin. These sediments were down-warped with the subsequent thrusting associated with Mt. Diablo to the north (see Mt. Diablo frontal thrust zone labeled on **Figure 2-8**). This thrust zone closed the basin on the north and re-directed surface drainage to the southwest. Additional tectonic activity along the Calaveras and Greenville fault zones continued to deform and shape the Valley.

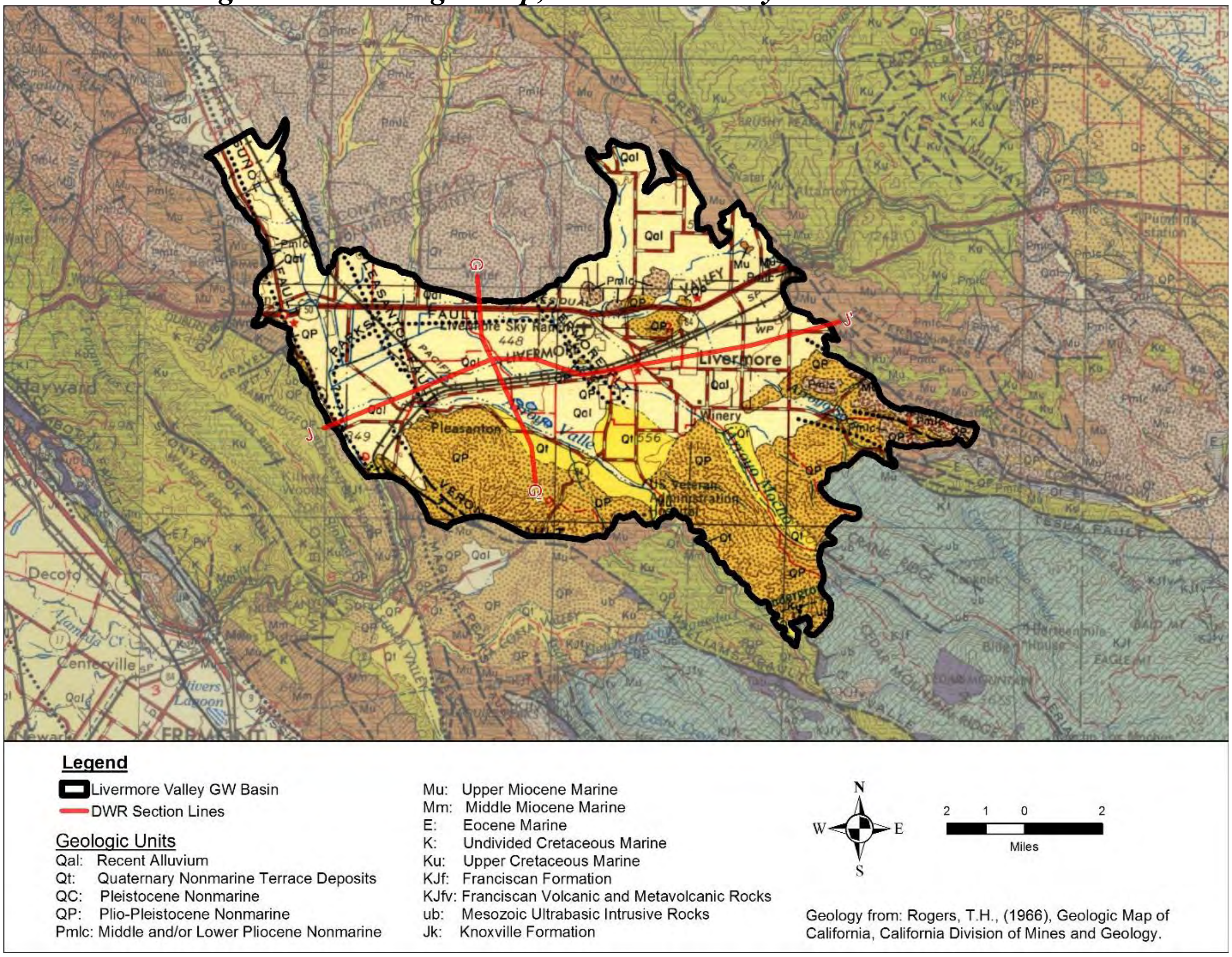
Figure 2-8: Generalized Geologic/Tectonic Map, Livermore Valley



The geologic map on **Figure 2-9** (from *Rogers, 1966*) illustrates the older deformed sedimentary and bedrock units defining the basin along with the valley-fill alluvial sediments; the groundwater basin is outlined in black on the map. The map also contains many of the northwest-southeast trending faults[1] that have offset the consolidated geologic units and, in some cases, shallow alluvium.

[1] Several faults shown on this 1966 geologic map have been re-interpreted and, in some cases, removed. However, the map is useful in illustrating the complex geologic units surrounding and beneath the groundwater basin.

Figure 2-9: Geologic Map, Livermore Valley Groundwater Basin



As shown on **Figure 2-9**, the valley is partially filled with Pleistocene-Holocene age alluvium (Qal), consisting of alluvial fan, fluvial, and lake deposits that range in thickness from a few feet along the margins to more than 400 ft in the west-central valley. The alluvium consists of unconsolidated gravel, sand, silt, and clay. The southern and southwestern alluvial deposits consist primarily of sand and gravel that were deposited by the ancestral and present Arroyo del Valle and Arroyo Mocho. These deposits are rimmed by slightly older terrace deposits (Qt).

The eastern and northern Fringe Management Areas of the valley are also filled with recent alluvial deposits, but sediments there were deposited from smaller streams and consist of thin, alternating layers of gravel, sand, silt, and clay that are laterally discontinuous. Consolidated units underlie the thin alluvial deposits as demonstrated by several areas in the northeast basin where these units crop out at the surface (see **Figure 2-9**). These outcrops consist of the older consolidated units north and south of the valley that underlie the alluvium (Pliocene [Pmlc] units on the north and younger Pliocene-Pleistocene [QP] units on the south, discussed in more detail below).

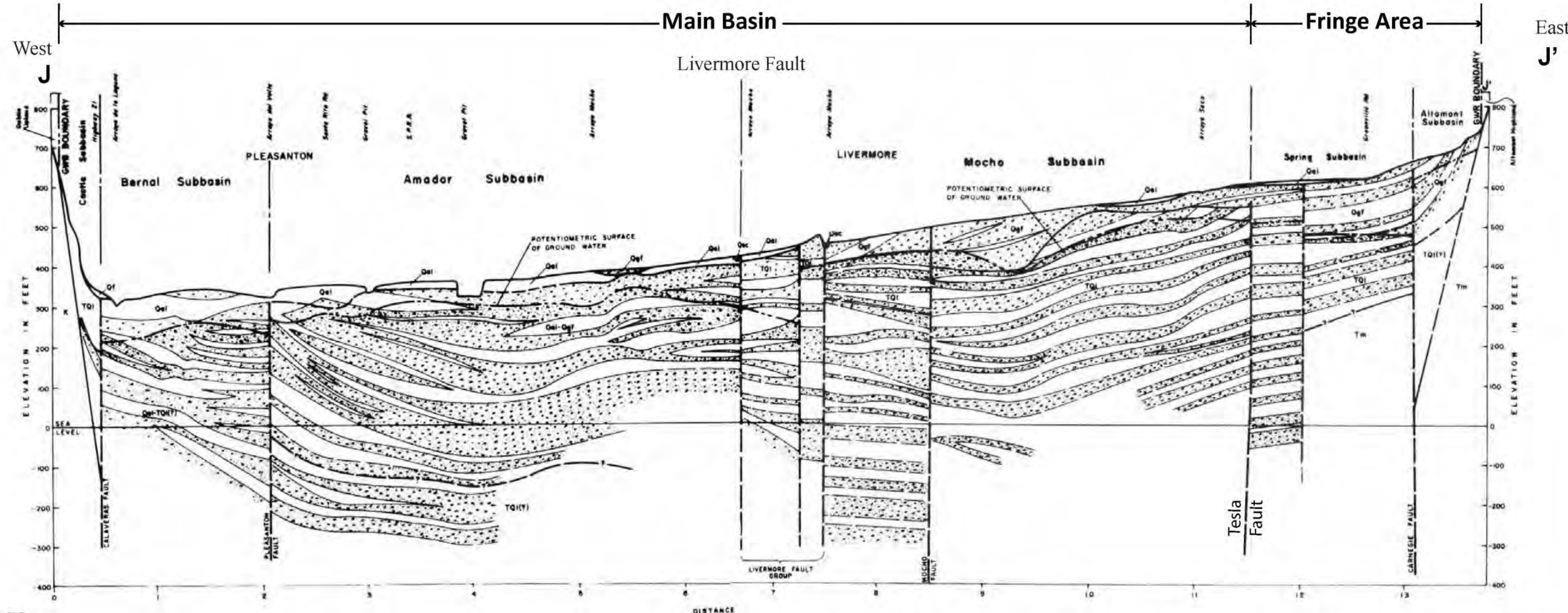
The groundwater basin is bounded on the north by uplands of the Tassajara and Green Valley Formations, consolidated units of Pliocene (Pmlc) and Miocene (Mu) age. These units consist of sandstone, tuffaceous sandstone/siltstone, conglomerate, shale, and limestone deposited under both brackish and freshwater conditions. Although the Tassajara Formation is in contact laterally and underlies the alluvium of the northern Fringe Management Area of the groundwater basin, subsurface groundwater inflow is thought to be minor. The extreme deformation associated with the Mt. Diablo thrust sheets has created numerous bounding faults and steep geologic dip in the subsurface. In addition, the Tassajara Formation (Pmlc) north of the valley consists of tuffaceous-clay-rich sediments of low permeability and weather to mostly clay soils (see also **Figure 2-6**).

Geologic units in the southern portions of the groundwater basin consist primarily of the Livermore Formation (QP) of Plio-Pleistocene age. The Livermore Formation (also referred to as the Livermore Gravels) consists of beds of clayey gravels and sands, silt, and clay that are unconsolidated to semi-consolidated and estimated to be 4,000 ft thick in the southern and western portion of the basin. The formation dips to the south and underlies the groundwater basin. The upland area of the Livermore Formation is well-cemented with relatively low permeability and has been associated with low-yielding wells. Yet the upper Livermore Formation beneath the Main Basin is sufficiently weathered and comprises the lower portion of the Lower Aquifer.

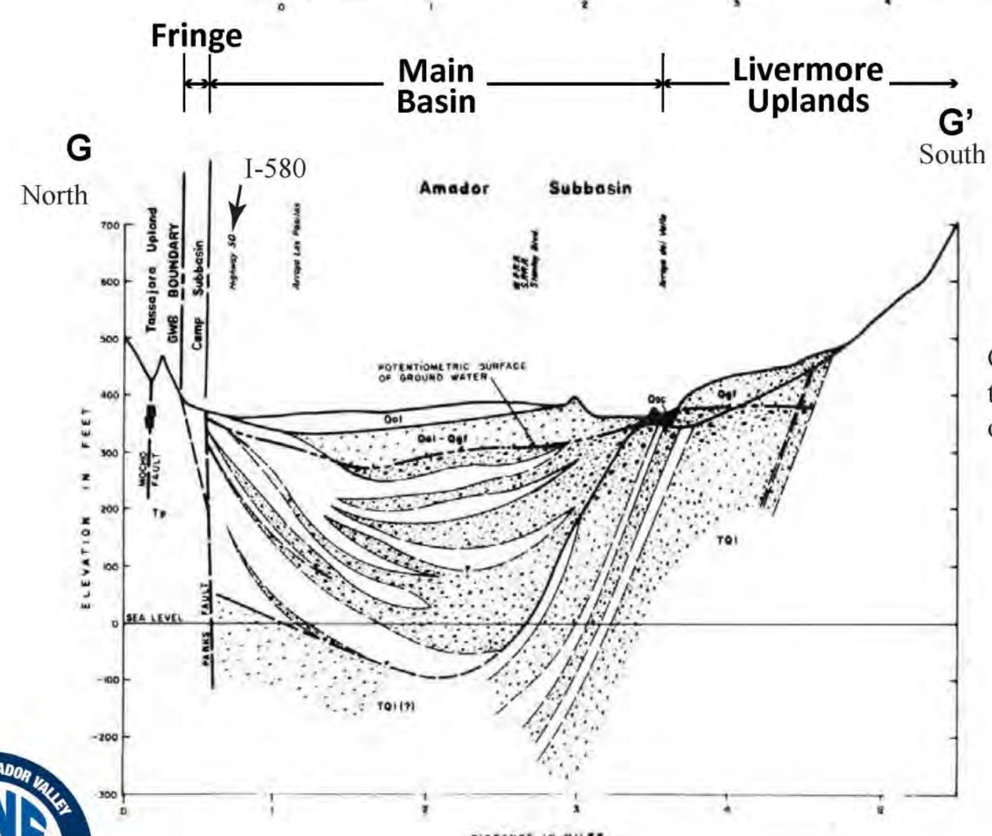
Two cross sections prepared by DWR in 1974 are reproduced in **Figure 2-10** to illustrate the geologic units and the overall geometry of the groundwater basin. Cross Section J-J‘ provides a west-to-east profile across the basin. The section extends from the western basin boundary at the Calaveras Fault to the eastern Altamont Uplands. The section crosses the southern Main Basin and continues into the Fringe Management Area across the Tesla Fault. Subareas (referred to as subbasins on the section) are generally shown as defined by geologic faulting. Although some of these traces have not been confirmed, the delineation of subareas provides a useful management tool for grouping areas of similar structure and stratigraphy.

Also shown on **Figure 2-10** is Section G-G,‘ a north-south profile extending from the Fringe Management Area in the north, across the Main Basin Management Area, and into the Livermore Uplands in the south. Section G-G‘ also illustrates the complex fault bounded Tassajara Formation on the north and the Livermore Formation on the south that dips to the north and underlies the groundwater basin.

Although these cross sections were prepared prior to the improved understanding of the tectonic history and structure of the basin, both sections provide useful information on the overall framework of the groundwater basin. Additional information on basin boundaries, management areas and delineation of subareas is provided in the following section.



J-J' is and east-west cross-section across the lower part of the Livermore Basin. It extends from the east side of Livermore to the Calaveras fault west of Pleasanton.



G-G' is a north-south cross-section across the center of the Livermore Valley west of the Livermore fault (DWR, 1974).

After Norfleet Consultants, 2004

Figure 2-10
Regional Cross Sections
Livermore Valley Groundwater Basin

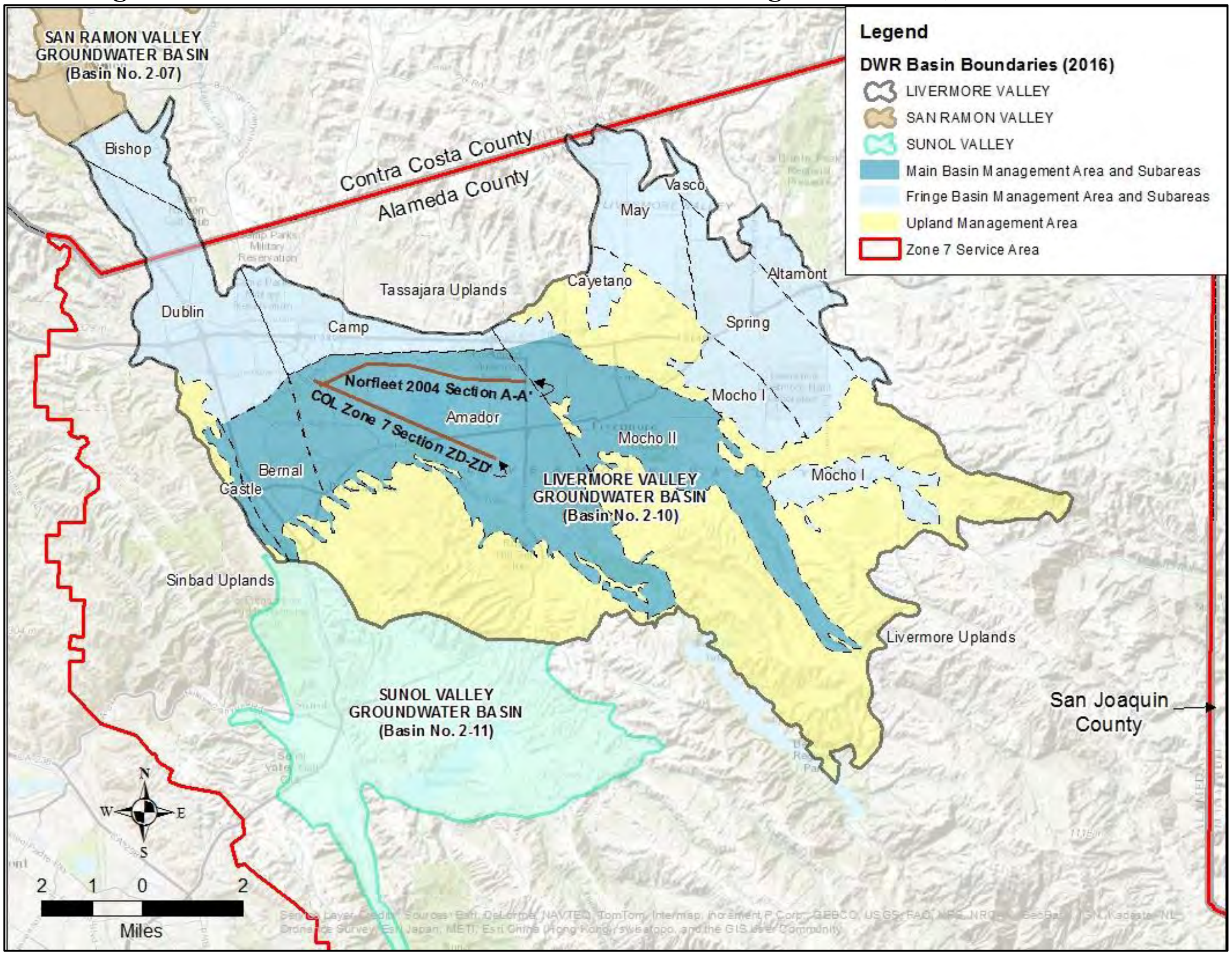
2.2.2 Basin Boundaries

2.2.2.1 Overview

As described above, the groundwater basin is delineated primarily by the recent alluvium and southern uplands of the Livermore Formation (see **Figure 2-9**). The sediments within the upper portions of the Livermore Formation and the overlying recent alluvium combine to form the aquifer system of the groundwater basin, which has been subdivided into an Upper Aquifer and a Lower Aquifer in the Main Basin Management Area. The Lower Livermore Formation and upland bedrock units that crop out around the alluvium have not been found to yield significant quantities of water in wells and are considered to be the subsurface basin boundary.

For the purposes of groundwater investigations and management, the non-upland areas have been divided into the Main Basin and Fringe Management Area, based on the thickness of the alluvium and changes in stratigraphy and groundwater quality. These two areas have been further subdivided into subareas (previously referred to as subbasins), as shown on **Figure 2-11.** Boundaries of the management areas and subareas are described in more detail below.

Figure 2-11: Groundwater Basin Boundaries, Management Areas, and Subareas



2.2.2.2 Main Basin Management Area

The Main Basin[2] 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 defined by the following boundaries:

- on the west by northwesterly trending ridges of the California Coast Ranges (including Pleasanton Ridge) and the Calaveras fault,
- on the north by stratigraphic and structural changes associated with relatively shallow bedrock and thin, clay-rich deposits sourced from the steeply-dipping bedrock of the Tassajara Uplands,
- on the east by bedrock outcrops, thin alluvial deposits and upland areas of the basin, and
- on the south by the Livermore Uplands.

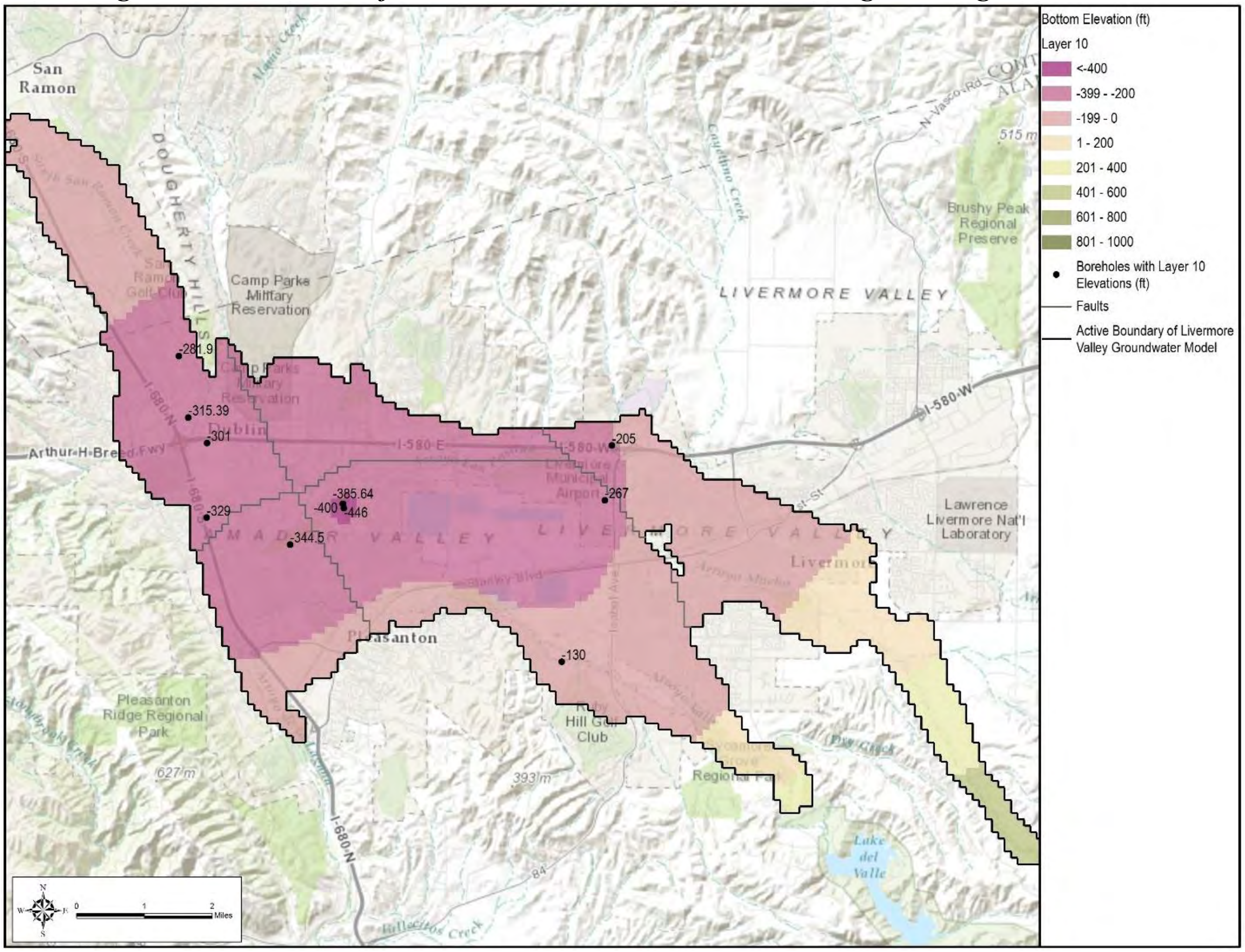
The bottom of the Main Basin is defined by the base of the Lower Aquifer and represents the transition zone from prolific aquifers in the upper Livermore Formation to the more consolidated units in lower portions of the formation. Although the thickness of the productive Livermore Formation varies, it has been estimated to be about 200 ft thick in the southern Main Basin (representing the lower 200 ft of the Lower Aquifer). The elevation of the bottom of the Main Basin and adjacent Fringe Management Areas was estimated for a recent update of the Zone 7 groundwater model and is shown on **Figure 2-12**.

As indicated by **Figure 2-12**, the base of the Lower Aquifer in the Main Basin extends below an elevation of -400 ft msl in the west-central portion of the basin. Over most of the Main Basin (and including some of the northern Fringe Management Areas), the basin bottom is estimated to be between -400 ft to -200 ft msl. In the northwestern San Ramon Valley and the southern and southeastern portions of the Main Basin, the basin bottom is estimated to be between -200 ft msl to sea level, with a shallower base in the southeast reaches of Arroyo Mocho and Arroyo Valle. In general, this basin geometry is consistent with previous interpretations by DWR (see **Figure 2-10**).

The Main Basin has a much larger capacity than the surrounding areas to store and convey groundwater. The thick and generally more permeable aquifers have been divided into Upper and Lower Aquifers, discussed in more detail in subsequent sections. In particular, the Lower Aquifer is tapped by many of the basin‘s production wells. Since the early 1900s, the Lower Aquifer of the Main Basin has been the most significant for local groundwater supply. Accordingly, many of Zone 7‘s management actions have focused on enhancement and protection of the Main Basin aquifers.

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

Figure 2-12: Bottom of the Main Basin and Northern Fringe Management Areas



2.2.2.3 Subareas within the Main Basin

The Main Basin Management Area has been further subdivided into four Subareas to delineate areas of similar groundwater conditions and provide a reference framework for locating wells and defining conditions of water supply. The Subarea names and boundaries are summarized below and shown on **Figure 2-11**.

Castle Subarea

The Castle Subarea is a thin strip that extends along the southwestern portion of the Main Basin. It is bounded to the south, west, and north by marine sediments of the Coastal Range and to the east by the Calaveras Fault. While usually included in the Main Basin, this subarea is not used for municipal groundwater production. This subarea functions as a westward extension of the Bernal subarea.

Bernal Subarea

The Bernal Subarea is located in the southwestern portion of the groundwater basin and is bounded to the west by branches of the Calaveras Fault, to the east by the inferred extension of the Pleasanton Fault, to the north by the Parks Boundary, and to the south in part by contact with non-water-bearing formations and in part by contact with the Verona Fault. Both unconfined and confined aquifers exist in the subarea.

The area overlying the Bernal Subarea is the point of convergence for all major streams that drain the Livermore Valley and converge into the Arroyo de la Laguna. Like surface water, groundwater also historically converges in this subarea, which allows for the mixing of various groundwater qualities throughout the basin.

The Quaternary alluvium is estimated to have a thickness of at least 800 ft in this subarea and overlies the Livermore Formation. Well production (primarily by Zone 7 and the City of Pleasanton) in this subarea ranges up to 3,500 gallons per minute (gpm) and specific capacities range from 3 to 260 gpm per foot of drawdown.

Amador Subarea

The Amador Subarea is located in the west central portion of the groundwater basin and is bounded to the west by the inferred extension of the Pleasanton Fault, to the east by the Livermore Fault, to the north by a permeability barrier of inter-fingering of alluvial deposits, and to the south by the drainage divide and contact with consolidated units of the Uplands Management Area. This subarea contains most of the high-yielding wells and has both unconfined (Upper Aquifer) and confined (Lower Aquifer) aquifers.

The Quaternary alluvium has a maximum thickness in this subarea of approximately 800 ft and overlies the Livermore Formation, which may be up to 4,000 ft thick. Well production (primarily by Zone 7 and the City of Pleasanton) in this subarea ranges from 42 to 2,820 gpm and specific capacities of 1.1 to 217 gpm per foot of drawdown.

Mocho Subarea

The Mocho Subarea has been divided into two distinct areas, Mocho I (Fringe Management Area) and Mocho II (Main Basin Management Area), by a line of very low hills thought to be exposures of the Livermore Formation. The basins are further distinguished by a change in groundwater chemistry.

Mocho II Subarea is located in the east central portion of the groundwater basin and is bounded to the west by the Livermore Fault, to the east by thinning young alluvium and exposed Livermore Formation, to the north by the consolidated bedrock of the Tassajara Formation, and surrounded in the south by the Uplands Management Area. Both unconfined and confined aquifers exist in the water-bearing sediments.

The recent alluvium ranges in thickness from approximately 10-50 ft in Mocho I and up to 150 ft in Mocho II. In both subareas the alluvium overlies the Livermore Formation, both conformably and unconformably. Mocho I and Mocho II appear to be hydraulically connected only in the shallow alluvial deposits. Wells in this subarea are primarily owned and operated by Cal Water. Production ranges up to 950 gpm with specific capacities of 2 to 50 gpm per foot of drawdown.

2.2.2.4 Fringe Management Area and Subareas

As shown on **Figures 2-11** and **2-9**, the Fringe Management Area is defined by areas outside of the Main Basin that contain 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 Area and the Main Basin Management Area is through the Upper Aquifer. In general, Lower Aquifer units in the Main Basin do not extend into the Fringe Management Area. Areas of significant subsurface inflows through the Upper Aquifer from the Fringe Management Area into the Main Basin Management Area occur:

- along the northern and eastern boundaries between the two areas, currently estimated at about 900 AFY; and
- along the northwestern boundary (at the Bernal Subarea) of the Main Basin estimated to be about 100 AFY, as estimated by transect wells.

Similar to the Main Basin Management Area, ten subareas have been defined in the Fringe Management Area to delineate areas of similar groundwater conditions and provide a reference framework for locating wells. These subareas were defined in the 1970s using primarily inferred fault traces for many of the boundaries. Although the presence of some of the faults have either been re-interpreted or not confirmed, the subarea delineation provides a useful system for groundwater management and has been retained in subsequent groundwater documents. Subareas in the northwest include Bishop, Dublin, and Camp. Subareas in the northeast include Cayetano, May, Vasco, Altamont, Spring, and Mocho I.

2.2.2.5 Uplands Management Area

The Uplands Management Area is primarily defined by areas without recent alluvium that are underlain by the Livermore Formation and older bedrock units. 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 Uplands Management Area leaves the area as runoff and contributes to streams in the Fringe and the Main Basin Management Areas. A small amount of deep percolation of precipitation in the Uplands could also contribute to subsurface inflow. Subsurface inflow from the Livermore Uplands Management Area into the Main Basin Management Area has been estimated at about 360 AFY. Formal subareas have not been delineated in the Uplands Management Area because of the absence of significant groundwater pumping or the lack of need for localized groundwater management actions.

2.2.3 Basin Hydrostratigraphy

2.2.3.1 Overview

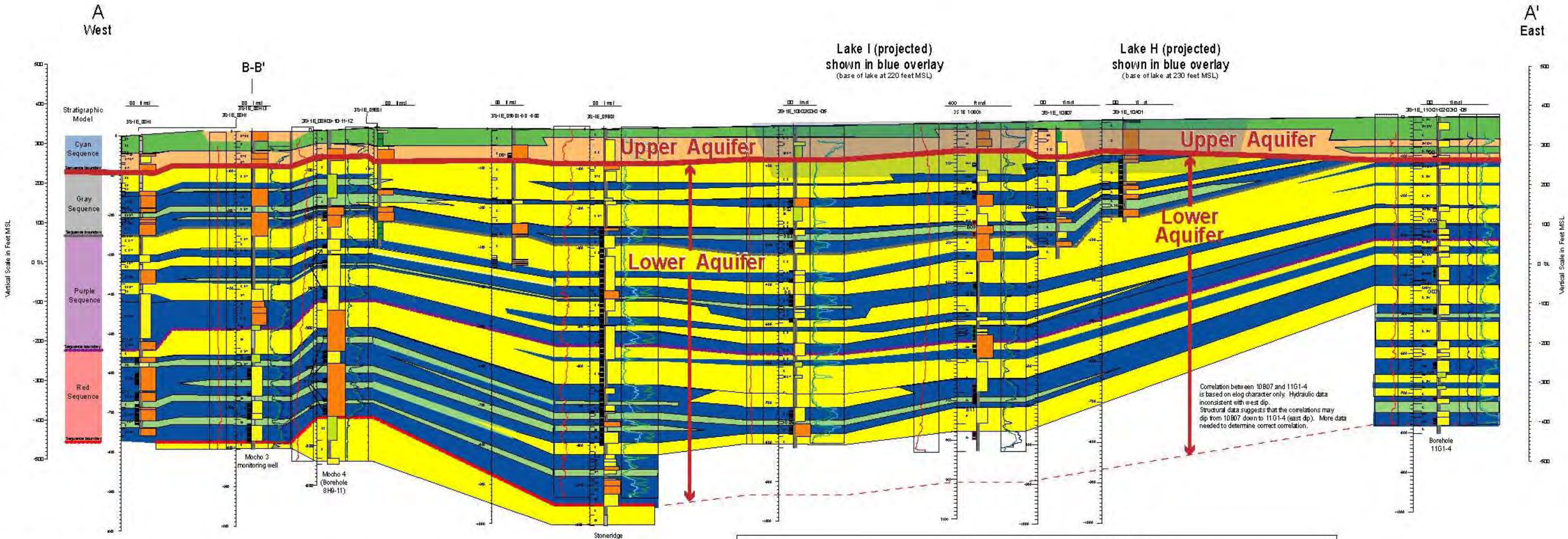
Observed differences in water levels and water quality with depth have been used to delineate an Upper Aquifer and Lower Aquifer in the basin. In 2004, an important local hydrostratigraphic study was conducted in the Amador Subarea of the Main Basin Management Area to examine the aquifer system in more detail (*Norfleet Consultants, 2004*). This area contains up to about

1,000 ft of water-bearing sediments and highly productive aquifers. The area is also important in that it contains gravel quarries, referred to as the quarry area or ―Chain of Lakes,” some of which are used currently for conjunctive use; this program will be expanded in the future as ongoing gravel mining is completed and additional quarries are available for Zone 7 use.

The 2004 hydrostratigraphic study applied sequence stratigraphy techniques to the 1,000 ft of aquifers and aquitards in the area. Four overall hydrostratigraphic packages, or sequences, were mapped across the area based on the occurrence of generalized stratigraphic facies. These sequences were labeled (shallow to deep) cyan, gray, purple, and red. A cross section from the 2004 study showing the sequences mapped across the area, along with the delineation of the Upper and Lower Aquifers is shown on **Figure 2-13**. The location of the cross section is shown on **Figure 2-11**.

As indicated on **Figure 2-13**, the Cyan sequence is correlative to the delineation of the Upper Aquifer. Stratigraphic continuity within the Lower Aquifer was examined by the mapping of the remaining three sequences (gray, purple, and red). Although it is difficult to distinguish the basal units of the recent alluvium from the upper, productive zones of the Livermore Formation, the boundary between the purple and red provides a reasonable stratigraphic framework.

An examination of water levels confirmed differences between the Upper Aquifer and Lower Aquifer systems. In 2011, additional cross sections were completed in the area using the same techniques as in 2004; a cross section from that study is provided as **Figure 2-14**. The cross section location is also shown on **Figure 2-11**. The Upper Aquifer and Lower Aquifer are described in more detail in the following sections.



Source: Plate 3.
Cross Section A-A' Chain-of-Lakes Area
Livermore Valley

Zone 7 Water Agency

Stratigraphic Interpretation by
Kenn Ehman and Rick Blake
December 2003

Assistance from
Tom Rooze, Zone 7 Water Agency
David Lunn, Zone 7 Water Agency
Ken Stevens, GIS Solutions
Rick Cramer, Groundworks Environmental, Inc.
Sands Figuers, Norfleet Consultants

0 1000 2000 3000 4000 5000
Approximate Horizontal Scale in feet

5:1 Vertical Exaggeration

Explanation

Major Generalized Stratigraphic Facies

- Overbank and lacustrine clays and silts (aquitard facies) exposed at Lake I.
- Fluvial gravels ("Carol's Cut Gravel") (aquifer facies) exposed at Lake I.
- Fluvial overbank and floodplain clays and silts (aquitard facies). May include lacustrine facies.
- Fluvial and deltaic(?) sands and gravels (aquifer facies)
- Regional correlative lacustrine clay and silt units (aquitard facies). May include floodplain and overbank facies.

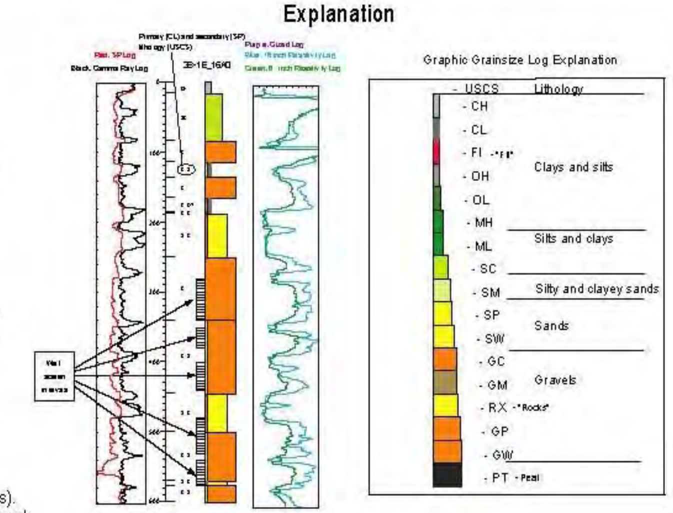
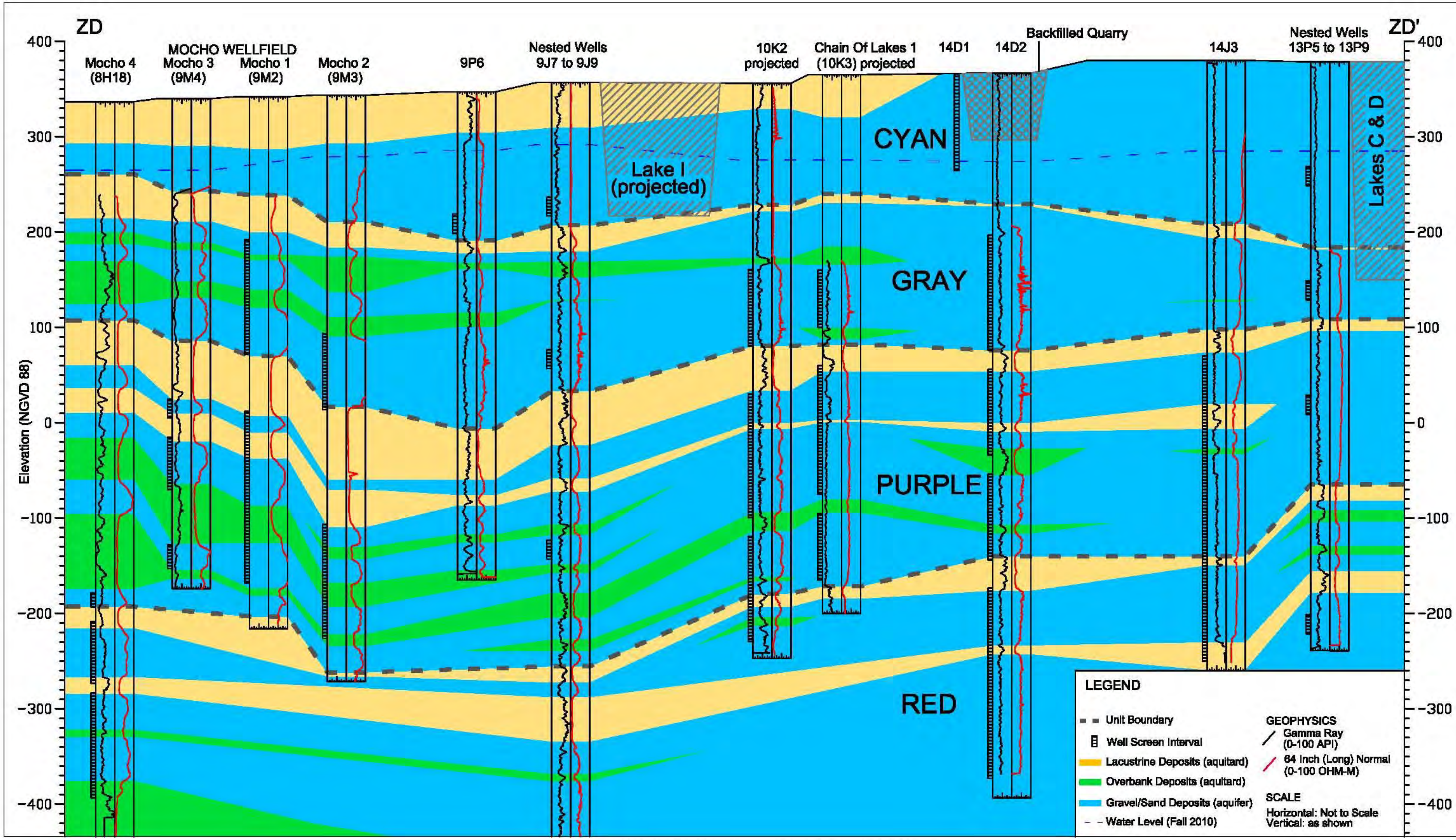


Figure 2-13
Stratigraphic Cross Section, Main Basin



SCALE: Horizontal: none; Vertical: 1"=100'

May 20, 2011

E:\GISProg\Zone7\GeoSections\MainSections\Section-ZD.dwg

Figure 2-14
Cross Section ZD
Livermore Valley Groundwater Basin

2.2.3.2 Upper Aquifer

The Upper Aquifer consists of alluvial materials, including primarily 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. The overburden thicknesses have been contoured, as discussed previously and shown on **Figure 2-7**. The base of the Upper Aquifer varies from about 70 to 190 ft bgs. A relatively thin Upper Aquifer is shown on **Figure 2-13**, located in the northern Main Basin (cross section location on **Figure 2-11**). On this section, the thickness of the Upper Aquifer ranges from about 70 ft to about 110 ft. These units are thicker to the south, as shown on **Figure 2-14.** The Upper Aquifer ranges from about 70 ft thick in the west to about 190 ft thick in the southeast.

In the 2004 hydrostratigraphic study, the Upper Aquifer was determined to contain several stratigraphic facies representing varying depositional environments across the central portion of the basin. In that area, the Upper Aquifer contained fluvially-deposited gravels occurring primarily beneath aquitards of overbank and lacustrine deposits of clay and silt (**Figure 2-13**). A regional correlative lacustrine clay and silt unit underlies these deposits over much of the central and western Main Basin.

A comparison of water levels from nested monitoring wells suggests that the lacustrine unit between the Upper Aquifer and Lower Aquifer is a regional confining layer (see nested wells in the central and eastern Main Basin shown on **Figure 2-14**). However, the confining layer between the two systems appears to thin in the east, providing more hydraulic continuity between the two aquifers (see **Figure 2-14**). Groundwater in the Upper Aquifer is generally unconfined; however, when water levels are high, the zone becomes more confined in the western portion of the Main Basin where overlain by surficial clays.

2.2.3.3 Lower Aquifer

All aquifers encountered below the confining aquitard in the central and eastern Main Basin are known collectively as the Lower Aquifer. The lower aquifer materials consist of coarse-grained, water-bearing units interbedded with relatively low permeability, fine-grained units. The 2004 hydrostratigraphic study of the central portion of the Main Basin indicated that aquifers were primarily fluvial and deltaic sands and gravels interbedded with fluvial overbank and floodplain deposits (silts and clays).

Most of the recharge to the Lower Aquifer occurs through vertical leakage from the Upper Aquifer 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 alluvium.

Upper members of the Livermore Formation also appear to be sufficiently weathered and more permeable beneath the alluvium than in outcrops in the Upland Management Area. These zones comprise the lower portion of the Lower Aquifer, although sediment samples from wells are not sufficiently distinct to allow clear differentiation between these two units. Nonetheless, the lower portion of the Lower Aquifer is often characterized as having the thickest and most productive aquifers. The predominance of fluvial and deltaic sands and gravels in the lower portion of the Lower Aquifer can be seen on the western side of Cross Section A-A‘ on **Figure 2-13** (labeled the Red Sequence). These lower sands are screened in many of the high-yielding production wells, especially in the western and central portions of the Main Basin.

2.2.3.4 Representation of Aquifers and Aquitards in Groundwater Models

Zone 7 maintains a numerical groundwater model of the basin for predicting the consequences of proposed groundwater basin management actions. The model, originally created in Visual MODFLOW, has been converted to Groundwater Vistas and uses MODFLOW packages (e.g., NWT, MT3D) to perform the modeling calculations. In 2006, Zone 7 and HydroMetrics WRI (HydroMetrics) reevaluated, recalibrated, and revised the model.

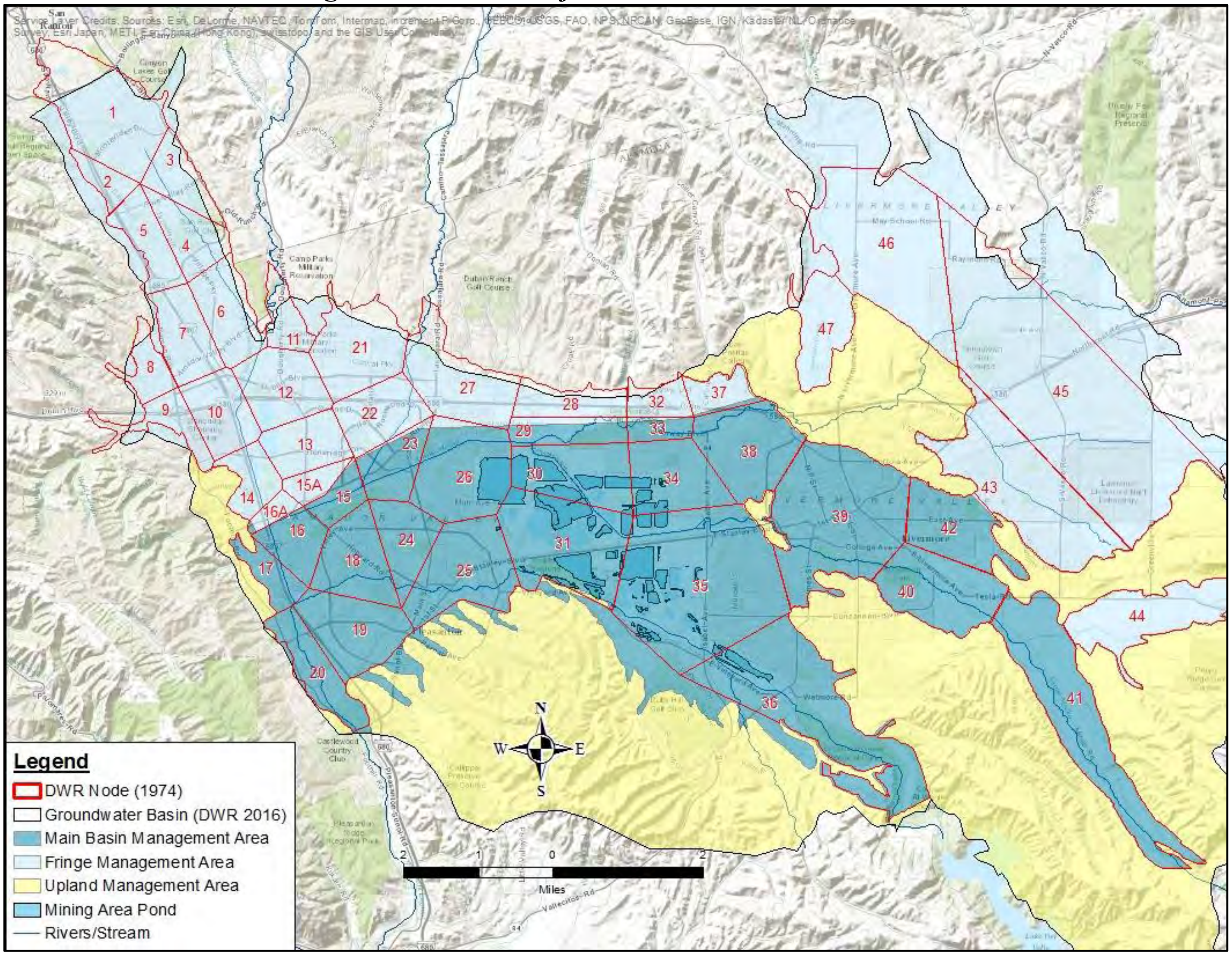
The active part of the groundwater model covers subareas in both the Main Basin Management Area (Castle, Bernal, Amador, and Mocho II Subareas) and the northwestern Fringe Management Area (Bishop, Dublin, and Camp Subareas). The model consists of three layers: the Upper Aquifer (Layer 1), an aquitard (Layer 2), and the Lower Aquifer (Layer 3). Most municipal water supply production wells in the basin are screened in the lower aquifer (Layer 3). Production in the Upper Aquifer (Layer 1) is limited primarily to small private wells (Layer 1).

Nodes originally delineated in the 1974 groundwater model (developed by DWR) also recognized the Upper and Lower Aquifers in the Main Basin Management Area as well as the thin alluvial Upper Aquifer Units in the Fringe Management Area. The model delineated nodes over these alluvial areas, as shown on **Figure 2-15**. These nodes have aquifer parameters associated with them that have been confirmed over time and are used by Zone 7 for calculation of groundwater in storage, changes in storage, and groundwater quality analyses. The application of these nodes in Zone 7 groundwater management is described in more detail in the discussion of groundwater quality (**Section 2.3.8**) and basin water budgets (**Section 2.4**) of this Alternative Plan. The Zone 7 groundwater model is currently being updated and will be applied to future water supply scenarios including long-term drought conditions. The conceptualization of the two primary aquifer zones and intervening aquitards will be represented more discretely in the updated flow model than had been done previously. The model will be constructed with 10 layers to represent primary intervals of aquifers and aquitards as summarized below:

- Layer 1 – shallow clay layers overlying the Upper Aquifer in the western basin
- Layers 2 and 4 – primary aquifer units within the Upper Aquifer
- Layer 3 – intervening clay layers within the Upper Aquifer
- Layer 5 – confining to semi-confining layer delineating the Upper Aquifer from the Lower Aquifer
- Layers 6, 8, and 10 – primary aquifer units within the Lower Aquifer

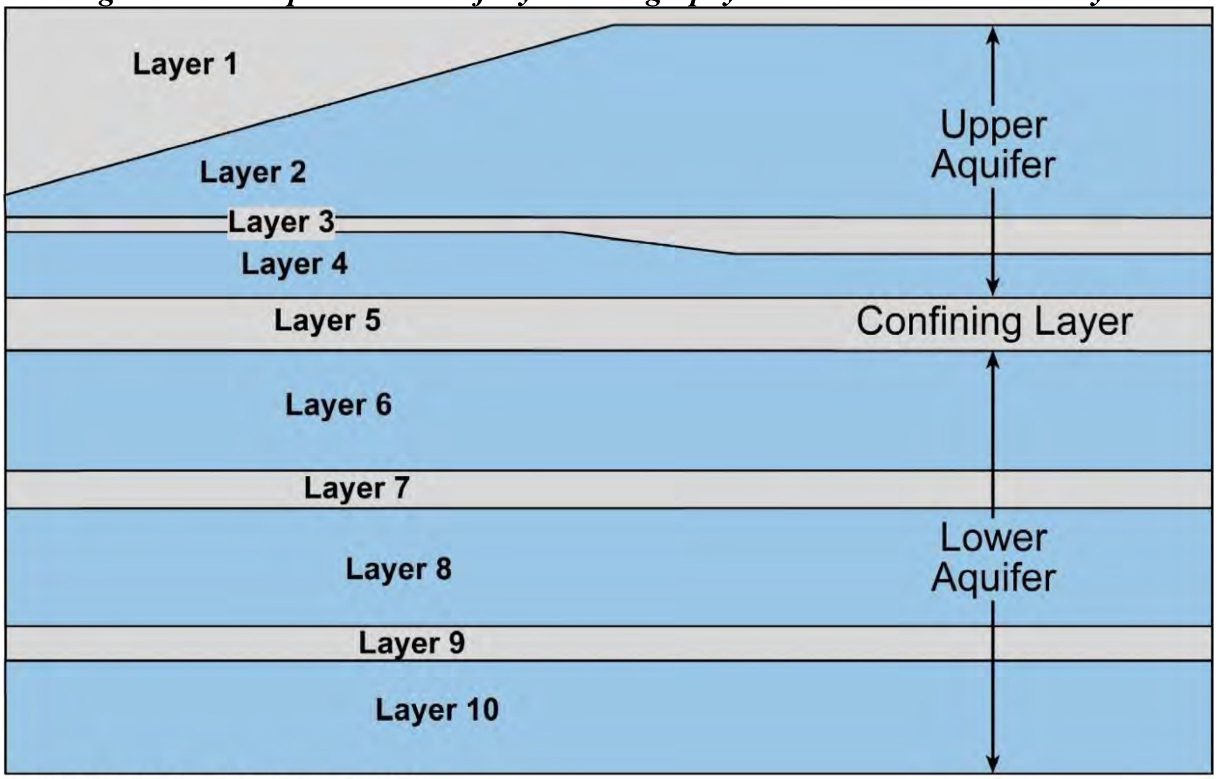
- Layers 7 and 9 – intervening aquitards between the aquifer units in the Lower Aquifer

Figure 2-15: Nodes from DWR Groundwater Model



As described previously, the base of Layer 10 is estimated to be the base of the more permeable water-bearing units and is considered to be the bottom of the basin (**Figure 2-12**). A schematic profile of these model layers is presented in **Figure 2-16**.

Figure 2-16: Representation of Hydrostratigraphy in Groundwater Model Layers



Source: Modified from Hydro Metrics, 2016.

2.3 Groundwater Conditions

2.3.1 Overview

This section characterizes current and historical groundwater conditions in the Livermore Valley Basin. Best available data are used to characterize historical conditions, extending from 1974 to 2015 WY. Subsections address groundwater use, groundwater occurrence and flow, groundwater levels, groundwater in storage, groundwater quality, subsidence issues, and surface water-groundwater interactions.

2.3.2 Groundwater Use

Groundwater in the Livermore Valley Groundwater Basin is used for agricultural, municipal, industrial, domestic and undifferentiated supply purposes. As illustrated in **Figure 2-17**, supply wells are distributed throughout the basin with the greatest densities mostly in the central and southern portions of the basin (i.e., Main Basin). The Main Basin also is the locale of major municipal wells. **Figure 2-17** also shows the distribution of wells with regard to completion in the Upper, Lower, and Deep Aquifer zones.

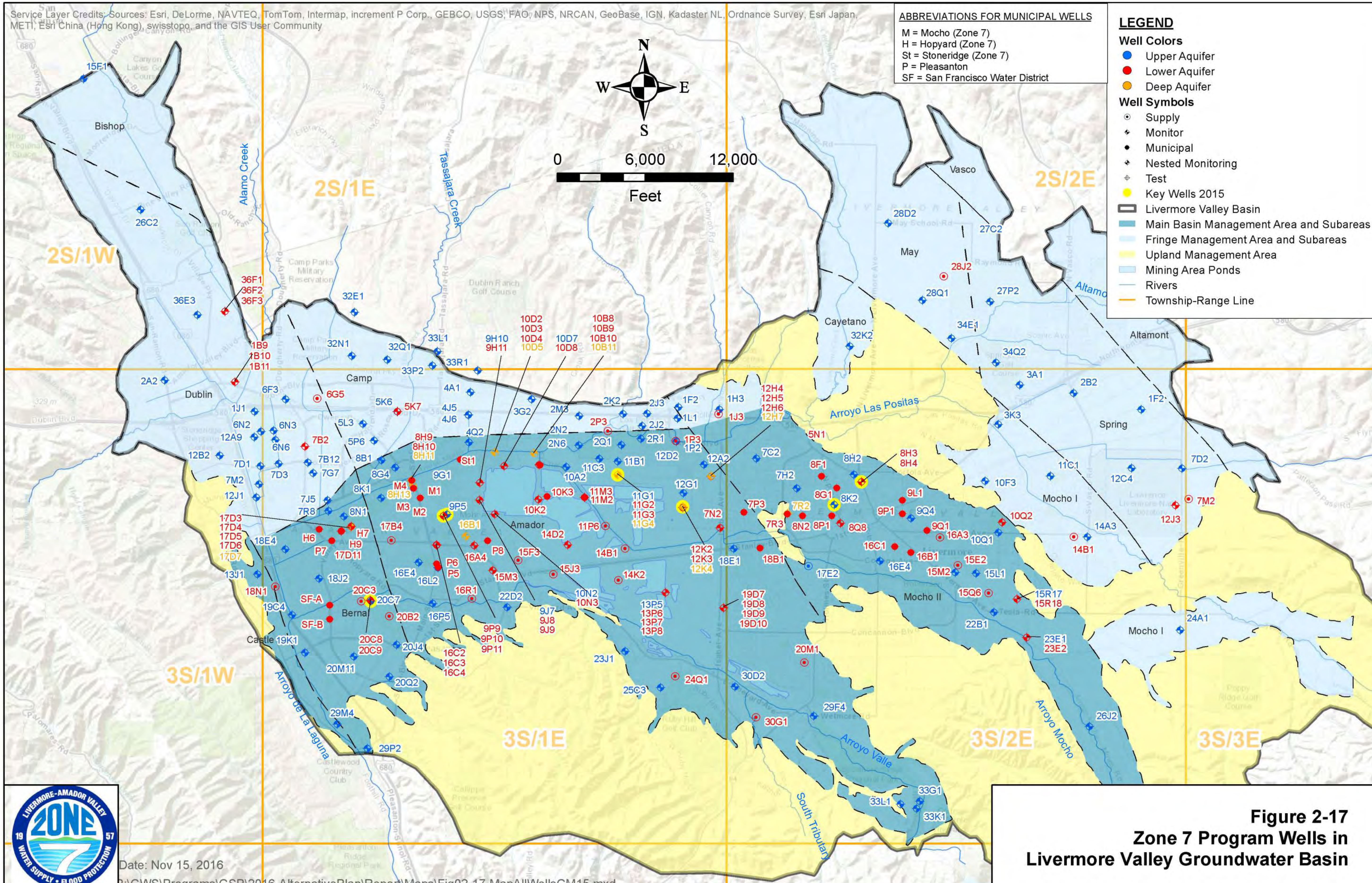


Figure 2-17
Zone 7 Program Wells in Livermore Valley Groundwater Basin

Most pumping currently is for municipal purposes. Municipal pumpers include City of Pleasanton and Cal Water plus the SFPUC and Fairgrounds; DSRSD receives pumped groundwater through Zone 7. In 1992, Zone 7 Water Agency calculated the natural sustainable yield for the basin at 7,214 AFY and collaborated with the Retailers to allocate the yield. As a result, each retailer is limited to an annual independent Groundwater Pumping Quota (GPQ), which is generally based on average historical uses and is pro-rated based on the agreed upon natural sustainable yield. Together, the retailers are permitted to pump a total average of 7,214 AF annually per calendar year without paying recharge fees to Zone 7. Averages are maintained with a process of carry-overs (limited to 20% of the GPQ) and recharge fees for all groundwater pumped exceeding the GPQ and carry-over credit.

Zone 7 regularly monitors groundwater pumping for all large capacity wells; records of other metered pumping wells are obtained when available. Pumping volumes from significant wells without meters are estimated. Groundwater use in 2015 by pumpers other than Zone 7 is listed in **Table 2-2.** The listed average amounts for the municipal pumpers represent the respective GPQ; the remaining averages are estimated.

Table 2-2: Groundwater Pumping by Others

PUMPING BY OTHERS	2015 WY (AF)	AVERAGE (AFY)
Pleasanton	2,775	3,500
Cal Water	2,012	3,070
DSRSD†	645	645
SFPUC	309	450
Fairgrounds	268	310
Domestic Wells**	112	200
Golf Courses**	243	227
Agricultural Pumping**	590	400
TOTAL PUMPING	6,954	8,802

*Average based on annual Groundwater Production Quota
** Estimated
† Pumped by Zone 7 for DSRSD

Zone 7 also pumps groundwater for municipal purposes, accounting for salt management, demand peaks, and any shortage or interruption in its surface water supply or treatment. This is not a portion of the sustainable yield, but represents water that had been stored in the basin as part of the Zone 7 artificial recharge program. Zone 7 pumping for 2015 WY is summarized in **Table 2-3.**

Table 2-3: Zone 7 Groundwater Pumping

ZONE 7 PUMPING BY WELLFIELD	2015 WY (AF)
Amador Subarea	2,252
*Mocho wellfield**	1,228
COL wellfield	390
Stoneridge Well	634
Bernal Subarea	306
Hopyard wellfield	306
TOTAL PUMPING	2,558

* Includes 645 AF of groundwater pumped for DSRSD

A map showing the clusters of municipal wells in the basin is provided on **Figure 2-18**. The map includes Zone 7 wells and production wells operated by SFPUC, the City of Pleasanton, and Cal Water.

Figure 2-18: Map of Municipal Wells

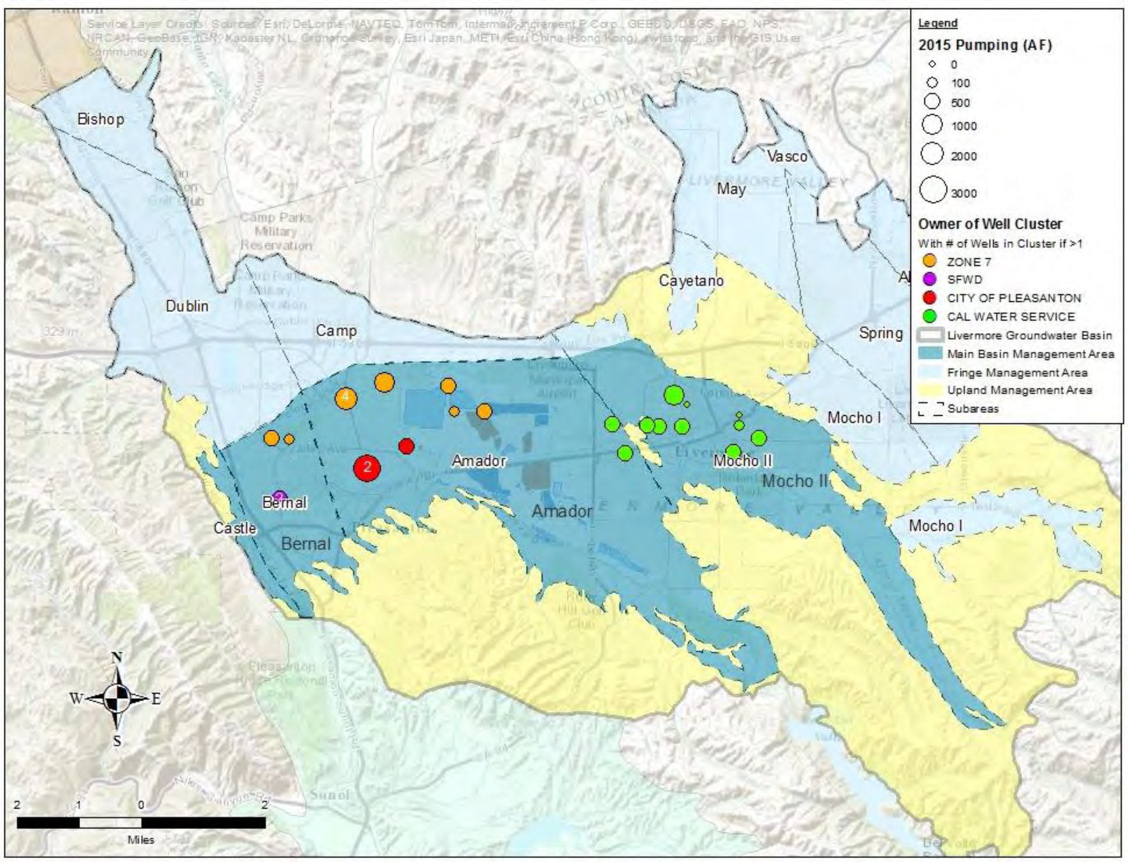
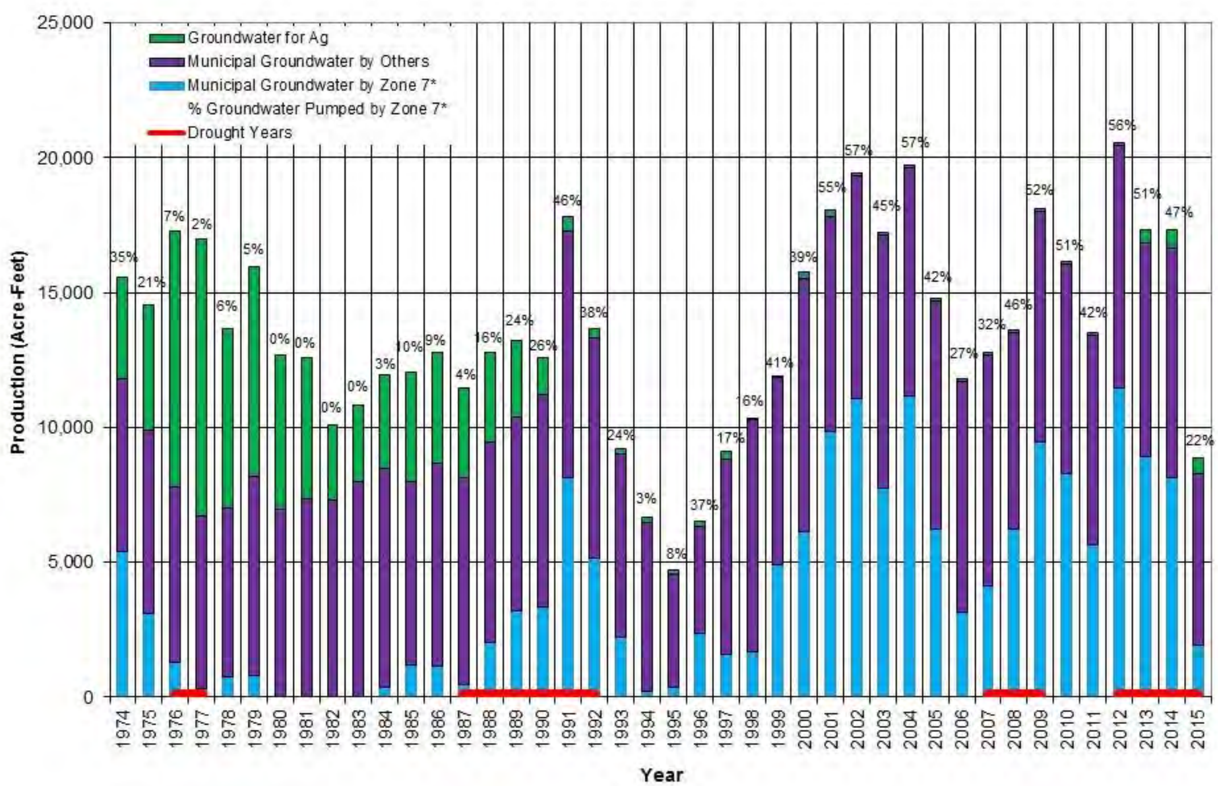


Figure 2-19 illustrates the major uses of groundwater (agricultural, municipal, Zone 7) from 1974 through 2015. As indicated, agricultural uses accounted for a major portion of groundwater use in the late 1970s, but dwindled to a small amount by 1990, mostly reflecting the urbanization in the basin. Urbanization also caused an increasing trend in municipal pumping until 1991.

Thereafter with the 1992 adoption of the GPQ process, groundwater use by municipal pumpers has remained relatively steady.

Figure 2-19: Groundwater Use 1974-2015



Zone 7 municipal pumping has been quite variable since 1974 reflecting Zone 7's broad management role in the basin, including artificial recharge and management of groundwater storage, salt management and compensation for demand peaks, shortages or interruption in surface water deliveries. As previously mentioned, Zone 7 pumping is not part of the sustainable yield, but represents water that had been stored through the Zone 7 artificial recharge program. The portion of total pumping represented by Zone is enumerated for each year; as indicated, Zone 7 pumping has ranged from zero (for example, in the wet years of the early 1980s to more than 50 percent of total pumping. Significant drought years are highlighted, for example from 1987 to 1992 and from 2007 to 2009; the increasing pumping by Zone 7 from year to year in these droughts illustrates how Zone 7 used its stored groundwater to maintain supply. In the latest drought, Zone 7 pumping ranged from 56 percent (2012) to 22 percent (2015); urban demands declined overall in response to voluntary and then mandatory water use restrictions.

While not directly a groundwater ―use", mining activities in the central portion of the basin have caused groundwater losses due to export of moist gravels and groundwater that has been extracted from the quarry pits. Historically, a portion of the extracted groundwater was discharged into a stream without subsequent recharge. The volume of the lost groundwater varied over time depending on the stage of mining in any given pit and the demand for aggregate resources (**Section 2.4.2.3**).

Groundwater pumping in the Fringe and Uplands Management Areas is minor relative to the Main Basin. Groundwater uses in the Fringe Management Area is primarily for agricultural, domestic, and golf course irrigation. In the Uplands Management Area groundwater is primarily used for domestic supply with minor pumping for agricultural uses. Estimated groundwater pumping in the Fringe and Uplands Management Areas for an average water year is summarized in **Table 2-4**.

Table 2-4: Estimated Groundwater Pumping in the Fringe and Uplands Management Areas in an Average WY

PUMPING BY OTHERS	FRINGE (AF)	UPLANDS (AF)
Domestic Wells	126	192
Golf Courses	392	0
Agricultural Pumping	210	25
TOTAL PUMPING	**728**	**217**

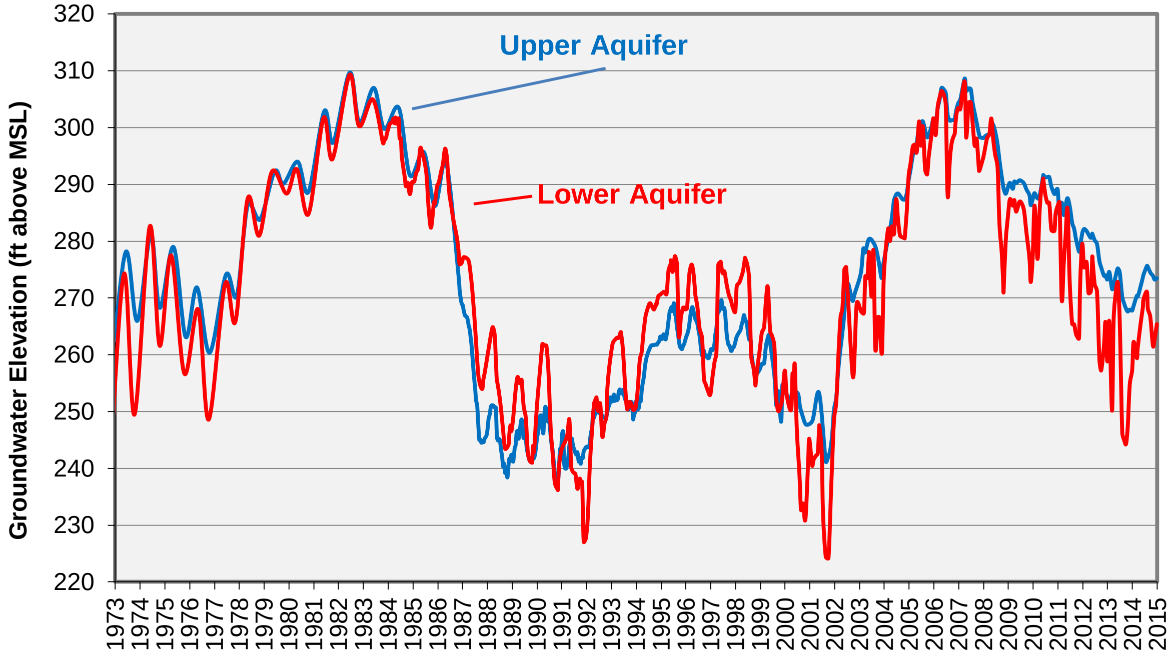
2.3.3 Groundwater Occurrence and Flow

The geologic setting of the Livermore Valley Basin comprises a complex stratigraphy of fluvial channels, floodplain deposits, and regionally extensive lacustrine deposits. For management purposes, these have been organized into an Upper Aquifer System consisting primarily of sandy gravels underlain by a relatively continuous, silty clay aquitard and a Lower Aquifer System that includes aquifers below the aquitard. Groundwater is generally unconfined in the Upper Aquifer Zone and semi-confined to confined in the Lower Aquifer Zone.

Groundwater flow generally is from the Fringe Management Areas (which contain only Upper Aquifer) toward the Main Basin. Most of the subsurface inflow occurs across the northern boundaries of the Main Basin—in particular the Dublin and western Camp Subareas—and flows in a southerly direction. Within the Main Basin, groundwater in both aquifer zones generally follows a westerly flow pattern, mirroring the surface water streams, along the structural central axis of the valley toward municipal pumping centers.

Figure 2-20 is a hydrograph illustrating the overall trend and seasonal fluctuations of water levels over the last 43 years in the basin. This well is located in the western portion of the Main Basin where conditions in the Lower Aquifer are likely more confined compared to the eastern Main Basin. Also, groundwater is consistently pumped in this area of the basin. Therefore, the largest differences in water levels between the Upper Aquifer and the Lower Aquifer are best represented by this hydrograph.

Figure 2-20: Key Well Water Levels in Amador West Subarea (1973 to 2015)



As shown in the figure, the overall trends and fluctuations are quite similar in both the Upper and Lower Aquifer systems. In general, seasonal fluctuations are slightly larger in the Lower Aquifer where most of the pumping occurs. Water levels in the Lower Aquifer can fall as much as 10 to 20 ft lower than levels in the Upper Aquifer during the high demand summer pumping season (e.g., 1973, 1976, 1991, 2001, and 2013). Water levels are closer during winter seasons and overall wet periods (e.g., 1978-1986). Data typically indicate a downward vertical gradient, although water levels in the Lower Aquifer rose higher than those in the Upper Aquifer during the wet seasons of the mid- to late-1990s, corresponding to a time of lower amounts of pumping.

2.3.4 Groundwater Levels

2.3.4.1 General Trends

As described in detail in **Section 4**, Zone 7 Water Agency has a long-standing and extensive program of groundwater level monitoring throughout the Livermore Valley Groundwater Basin. Currently 241 wells are included in the program. **Figure 2-21** shows hydrographs for the period 1974 to present from fourteen selected wells from the Fringe and Main Basin Management Areas; an inset map shows the well locations.

Along the top of **Figure 2-21,** six wells represent groundwater level trends in the northern Fringe Subareas: Dublin, Bishop, Camp, May, Cayetano, and Spring. In addition, at lower right, one well represents conditions in the Mocho I Fringe Subarea. At lower left, one well shows groundwater levels for the Castle Subarea. All of these represent conditions in the Upper Aquifer (given that the Lower Aquifer generally is not present in these subareas). With the exception of a slight decrease in the May Subarea well, groundwater levels in these wells generally are steady and groundwater variations (both seasonal and long-term) are less than 20 ft. This generally reflects the relatively thin basin sediments in the Fringe Subareas and lack of groundwater use. Seasonal peaks in the Castle Subarea well may reflect seasonal pumping variations in the Main Basin.

In **Figure 2-21**, seven selected wells represent groundwater level trends in the Main Basin, including Mocho II, Amador East and West (i.e., on either side of the mining area), and Bernal Subareas. Of these, six wells are designated Key Wells; these are shown along with a yellow line indicating the elevation of the bottom of operational storage at that locale. Of the Main Basin wells on **Figure 2-21**, three show groundwater levels only in the Upper Aquifer (blue line) and two show groundwater levels only in the Lower Aquifer (red line). Two additional wells provide information on both aquifer zones.

Review of the Main Basin hydrographs indicates clear seasonal variations, typically less than 20 ft. The two easternmost key wells (Mocho II) show seasonal variations (more pronounced in the Lower Aquifer) and response to drought (for example between about 1986 and 1992). Nonetheless, the overall trend is steady. Hydrographs for wells in the central and western Main Basin also indicate more pronounced seasonal variations in Lower Aquifer zones relative to the Upper Aquifer. Most significantly, these hydrographs show longer-term variations spanning 60 to even 100 vertical feet and extending over decades with troughs generally occurring about 1992, 2002, and 2014. These broad groundwater level changes reflect active management of groundwater storage in the Livermore Valley Groundwater Basin, whereby available surface water is stored during wet periods and then utilized during drought.

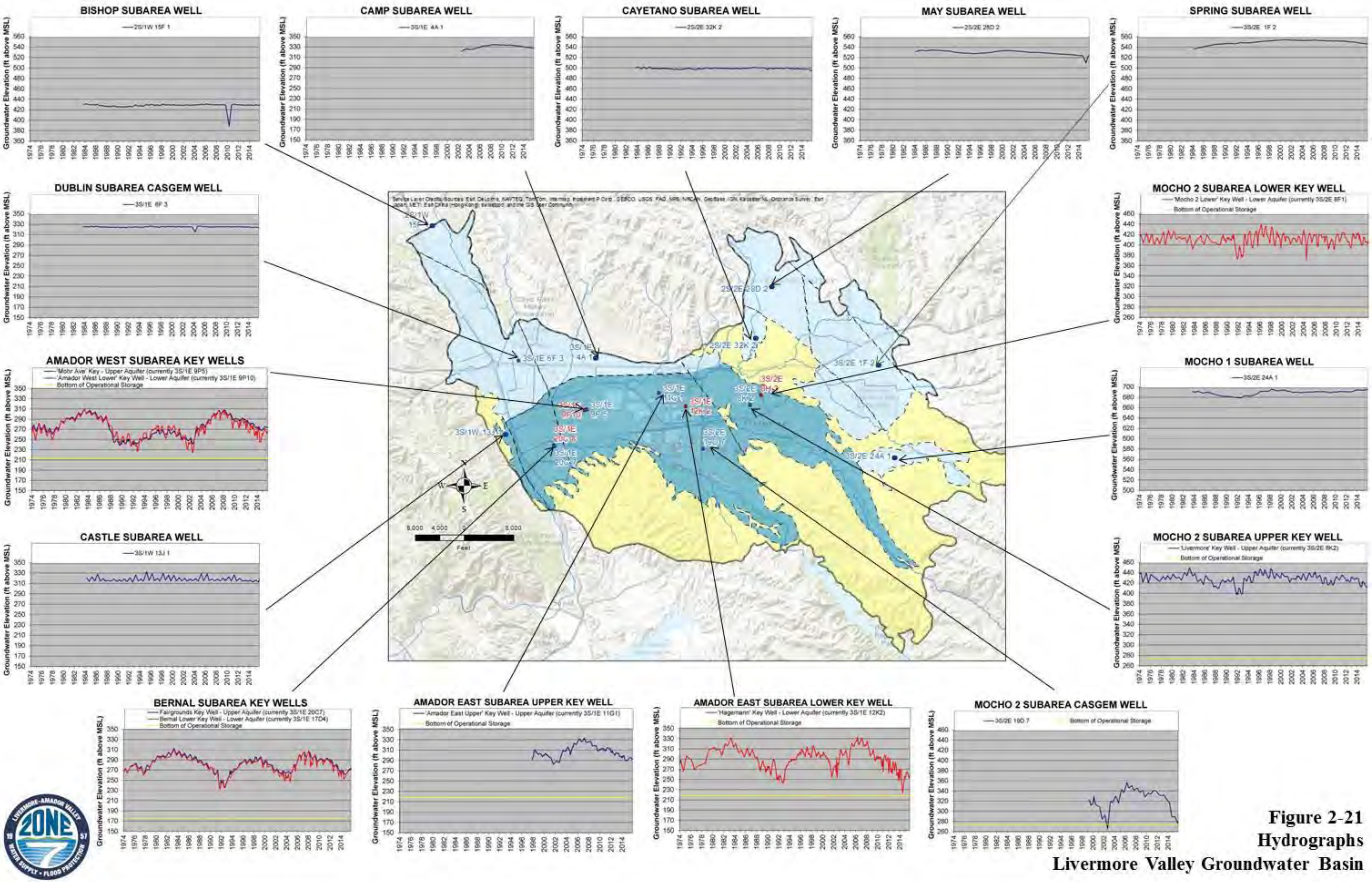


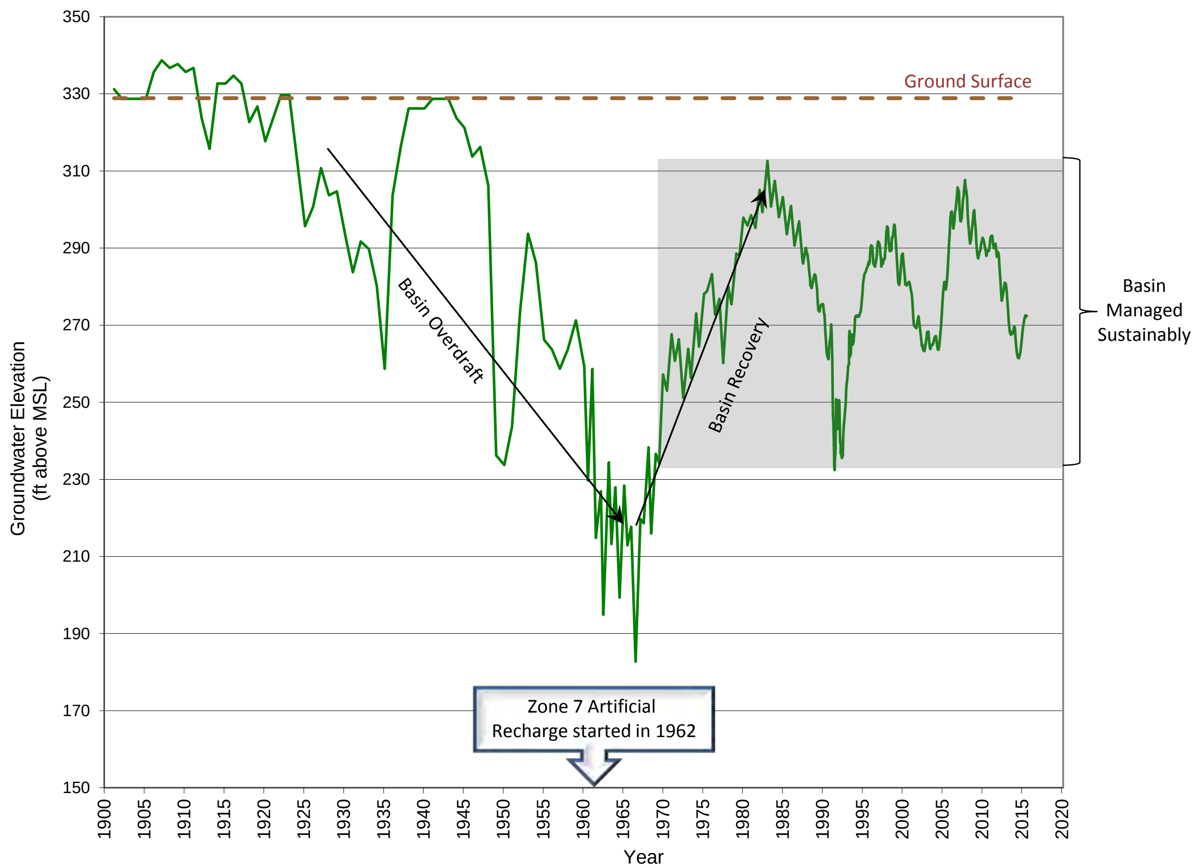
Figure 2-21
Hydrographs
Livermore Valley Groundwater Basin

2.3.4.2 Historical Groundwater Levels

Figure 2-22 shows historical groundwater levels at the Fairgrounds Key Well (in the westernmost Main Basin) from 1900 to present and demonstrates the long term sustainable management of the Livermore Valley Groundwater Basin.

Prior to groundwater development, much of the Main Basin experienced artesian conditions, as indicated by groundwater levels above the ground surface. In the late 1800s, the pre-development groundwater levels and hydraulic gradients caused groundwater to flow from east to west across the basin and naturally exit the basin as surface outflow (baseflow) into the Arroyo de la Laguna. In the early and mid-1900s, groundwater began to be extracted in appreciable quantities, causing groundwater levels to drop throughout the basin. As a result, groundwater levels dropped below the point (about 295 ft msl) where groundwater would naturally flow into the Arroyo de la Laguna, and continued to drop significantly during the 1940s and 1950s.

Figure 2-22: Groundwater Basin Management: Historical Groundwater Elevations at Fairgrounds Key Well



Zone 7 was established in 1957 partially to address the water supply overdraft. The downward trend in groundwater elevation began to reverse in 1962 when Zone 7 began importing water from the State Water Project (SWP) and later in the 1960s when Zone 7 began capturing and storing local runoff in Lake Del Valle. The first imports were diverted to an off-stream recharge facility called Las Positas Pit. This facility was operated from 1962 until the late 1970s and again, briefly, in the 1980s. Since that time, the Zone 7 program of capturing and storing water has been expanded throughout the Main Basin.

Thus, after experiencing historical groundwater lows in the 1960s, Main Basin water levels stabilized in the late 1960s and started to rise in the early 1970s with the advent of regional groundwater management programs. Following a ‗very critical dry' year in 1977, groundwater levels continued to recover and peaked in 1983, which is considered to be the modern maximum (―basin full") limit.

Since 1983, water levels have been drawn down three separate times in response to times of limited water importation from the SWP, but have not reached previous historic low levels (see **Figure 2-22** of the Fairgrounds Key Well). As shown on the hydrograph, groundwater levels subsequently recovered following the dry cycles in the early 1990s and the early 2000s as a result of Zone 7's managed aquifer recharge operations and a corresponding reduction in groundwater production. The recent severe drought cycle of 2012-2015 resulted in a lowering of basin-wide water levels, but levels remained above the drought cycle of the early 1990s and significantly above historic lows (**Section 2.3.4.3**). These water level data are consistent with sustainable groundwater management practices since at least the early 1970s.

2.3.4.3 Map of Historic Low Water Levels

In order to provide a performance benchmark for maintaining sustainable water levels in the basin, Zone 7 has prepared a contour map representing historic low groundwater elevations in the basin. This *Historic Lows* map, presented in **Figure 2-23**, represents a compilation of historic recorded low groundwater elevations in various wells in the basin. Data used to create the composite contours are typically from the 1960s, 1977, or 1987-1992 drought periods. The historic low values are a function of both data availability and some variability in water levels during drought cycles. Although the 1960s generally represented the lowest water levels across the region, wells added to the monitoring program after the 1960s were used to provide more detailed information in areas of limited data or areas with a lack of historical pumping. By including historic lows for numerous generations of wells in the region, the map represents a more conservative benchmark and provides for adaptive management in the future.

This map represents a groundwater management tool used by Zone 7 to guide management actions in the basin. On an annual basis, low water levels in each year are compared to these values to ensure that the basin is being operated in a sustainable manner and to identify areas to focus management actions. Such actions have included redistribution of pumping among wells, and focused conjunctive use, among others. Using terms defined in SGMA, this map has functioned as a minimum threshold for the water level sustainability indicator, as discussed in more detail in **Section 3**.

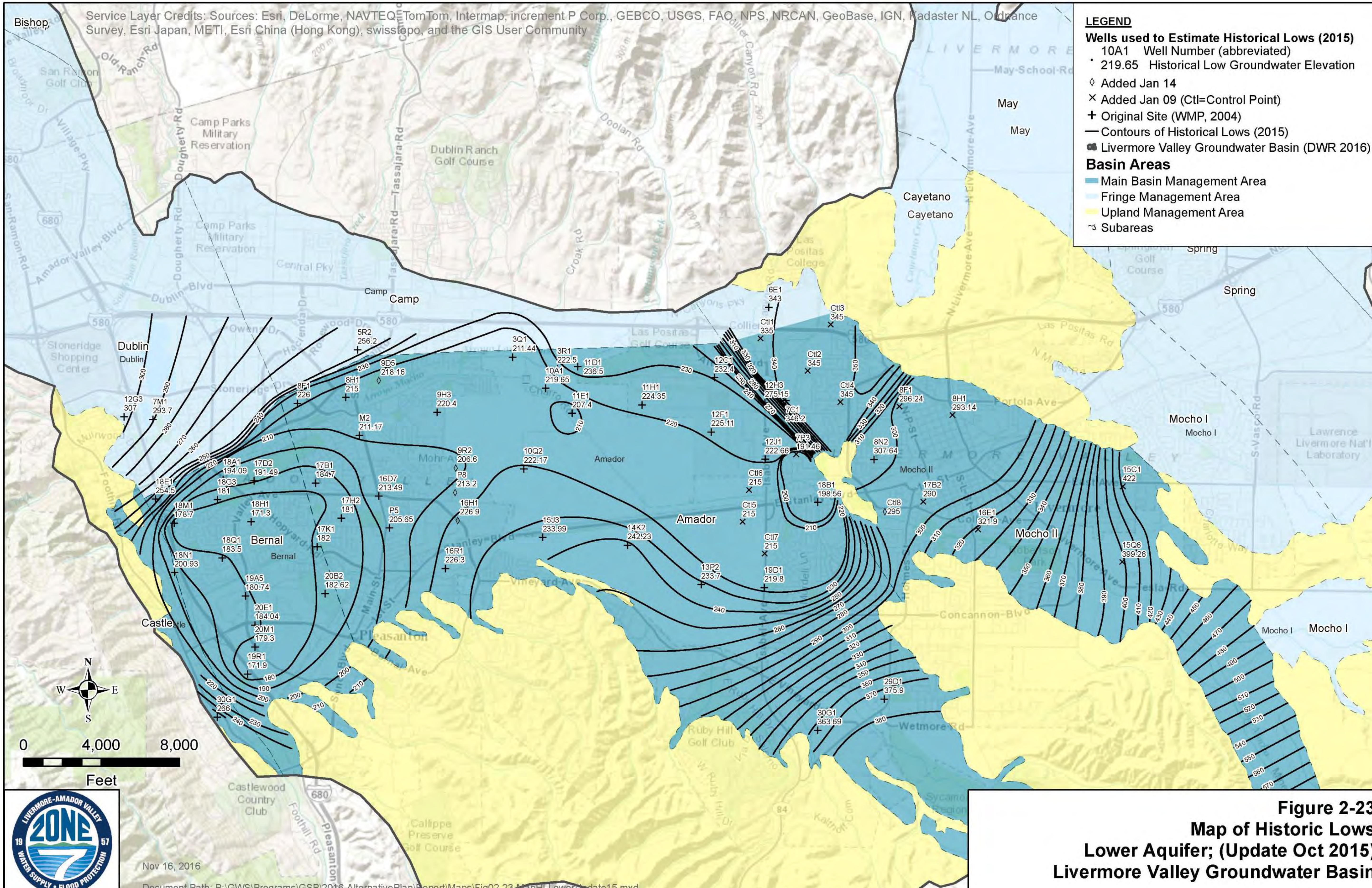


Figure 2-23
Map of Historic Lows
Lower Aquifer; (Update Oct 2015)
Livermore Valley Groundwater Basin

The Historic Lows map was first created in 2005 for the Zone 7 Well Master Plan (WMP, *Zone 7, 2003*) Environmental Impact Report (EIR, *Zone 7, 2005b*) to help define possible mitigation measures for the potential risk for groundwater pumping-induced subsidence. As a conservative measure, when groundwater levels approach the “historic low” in a localized area, Zone 7 takes steps to reduce pumping from the closest Zone 7 well(s) and redistribute the pumping to areas with higher groundwater elevations. Zone 7 uses static water levels from local monitoring wells rather than pumping level data to evaluate the height above the historic lows. Although there has been no documented subsidence in the valley, the Historic Lows map has served as a useful groundwater management tool and is being incorporated into this Alternative Plan as a sustainability indicator (explained in **Section 3.3.1**).

The historic low surface used in the Zone 7 WMP EIR was revised in 2009 and converted to a surface grid (i.e., *ArcGIS* raster image) for comparison with end-of-water-year elevations and for spatial analyses. The surface was modified again slightly in January 2014 and October 2015 as additional information became available. See **Section 2.3.6** for a discussion of the 2015 WY groundwater elevations relative to the historic low surface.

Groundwater storage beneath the historic low surface has been estimated to be about 128,000 AF and is considered emergency reserves. The “basin-full” mark (recorded in the 1983 WY) corresponds to a total storage volume of about 254,000 AF. The range from historical low to basin-full provides an operational storage of about 126,000 AF. “Operational Storage” is discussed more in **Section 2.3.7**.

2.3.4.4 Current Groundwater Levels

As is usually the case, the 2015 WY groundwater levels varied with seasonal recharge and extraction. Typically in the Livermore Valley, the highest groundwater levels occur at the end of the rainy season and the lowest occur at the end of the high demand summer/fall seasons. In general, for the first half of the 2015 WY, groundwater elevations rose due to rainfall recharge and subsequent reduced water pumping. During the second half of the water year, water elevations leveled off and then dropped as rainfall decreased and water demand increased. For the 2015 WY, water levels generally ended higher than they were at the end of the 2014 WY.

Key Well water levels in the Bernal and Amador Subareas (from which Zone 7 pumps) ended the year approximately 4 to 15 ft above those observed at the end of the 2014 WY (see **Table 2-5** below). Lower aquifer Key Wells in these subareas had water levels that were 24 to 95 ft above historic lows at the end of the 2015 WY (compared to 5 to 93 ft above historic lows at the end of the 2014 WY).

Table 2-5: Change in Groundwater Elevation in Key Wells from Fall 2014 to Fall 2015

Subarea	Upper Aquifer (ft)	Lower Aquifer (ft)
Bernal	Up 10.7	Up 14.6
Amador West	Up 6.3	Up 14.3
Amador East	Up 4.2	Up 18
Mocho II	Down 1.2	Up 4.9

Key Well water levels in Mocho II Subarea dropped one foot in the upper aquifer and rose 5 ft in the lower aquifer during the 2015 WY. The water elevation in the Mocho II lower aquifer Key Well was 130 ft above historic lows at the end of the 2015 WY.

The 2015 WY Annual Report contains a tabulation of spring (collected in May 2015) and fall (collected in September and October 2015) groundwater elevations for all program wells and includes a comparison with water levels of the previous fall. The Annual Report also shows long-term hydrographs for each of the eight Key Wells and graphs of groundwater elevations in the Key Wells along with Main Basin inflow/outflow components over the last two years.

2.3.5 Upper Aquifer Elevations

Figures 2-24 and **2-25** show groundwater elevations in the Upper Aquifer for the Spring 2015 WY (measured in May 2015) and Fall 2015 WY (measured in September and October 2015) water level measurement events, respectively. Both of these figures include water levels from mining area ponds, located in the central and southern Amador Subarea, most of which are believed to be connected with the Upper Aquifer. The figures differentiate groundwater mounds (shown in dark blue) or depressions (shown in light blue), where mining companies are actively pumping into or pumping from some of these ponds, respectively..

During the 2015 WY, the groundwater gradient in the Upper Aquifer was generally from east to west towards the Bernal Subarea, then to the south where groundwater flows out of the Main Basin. The gradient in the upper aquifer generally ranged from 0.005 to 0.025 with isolated areas of flatter or steeper gradients, especially near subarea boundaries. These are the same gradient conditions observed during previous years. Upper Aquifer water levels in the entire Main Basin (Bernal, Amador, and Mocho II Subareas) rose up to 20 ft from Fall 2014 to Fall 2015 because of the near-average rainfall recharge and minimal municipal pumping volumes during the water year.

For the entire water year, water levels in wells near the Arroyo De La Laguna in the southwestern portion of the Bernal Subarea (as indicated primarily by the Bernal Upper Key Well, 3S/1E 20C 7, and Well 3S/1E 29M 4) remained below the elevation at which basin overflow occurs (approximately 295 ft above msl). Consequently, there was no basin overflow from the Upper Aquifer into the Arroyo De La Laguna during the 2015 WY.

Groundwater levels in the Fringe Management Areas (which only have an upper aquifer) stayed relatively constant throughout the 2015 WY, varying by less than about 5 feet. The groundwater gradients in the northwestern Fringe Management Area (Bishop, Dublin, and Camp Subareas) ranged from 0.002 to 0.02 generally southward towards the Main Basin. The groundwater gradients in the northeastern Fringe Management Area (Cayetano, May, Altamont, Spring, and a portion of the Mocho I Subareas) ranged from 0.001 to 0.004 generally westward towards the Main Basin or gaining streams in the northwestern portion of the basin (Altamont Creek and Cayetano Creek). The groundwater gradient in the eastern Fringe Management Area was about 0.006 westward towards the Main Basin.

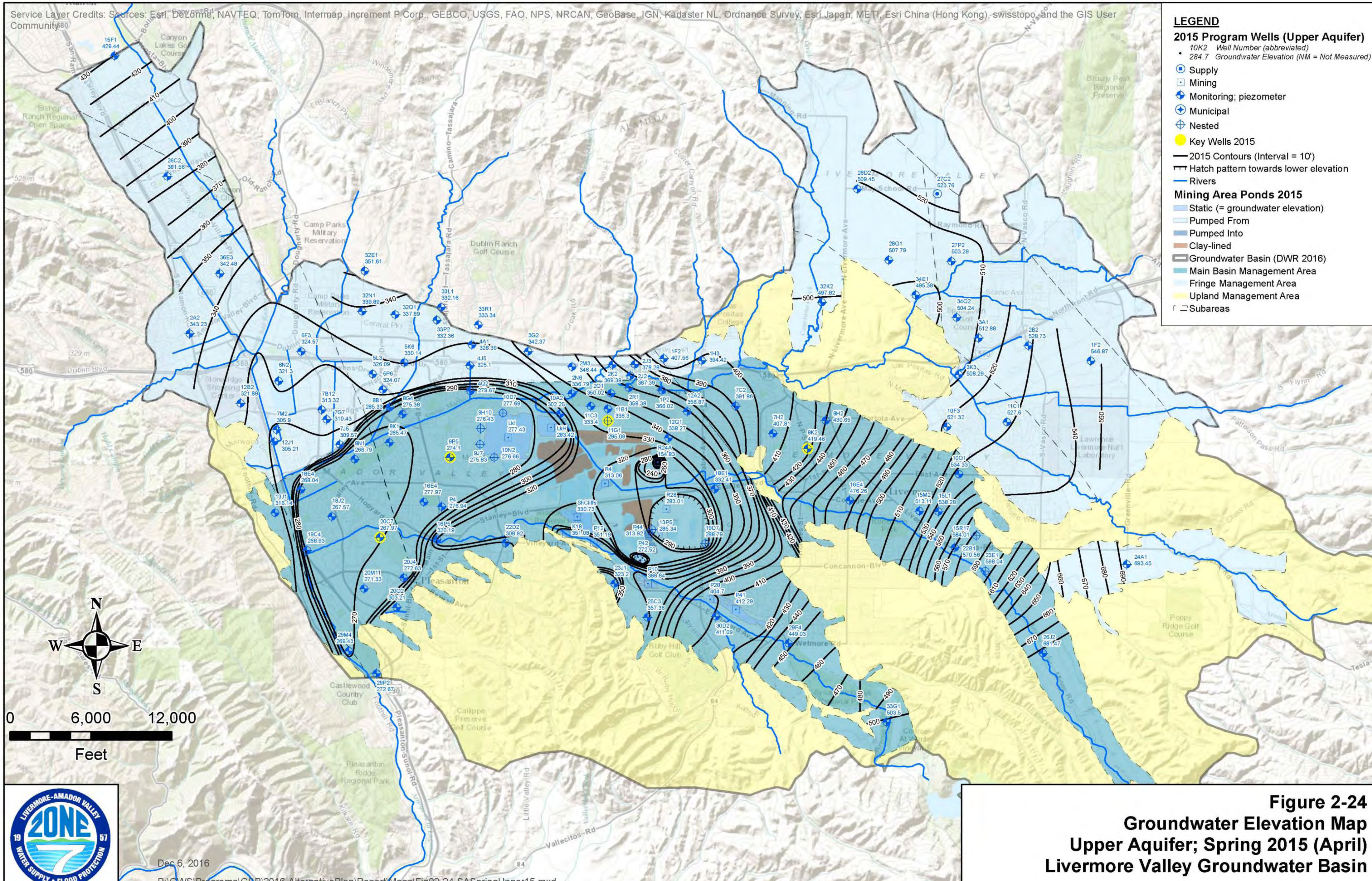


Figure 2-24
Groundwater Elevation Map
Upper Aquifer; Spring 2015 (April)
Livermore Valley Groundwater Basin

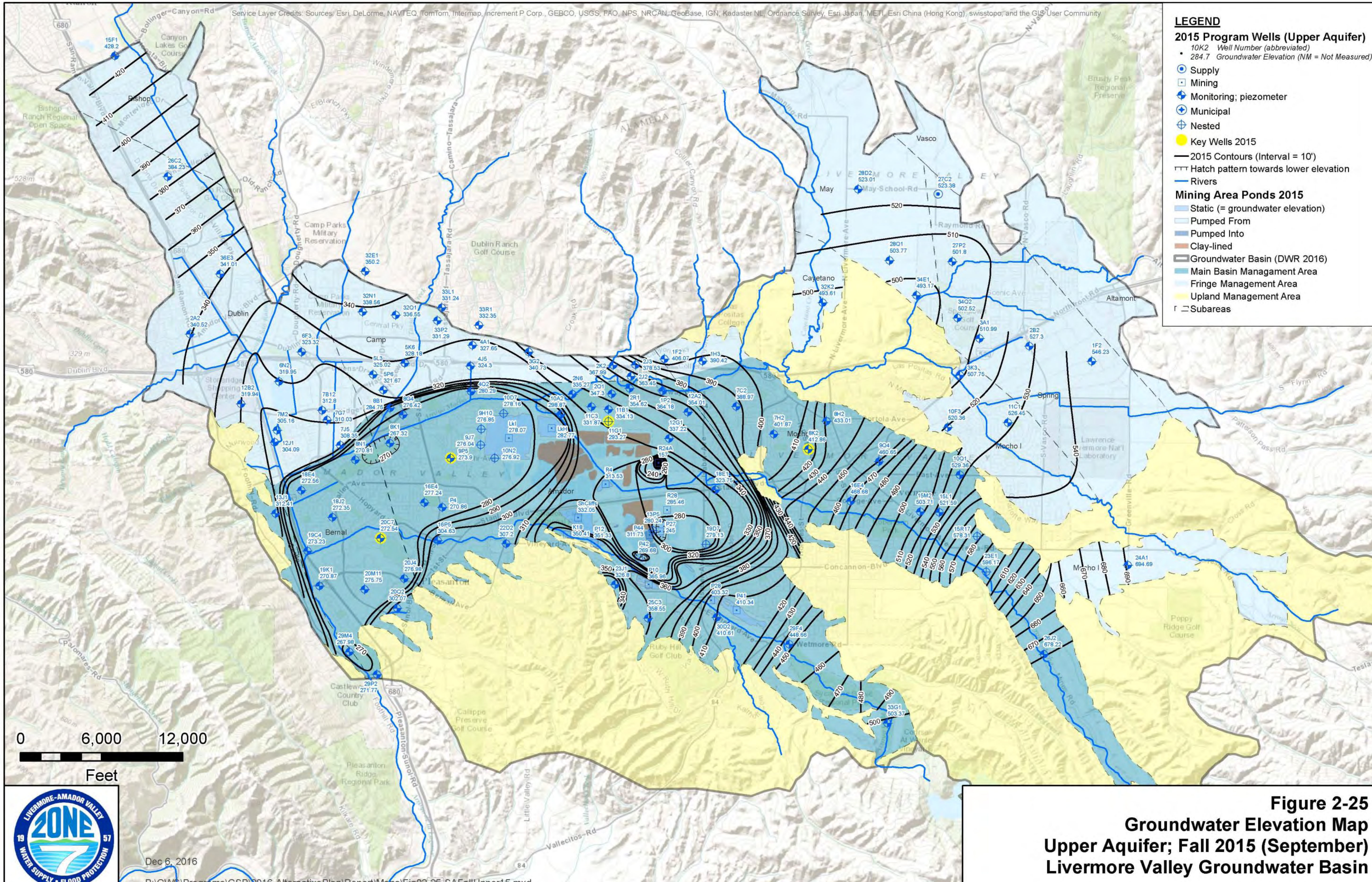


Figure 2-25
Groundwater Elevation Map
Upper Aquifer; Fall 2015 (September)
Livermore Valley Groundwater Basin

Figure 2-26 shows depths to the water table across the groundwater basin, based on a comparison of the Spring 2015 Upper Aquifer Groundwater Elevation map and the 2014 Lidar map of the ground surface. Areas of greatest depth to groundwater occur along the higher-topography fringes of the basin and in the central and western portions of the Main Basin, where groundwater levels are lower due to pumping and the presence of mining pits that reduce the depth to groundwater or expose groundwater. Relatively narrow bands of shallow groundwater occur along the major streams. In the case of Arroyo Valle, these reflect managed aquifer recharge and the presence of mining pits.

Major areas of shallow groundwater overlie Fringe Subareas where alluvial sediments are relatively thin and groundwater use is limited. In the northwest (Dublin and Camp Subareas), the area is predominantly urbanized (see **Figure 1-7**) and streams channels have been modified significantly for flood control purposes. The northeast (Altamont, Spring, Cayetano) is characterized by urban land uses and open space, most notably the Springtown Alkali Sink (see **Section 2.1.4**). Southeastern portions (Mocho I) are characterized by extensive vineyards.

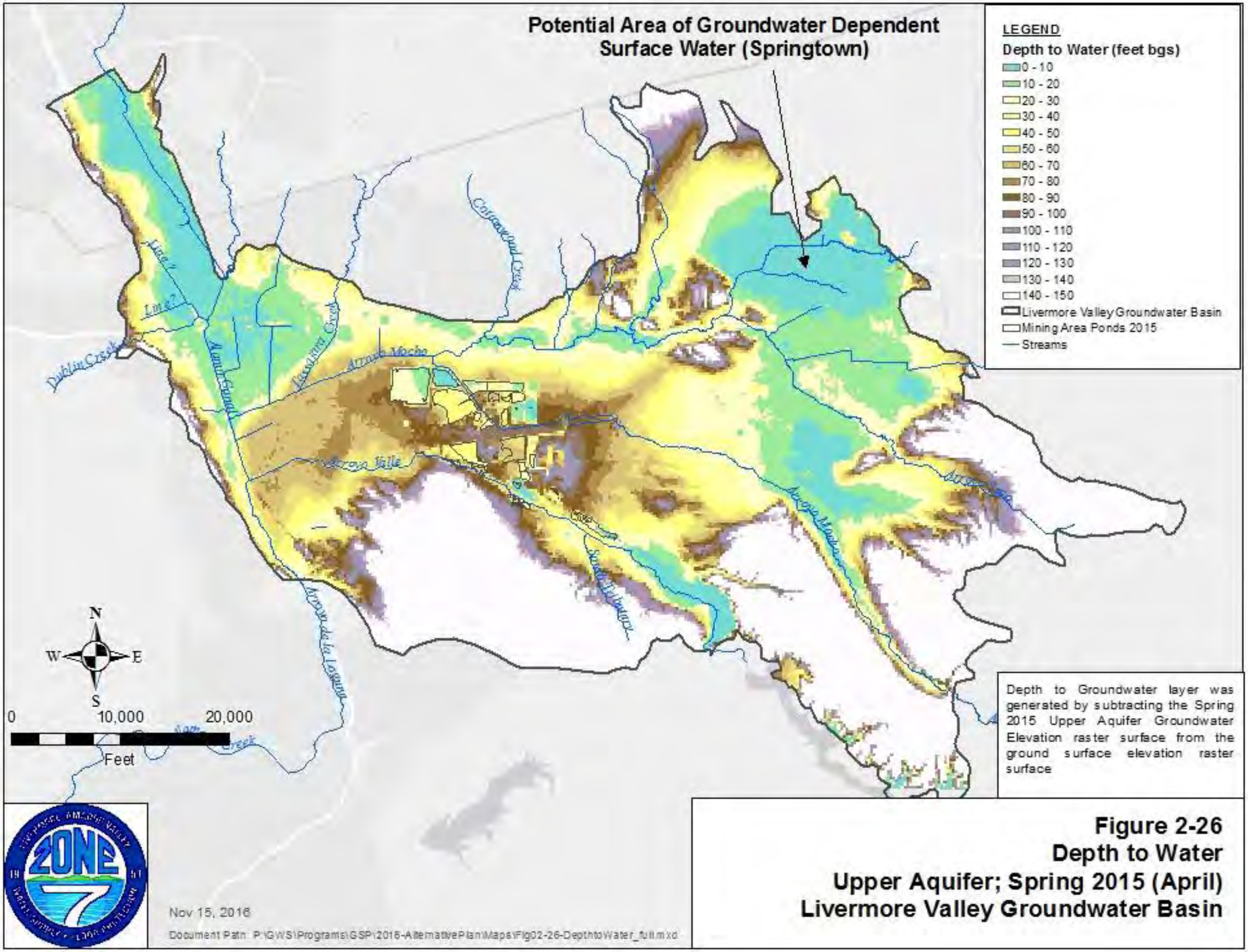


Figure 2-26
Depth to Water
Upper Aquifer; Spring 2015 (April)
Livermore Valley Groundwater Basin

2.3.6 Lower Aquifer Elevations

Figures 2-27 and **2-28** show groundwater elevations in the Lower aquifer of the Main Basin for Spring (measured in May 2015) and Fall (measured in September and October 2015) of the 2015 WY, respectively. These maps show piezometric depressions around several municipal or domestic wells that were pumping around the time of the Spring and Fall measurements. There is also a depression in the northern portion of the Amador Subarea that may be related to mining operations just to the south (**Figure 2-28**). The groundwater gradient within the Mocho II and Amador Subareas in the Lower Aquifer ranged from 0.001 to 0.05 with groundwater flowing generally westward along the longitudinal axis of the valley. In the Bernal Subarea, the gradient (typically less than 0.01) was slightly to the north and east towards the Hopyard and Mocho Wellfields. As is usually the case, the lowest elevations corresponded to the municipal pumping wellfields in those subareas (**Figure 2-28**).

As indicated by the relatively high gradients (water level contours very close together) on both **Figures 2-27** and **2-28**, two major subsurface structural features act as partial barriers to the lateral movement of groundwater in the Lower Aquifer. These features define the boundaries between the Mocho II and Amador Subareas, and between the Dublin/Camp Subareas in the Fringe Management Area and the adjacent Main Basin. Groundwater levels are significantly higher on the up-gradient sides of these partial barriers, but it is believed that groundwater cascades across these linear features providing some subsurface recharge for the downgradient subareas.

During the 2015 WY:

1. Groundwater elevations generally rose (up to 34 ft) across the Main Basin from Fall 2014 to Fall 2015;

2. Groundwater elevations in the Mocho II Subarea were about 90 to150 ft higher than those to the west, across the Livermore Fault in the Amador Subarea;

3. Groundwater elevations in the Dublin/Camp/Bishop Fringe Subareas were 40 to 60 ft higher than those across the Main Basin Boundary to the south.

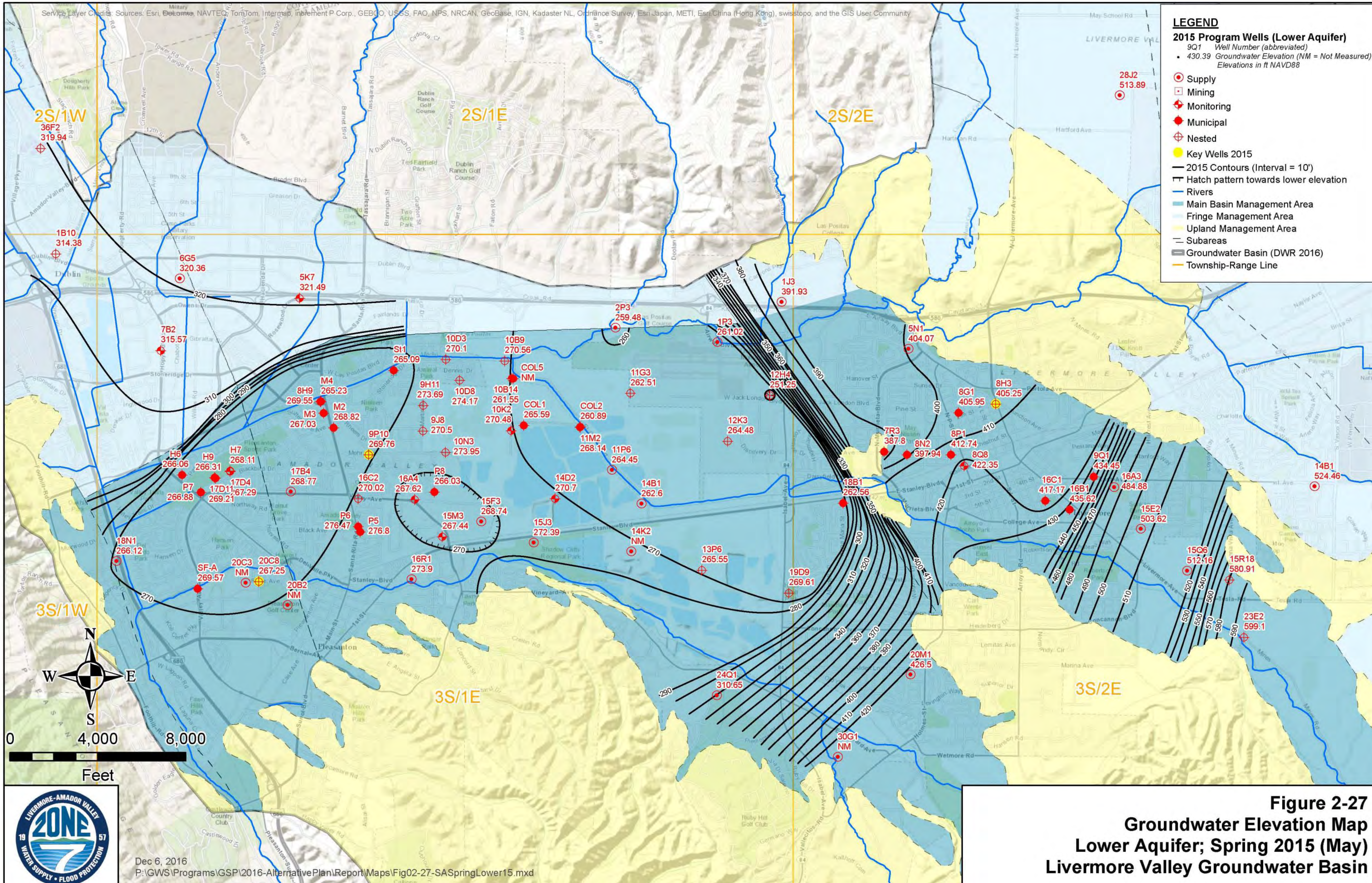


Figure 2-27
Groundwater Elevation Map
Lower Aquifer; Spring 2015 (May)
Livermore Valley Groundwater Basin

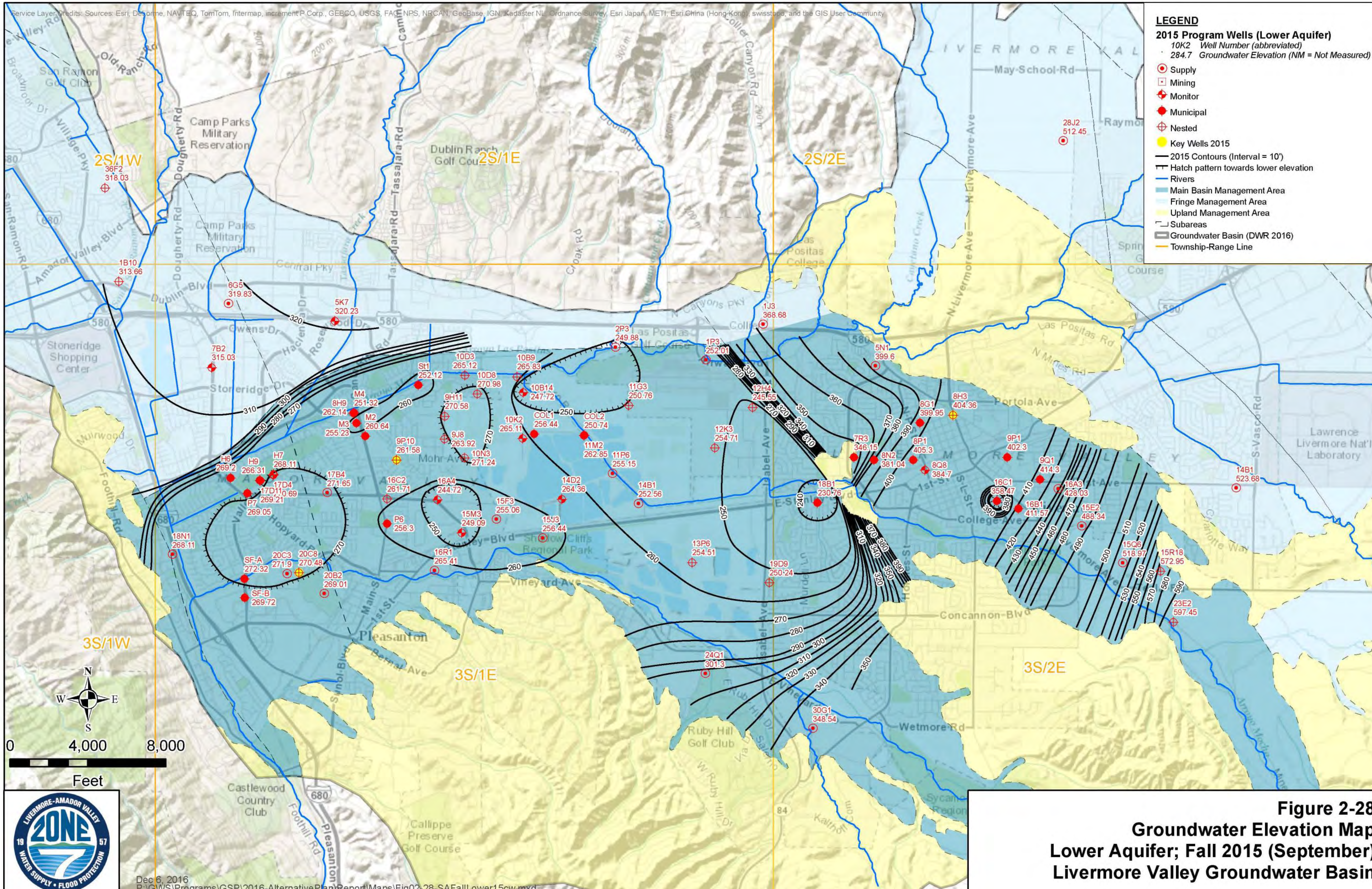
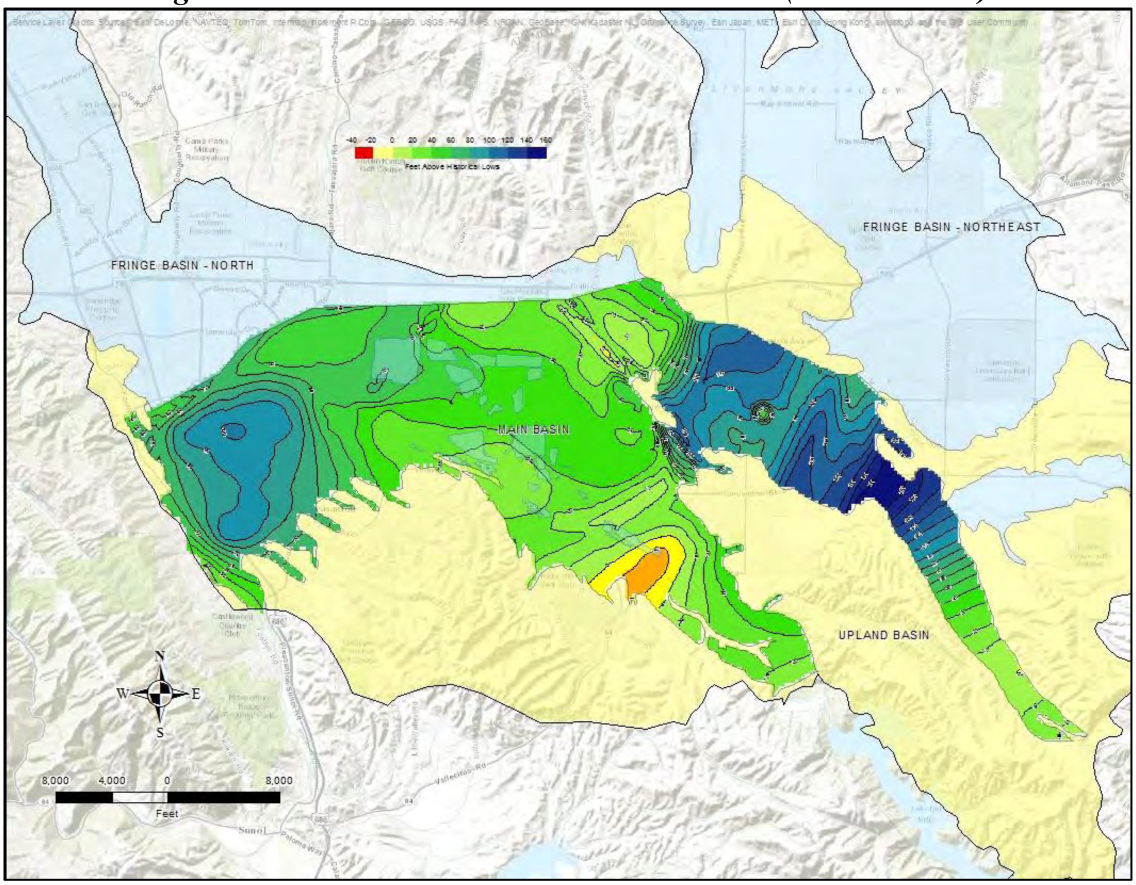


Figure 2-28
Groundwater Elevation Map
Lower Aquifer; Fall 2015 (September)
Livermore Valley Groundwater Basin

One key management tool is the annual comparison of low water levels in each water year to the historic lows that have been recorded in the basin (see **Figure 2-23**). For 2015 WY, this analysis evaluated the difference between groundwater elevations measured in the Lower Aquifer in Fall 2015 (**Figure 2-28**) and historic lows as defined basin-wide on **Figure 2-23**. A map showing this comparison is presented in **Figure 2-29.** Using GIS techniques, water levels above historic lows are represented in greens and blues and water levels below historic lows are shown in yellow and orange.

Figure 2-29: Water Levels above Historic Lows (Fall 2015 WY)



As indicated on **Figure 2-29**, groundwater levels in Fall 2015 were above historic lows throughout almost all of the Main Basin. In the vicinity of Zone 7 municipal wells in the western-central basin, (northern portion of the Bernal and Amador Subareas), water levels were 40 to 86 ft above historic lows at the end of the water year. Further to the southwest, in the central and southern portions of the Bernal Subarea, water levels remain at greater than 89 ft above historic lows, due to low volumes of pumping. Only SFPUC is using this part of the Bernal Subarea for municipal supply (supplying irrigation water to the Castlewood Country Club development).

Water levels in the central portion of the Main Basin (City of Pleasanton wells) ended the water year at least 20 ft above historic lows. This portion of the Amador Subarea also has influences from Zone 7's Chain of Lakes wells, when in use, and the quarry operations. Quarry operations pump groundwater from the mining pits as gravel is extracted and a certain amount of groundwater is lost to evaporation from the open pits. Zone 7 estimates the losses and has an agreement in place with Vulcan Materials to pipe the water extracted during mining into one of the pits owned and operated by Zone 7 for recharge back into the groundwater basin. This minimizes the overall loss of groundwater due to mining activities for this portion of the Amador Subarea and aids in water budget accounting. In the central portion of the Mocho II Subarea, where most of the CalWater wells are located, the Fall 2015 groundwater levels were 45 to over 120 ft above historic lows.

In fact, **Figure 2-29** shows that the Fall 2015 water levels were above historic lows in all areas of the basin with the exception of data from one well in the southern basin along Arroyo Valle (southern Amador Subarea). In that area, a water level measurement from Well 3S/2E 30G 1 indicated an elevation about 11 ft below the local historic low, as indicated by the orange and yellow shading. This one data point was questionable, given other levels in the vicinity, and may have been influenced from recent active pumping prior to the water level measurement. Follow-up measurements were above historic lows. Because this is an active pumping well and difficult to access, Zone 7 is looking for a replacement monitoring well in this area.

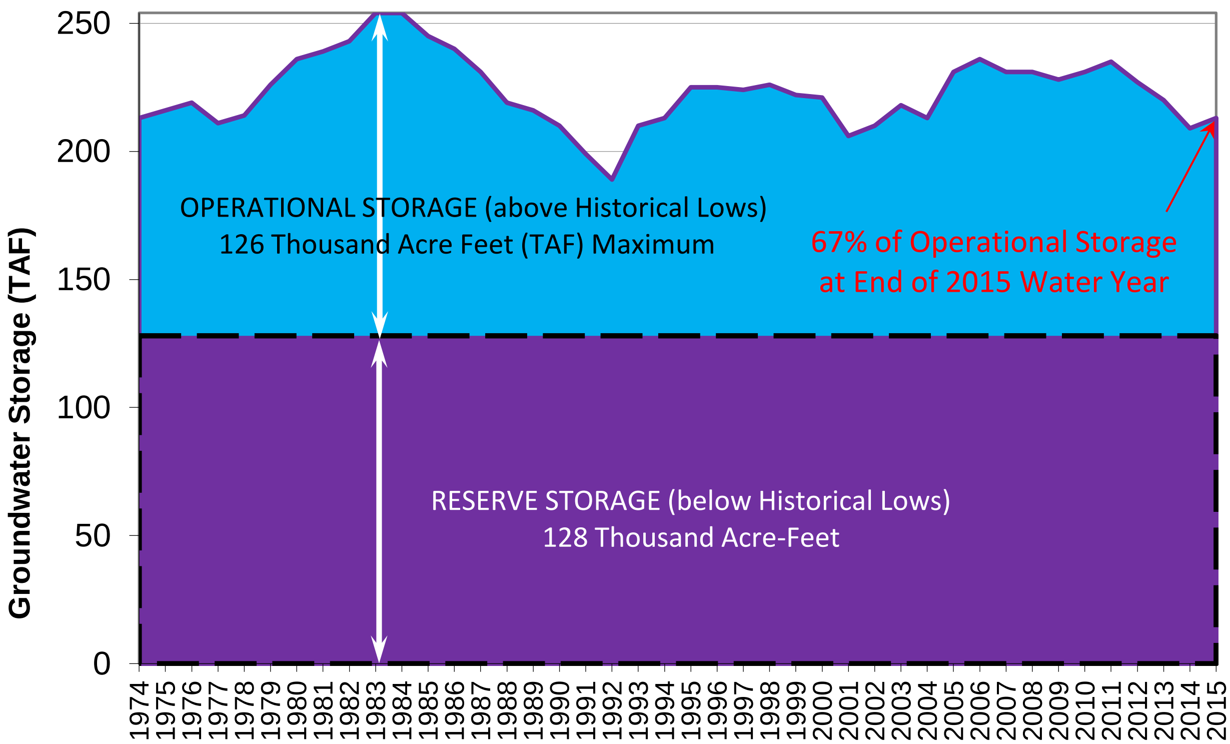
2.3.7 Groundwater in Storage

2.3.7.1 Main Basin

Most of the groundwater in storage is contained in the Main Basin, which is characterized by the largest saturated thickness. To evaluate groundwater in storage, nodes from the 1974 DWR study are used to divide the Main Basin into polygonal areas for the purposes of groundwater storage evaluations (see **Figure 2-15**). Each node has its own set of hydrogeologic parameters, such as storage coefficient, nodal thickness, and nodal area. The saturated thickness of the node is calculated using the nodal thickness, average groundwater elevations from the fall semiannual measuring event, and storage coefficient. The groundwater storage of each node is then calculated by multiplying the saturated thickness by the total area of the node. The total Main Basin groundwater storage is equal to the sum of all the nodal storage values for the 22 nodes in the Main Basin. Storage calculations before 1992 assumed a constant storage coefficient for the entire node (i.e., without differentiating between aquifers). The methodology has been improved over time and, starting in 2007, average groundwater elevations for each of the nodes and aquifers were calculated using *ArcGIS Spatial Analyst.*

This analysis has been conducted for the groundwater elevations shown on the map of historic low water levels (**Figure 2-23**). Similarly, the analysis has been completed for groundwater elevations in 1983, representing historic high levels when the basin was determined to be full. Those analyses have been used to develop a zone of operational storage as a management threshold for operating the basin within its sustainable yield. A schematic diagram showing this operational storage and changes in storage from 1974 through 2015 WY is shown on **Figure 2-30**.

Figure 2-30: Diagram of Groundwater in Storage in Main Basin Management Area



As illustrated on **Figure 2-30**, the Main Basin has a storage capacity of more than 250,000 AF. The Main Basin was full in early 1900 and full again in 1983 (as measured by rising water levels in gravel quarries in the central basin). Groundwater was drawn down to historic low storage levels in 1962 and 1966 with an estimated remaining storage of 128,000 AF in the basin. In 1987, Zone 7 adopted a Groundwater Management Policy to maintain groundwater levels high enough to provide emergency reserves adequate for the worst credible drought. For planning purposes, Zone 7 maintains this reserve above historic lows. The remaining half of the groundwater (the ―Operational Storage" above historical lows) is actively managed for supply reliability and is used for water supply storage and recovery during times of drought or emergency. For the purposes of compliance with SGMA, the base of operational storage is preliminarily adopted as a minimum threshold (see **Section 3.3.2**).

2.3.7.2 Fringe and Upland Areas

The Fringe Management Area is not used for municipal supply or managed groundwater storage primarily because of poor groundwater production. Groundwater quality is also typically poor in the Fringe Management Area (see **Section 2.3.8** below) due to natural elevated TDS and boron concentrations. However, the Fringe Management Area does provide limited supply for domestic and agricultural users. **Table 2-6** shows that the total groundwater storage for all of the Fringe Management Area regions, which consist only of an upper alluvial aquifer (**Section 2.3.5**), is estimated to be about 200,000 AF. For these calculations, the area-weighted average thickness of each region was calculated using nodal depth-of-alluvium estimates from *DWR 1974* and average depth to water measurements. The Specific Yield was estimated based on well permits and inspections.

Table 2-6: Estimated Fringe Management Area Storage

Fringe Region	Area (ac)[1]	Avg Depth (ft)[2]	DTW[3]	SY[4]	Storage (AF)
North	9,587	99	19	10%	76,499
Northeast	11,010	126	14	10%	123,291
East	1,359	50	26	10%	3,261
Total	**21,956**	**104**	**17**	**10%**	**203,051**

[1] From GIS
[2] Area-weighted alluvium depth by node from DWR 1974 and average depth to water.
[3] Average Depth to Water. Total DTW is area-weighted.
[4] Specific Yield. Roughly estimated from well permits and inspections.

The Upland Management Area provides only very limited groundwater supply for domestic and agricultural uses. The total groundwater storage of the Upland Management Area is unknown because it consists of semi-consolidated bedrock of highly-variable Specific Yields and of unknown thickness.

2.3.8 Groundwater Quality

2.3.8.1 General Water Chemistry and Constituents of Concern

Zone 7's understanding of groundwater quality throughout the basin has improved over time as additional monitoring points have been added to the monitoring network and additional analyses have been conducted when areas of concern have been identified. Consistent with adaptive management principles, Zone 7 has actively responded to numerous groundwater quality issues over time. This section provides a characterization of groundwater quality and changes in quality in space and time since 1974, a time period of sustainable management. Although numerous groundwater quality challenges have arisen during this time period, Zone 7 has been able to address each issue, preventing significant and unreasonable degradation of groundwater quality. **Section 3.3.3** defines significant and unreasonable undesirable results with respect to groundwater quality and establishes minimum thresholds in compliance with SGMA. Details on the Zone 7 water quality monitoring program are provided in **Section 4**.

In general, groundwater quality is highest in the Main Basin, where it is suitable for most urban and agriculture uses with some minor localized water quality degradation. Primary constituents of concern in the Main Basin are locally high TDS, hardness, nitrate, boron, and organic compounds. These elevated concentrations are naturally occurring in many areas of the basin and are not caused or being exacerbated by groundwater extractions.

Zone 7 analyzes these constituents of concern through numerous maps and statistical analyses. For this Alternative Plan, basin-wide maps and chemographs are presented to characterize both current and historical conditions of groundwater quality and provide a broad view of Zone 7 management of groundwater quality. Contour maps of constituents of concern are prepared on an annual basis for constituents of concern; those are not reproduced in this Alternative Plan. Rather the reader is referred to the most recent annual report (2015 WY, *Zone 7 2016c*, **Attachment B**), where *Figures 6-4* through *6-11* show contour maps for constituents of concern, and *Figure 6-3* presents a 5-page print-out from the Zone 7 data management system providing all of the tabular water quality results for 2015 WY.

In general, groundwater is of lower quality in the Fringe Management Area, which is characterized by relatively high TDS and locally elevated boron. TDS and boron concentrations are particularly elevated in the shallow Upper Aquifer and in the northeast, reflecting recharge from marine sediments adjacent to the basin. High boron levels and lower yields can limit the use of some Fringe Subareas for extensive agricultural irrigation.

Releases of fuel hydrocarbons from leaking underground storage tanks and spills of organic solvents at industrial sites have caused minor-to-significant groundwater impacts locally throughout the basin, although there is no impact on municipal wells to date. Zone 7 participated in the development of the Groundwater Ambient Monitoring and Assessment (GAMA) project, and with the exception of methyl tertiary-butyl ether (MTBE), no fuel hydrocarbons were detected in any of the municipal wells. Proactive cooperation with regulatory agencies on site cleanup is helping to protect the basin from fuel contamination.

Chlorinated organic solvent releases to soil and groundwater are an issue, primarily in the Upper Aquifer in portions of the Fringe Management Area. Cleanup programs at Lawrence Livermore National Laboratory (LLNL) are in place to remediate this large superfund site from a 50-year-old plume associated with World War II activities. Zone 7 assisted LLNL during the initial year of cleanup and has been working cooperatively with them ever since. During the past decade, LLNL has been providing valuable assistance to Zone 7 in the monitoring and analysis of groundwater conditions within the basin. The GAMA project and the GeoTracker program have advanced groundwater basin understanding and assisted the groundwater protection effort.

Zone 7 monitors more than 230 wells in the groundwater quality monitoring program (**Figure 2-17**) and submits samples to the Zone 7 laboratory located at the Del Valle Water Treatment Plant. Zone 7 also reviews results from site cleanup projects made available through GeoTracker and from cleanup reports routinely sent to Zone 7 for review. Results of these programs are documented annually in Zone 7 reports.

Groundwater quality issues that may affect the supply and beneficial uses of groundwater are discussed below, including a description and map of the location of known groundwater contamination sites and plumes. The current monitoring network for Groundwater Quality is documented in **Section 4.6**.

2.3.8.2 Total Dissolved Solids (TDS) Concentrations in the Basin

Zone 7 Water Agency has long maintained a groundwater quality monitoring program with annual sampling and reporting (see **Section 4.6** for details). Currently there are a total of 233 wells (**Figure 2-17**) in the program that are sampled and analyzed for inorganic constituents of concern for meeting the Livermore Basin groundwater quality objectives. These include TDS (as a surrogate for mineral salts), nitrate, boron, and hexavalent chromium (CrVI).

Figure 2-31 shows graphs of TDS for the period 1974 to present from 15 representative wells from the Fringe and the Main Basin Management Areas; an inset map shows the well locations. The local Basin Plan water quality objective for TDS is shown on the chemographs by a yellow dashed line. For the Fringe Management Area, the water quality objective is 1,000 mg/L (or ambient, whichever is lower). For the Main Basin Management Area (referred to in the Basin Plan as the Central Basin) the water quality objective is 500 mg/L (or ambient, whichever is lower).

Beginning at top left of **Figure 2-31** and reviewing clockwise, the five chemographs along the northern and northeastern Fringe Management Area show TDS concentrations in Bishop, Camp, May, Cayetano, and Spring Subareas. All of these five TDS graphs represent the Upper Aquifer. TDS concentrations are presented with a vertical axis from 200 to 3,200 mg/L; the 1,000 mg/L concentration is highlighted as the Basin Plan Objective. All five graphs show variations; for all but the Spring Subarea, the variations are between 200 and 1,000 mg/L. The Spring Subarea generally has concentrations between 1,200 and 2,000 mg/L; this reflects recharge from local streams with high TDS and watersheds characterized by marine sediments and deep saline water associated with the numerous bounding faults in the area. For all five graphs, trends generally are steady over the long term, although a slight increase is discernible in the May Subarea well. An additional TDS graph for the eastern Fringe Management Area is shown at lower right; this TDS graph for Mocho I Subarea indicates a slightly increasing trend at about 1,000 mg/L.

A chemograph from the Upper Aquifer in a Castle Subarea well is shown on the lower left of **Figure 2-31.** Although Zone 7 considers Castle Subarea to be a part of the Main Bain Management Area, the Basin Plan water quality objective is the same as in the Fringe Management Area, recognizing the local, higher-salinity groundwater. That chemograph indicates TDS concentrations generally between 200 and 700 mg/L and a steady trend since about 1994.

The remaining chemograph shown on **Figure 2-31** for the Fringe Management Area is the Dublin Subarea well, a well that is in the ongoing California Ambient Statewide Groundwater Elevation Monitoring (CASGEM) Program administered by DWR. Data are from the Upper Aquifer. Concentrations on this chemograph are between about 1,200 mg/L and 1,700 mg/L in the late 1970s and early 1980s. In the late 1980s, concentrations rose significantly to around 3,000 mg/L and have been relatively steady since that time. The cause of the rise in TDS is unknown and additional historical data that could provide a more complete understanding are not available. Naturally-occurring low permeability clays and historic lake beds have been documented in the area and some elevated TDS concentrations could be naturally occurring. Localized point sources, such as historical wastewater and sludge disposal practices are also potential causes.

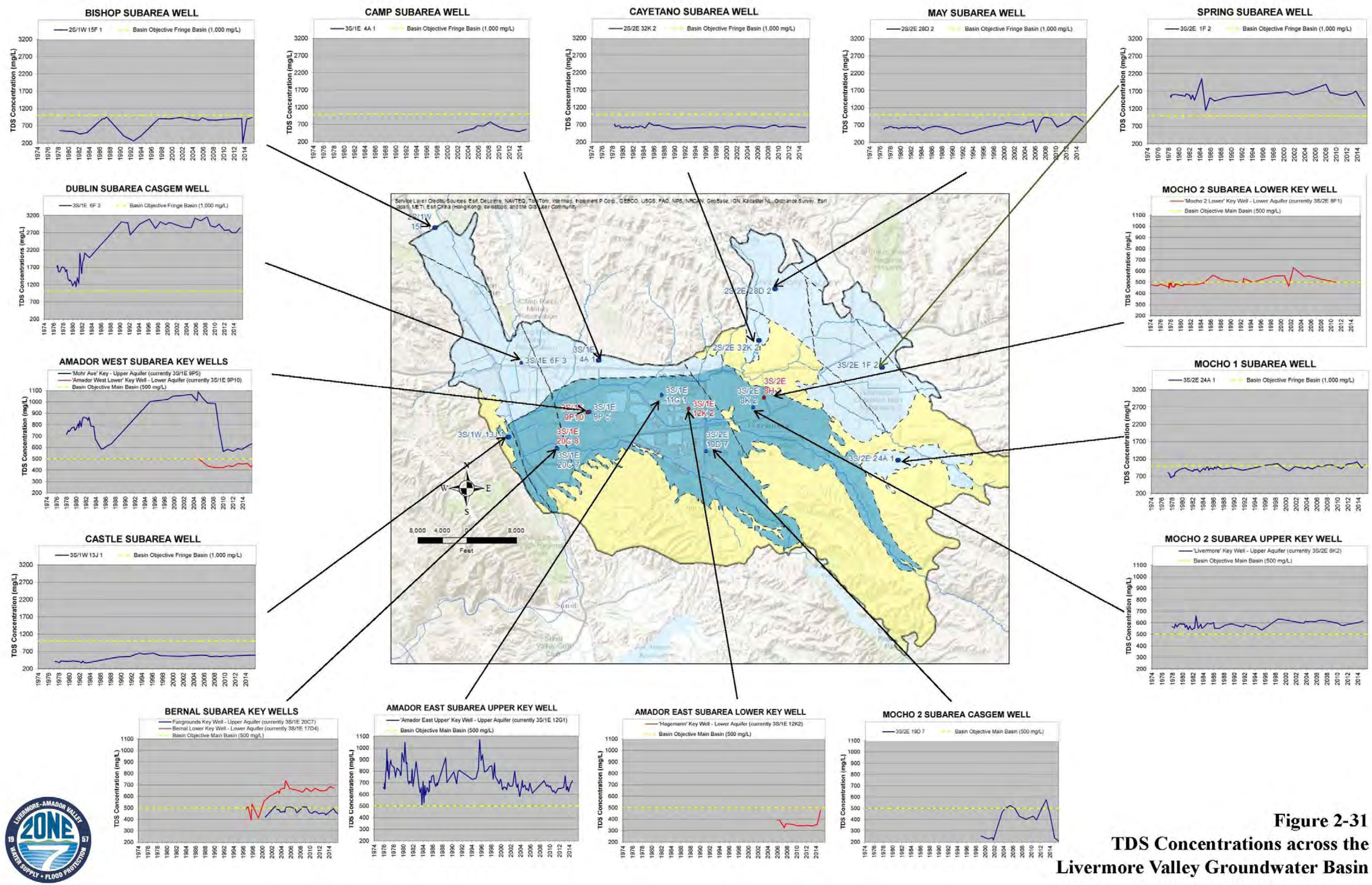


Figure 2-31
TDS Concentrations across the Livermore Valley Groundwater Basin

Because high-TDS groundwater from the Upper Aquifer of the Fringe Management Area provides subsurface inflow to the Upper Aquifer of the Main Basin, these concentrations are being carefully monitored for any additional increasing trends. As discussed in other portions of this Alternative Plan, Zone 7's Salt Management Plan (SMP, *Zone 7, 2004*, **Attachment D**) has been proactively addressing TDS concentrations, including demineralization projects, both ongoing (Mocho Wellfield demineralization) and planned (Tri-Valley Recycled Water Project – See **Section 5** of this Alternative Plan).

Also on **Figure 2-31** are seven selected wells that represent TDS trends in the central portion of the Main Basin, including Amador East and West, Bernal, and Mocho II Subareas. Vertical axes for these wells are from 200 to 1,100 mg/L and the Basin Plan Objective of 500 mg/L is highlighted. Of the Main Basin wells on **Figure 2-31**, four show TDS concentrations for only the Upper Aquifer (blue graph) and two show TDS concentrations only for the Lower Aquifer (red graphs). Two additional wells provide information on both aquifer zones.

Review of the Main Basin chemographs indicates that the two easternmost key wells (Mocho II Upper Key Well and Lower Key Well) show relatively steady TDS trends with concentrations generally between 500 and 600 mg/L. As in other portions of the Main Basin, concentrations are higher in the Upper Aquifer. Several of the other TDS graphs have relatively short records, representing wells that have been more recently incorporated into the groundwater quality monitoring program.

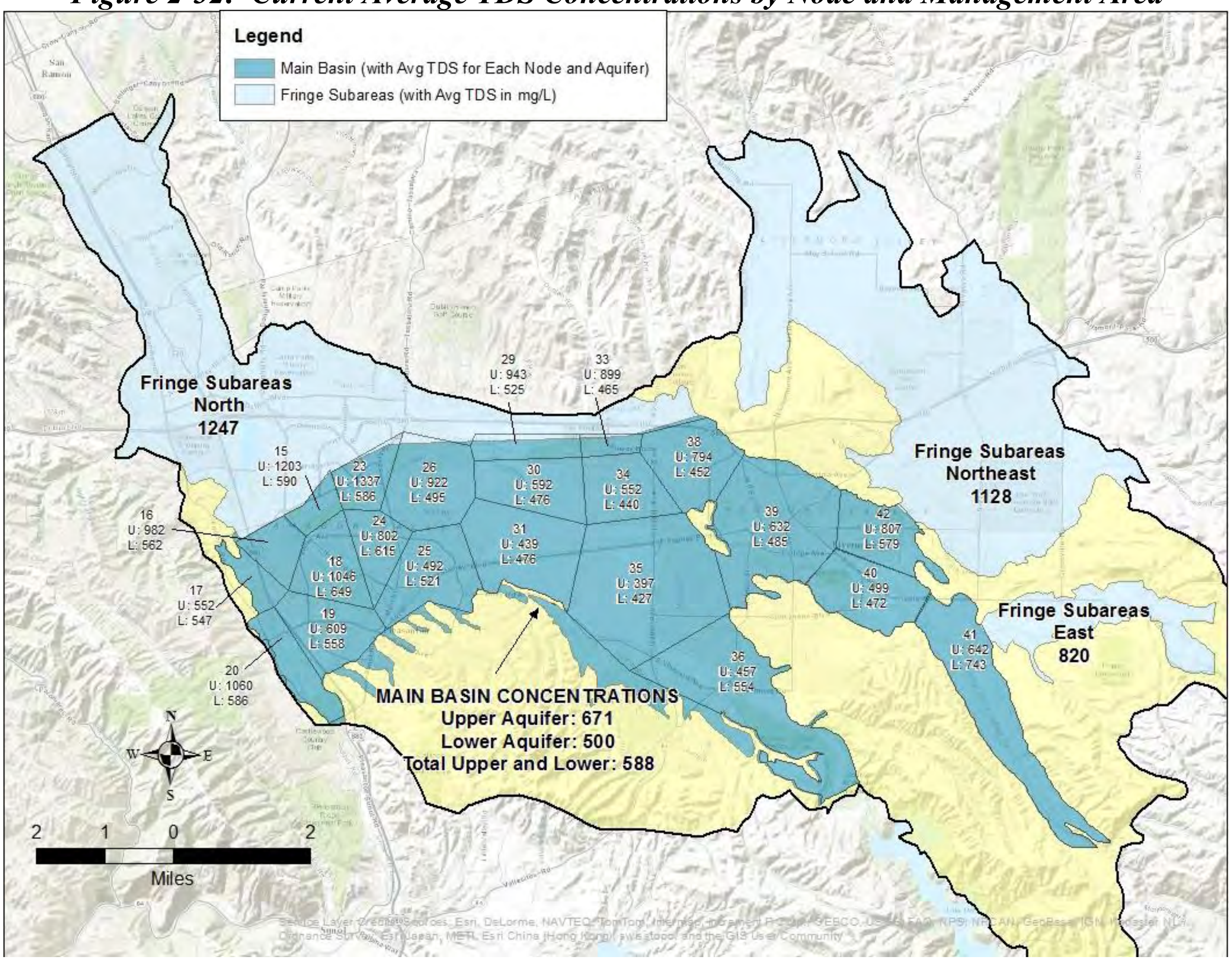
An exception is the TDS graph for the Amador East Subarea Upper Key Well, which has been maintained since 1976. This TDS graph indicates considerable variation between 500 and 1,000 mg/L, but documents that TDS concentrations were relatively high in this portion of the Upper Aquifer at the beginning of the time period and have not increased during the period of sustainable management. Most notably the graph shows a long-term decline in TDS that reflects, among other factors, the wastewater and salt management in the basin, including the 1980 construction of the Livermore-Amador Valley Water Management Agency (LAVWMA) wastewater export pipeline and the implementation of the 2004 SMP.

The Amador East Subarea lower Key Well also demonstrates lower TDS concentrations in the Lower Aquifer, with concentrations between about 350 mg/L and 450 mg/L. In the Amador West Subarea, two key wells illustrate this difference between Upper Aquifer and Lower Aquifer concentrations in the western Main Basin. In those wells, Upper Aquifer concentrations are significantly higher (above 1,000 mg/L prior to 2009), but have recently declined to about 600 mg/L. Concentrations in the Lower Aquifer have been consistently around 450 mg/L. In the Bernal Subarea, concentrations in the Lower Aquifer were observed to increase in the late 1990s and early 2000s (see chemograph on the lower left of **Figure 2-31**). In that subarea, TDS concentrations rose from around 450 mg/L to about 650 mg/L.

TDS increases in the basin, and, in particular, in some Lower Aquifer wells such as the Bernal Subarea Key Well, triggered aggressive development and implementation of the SMP by Zone 7 beginning in 2004. By 2010, Zone 7 had developed a groundwater demineralization program, providing reverse-osmosis treatment and export of brine out of the basin. Also, note that the Bernal key wells show that TDS concentrations in the Upper Aquifer are actually lower than the Lower Aquifer in this area. This is thought to be due, in part, to the recharge of low TDS water along Arroyo Valle as part of the Zone 7 conjunctive use program. These ongoing projects, along with other SMP actions, are discussed in **Section 5** of this Alternative Plan. Additional data and analyses conducted by Zone 7 for the examination of current and historical average TDS concentrations are discussed below.

Every year, Zone 7 Water Agency uses monitoring data to calculate average TDS concentrations in the Fringe and Main Basin Management Areas using nodes from the 1974 groundwater model (discussed in **Section 2.2.3.4**; see **Figure 2-15**). Calculations are made separately for upper and lower aquifers. The results of these calculations using 2015 WY data are shown on **Figure 2-32**. For the Main Basin, the average volume-weighted TDS concentrations for the upper and lower aquifers are 671 and 500 mg/L, respectively, with the overall volume-weighted concentration averaging 588 mg/L. The average concentrations across the Fringe Management Area, which represent the Upper Aquifer only, range from 820 to 1,247 mg/L. Additional observations from the data on **Figure 2-32** for the Upper Aquifer and Lower Aquifer are discussed in the subsections below.

Figure 2-32: Current Average TDS Concentrations by Node and Management Area



Current TDS Concentrations in the Upper Aquifer

As shown in **Figure 2-32**, TDS concentrations in groundwater are lowest in the southernmost portions of the Main Basin, generally less than 500 mg/L. This pattern reflects recharge of high quality water along Arroyo Valle and Arroyo Mocho. In contrast, three portions of the Main Basin have had TDS concentrations in excess of 1,000 mg/L:

1. At the boundary between the Dublin Subarea (Fringe Management Area) and the Bernal Subarea (Main Basin Management Area), and extending into the Amador Subareas (e.g., nodes 15, 23, and 18) average TDS concentrations range up to 1,203 mg/L. This area of high TDS is most likely due to the combination of the concentrating effects of urban irrigation, leaching of buried lacustrine sediments, and historical wastewater and sludge disposal practices.

2. In the boundary between the Camp Subarea (Fringe Management Area) and the northern Amador Subarea (e.g., Node 23), average TDS concentrations range up to 1,337 mg/L. This high TDS is most likely due to poor quality water from the marine sediments to the east and north that result in high TDS water in Altamont Creek, which then contributes to aquifer recharge along the Arroyo Las Positas. Irrigation with recycled water is another potential source of salt loading in this area.

3. In 2015 (and occasionally in the past), several wells along the southern boundary of the Main Basin had detectable TDS concentrations near or above 1,000 mg/L. This may reflect hill-front recharge and/or subsurface inflow from the Livermore and Sinbad Uplands to the south and west, respectively. These Upland areas consist primarily of sedimentary rocks from the Livermore Gravels and Panoche Formation that may contribute TDS.

Current TDS Concentrations in the Lower Aquifer

As indicated by concentrations on **Figure 2-32**, TDS concentrations in the Lower Aquifer generally meet the TDS Basin Objective of 500 mg/L or lower. In the Bernal Subarea and around the margins of the Amador and Mocho II Subareas, the Lower Aquifer contains groundwater with higher TDS concentrations (up to about 743 mg/L in node 41on **Figure 2-32**). This is most likely due to deep percolation of high TDS water from the Upper Aquifer.

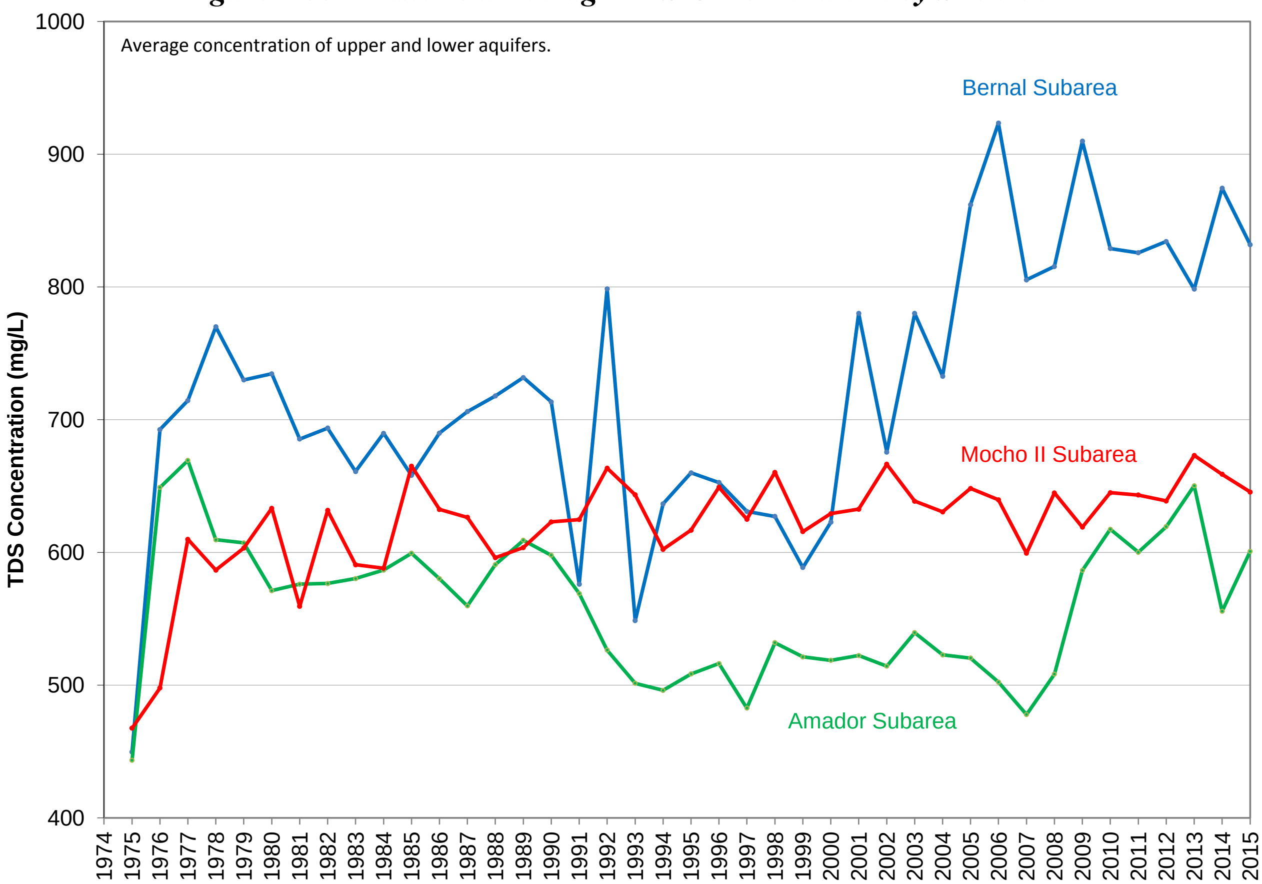
Starting in the 2007 WY, TDS concentrations increased in the Zone 7 Mocho Wells and in several deep monitoring and supply wells near the western margin of the Amador Subarea. In response, Zone 7 staff investigated potential sources and pathways, concluding that higher TDS groundwater in the Upper Aquifer (which the Mocho Wells are designed to exclude) has been migrating downward either by means of leakage through the intervening semi-confining layers or through local conduits caused by unsealed or improperly sealed wells that penetrate both the upper and lower aquifers; three such wells were identified as potential conduits. As an illustration of Zone 7‘s adaptive management strategies, all three of these abandoned wells were properly destroyed (sealed) during the 2013 WY. As of the 2015 WY, TDS concentrations in Mocho Well 2 showed a decrease, but data remain insufficient to determine if the conduit sealing has had a lasting beneficial impact on the TDS concentrations in the wellfield. All of the Mocho

Wellfield wells have been added to the groundwater quality monitoring network to continue this assessment.

Historical TDS Concentrations by Subarea

Historical TDS concentrations in both the upper and lower aquifers for each of the Main Basin subareas have been averaged on an annual, volume-weighted basis from 1974 through 2015 WY, as shown by the chemographs in **Figure 2-33**. The graphs indicate that TDS has increased in the Bernal Subarea, and to a lesser extent the Amador Subarea, since the early 2000s. The average TDS concentration in the Mocho II Subarea has remained relatively constant since the 1980s.

Figure 2-33: Historical Average TDS Concentrations by Subarea



A noticeable feature of the historical trend is the rise in TDS that occurred in the Bernal Subarea beginning in about 2000 (also noted in the Bernal Subarea Key Well on **Figure 2-31** and discussed above). The increase was detected and verified through the Zone 7 monitoring program. Consistent with its adaptive management principles, Zone 7 (in collaboration with other agencies) responded with development and implementation of the SMP (completed in 2004), including development of the Zone 7 Mocho Groundwater Demineralization Plant (MGDP), which began operating in 2009. As shown in **Figure 2-33**, the rise in TDS concentrations has been arrested and concentrations have stabilized.

2.3.8.3 Theoretical Salt Loading Calculations

Zone 7's salt loading calculations take into account the addition and removal of minerals in the Main Basin by tracking or estimating the salt mass associated with the recharge and discharge components of the basin hydrologic inventory. These calculations include all salts, including those applied at the ground surface and those that may exist in the overburden and interbedded aquitards. Therefore the calculated concentrations are theoretical and differ from the average basin-wide salt concentrations described above, which are based on measurement of TDS concentrations in groundwater. This approach to calculating salt loads is a conservative or ―worst case" analysis. (Actual, measured TDS concentrations are shown in **Figures 2-31, 2-32, and 2-33**). In general, salts are added to or removed from the Main Basin by the mechanisms listed in **Table 2-7.**

Table 2-7: Main Basin Salt Loading Calculation Components

SALT ADDITION	SALT REMOVAL
• Natural stream recharge • Natural areal recharge • Artificial stream recharge • Subsurface groundwater inflow • Pipe leakage • Applied water (irrigation) recharge o Municipal o Groundwater o Recycled water	• Municipal pumping, including brine export from the MGDP • Agricultural pumping • Mining area discharges and wet gravel export • Groundwater basin outflow

By assigning a TDS value for each inventory component, the net theoretical salt load is then calculated for each water year. Zone 7 calculates a theoretical average TDS concentration of the entire Main Basin by assuming a starting average concentration of 450 mg/L in 1973 (*DWR, 1974*), and calculating the net theoretical salt load and change in storage for every year since then. A negative value for the net theoretical salt mass from the basin may not result in a lowering of the theoretical average TDS concentration if it is associated with a loss of storage.

Groundwater pumping removes salts from the Main Basin as solute in the produced groundwater. Some of this salt mass is then exported from the Main Basin in the municipal wastewater, brine from the MGDP, mining area discharges, and deliveries of groundwater to areas outside of the Main Basin. Other portions of the salt mass removed by Main Basin pumping are reapplied to the Main Basin as recharge from irrigation, pipe leakage, subsurface groundwater inflow, and to a lesser degree, onsite wastewater discharges.

The calculations account for evapotranspiration and evaporation of groundwater in the mining area ponds, which have the effect of concentrating salts in the Main Basin. Similarly, the salt-concentrating effects of water applications for irrigation are calculated. In contrast, rainfall recharge dilutes the salt concentrations as it adds essentially salt-free water to the system. Artificial recharge with low salinity SWP water also tends to dilute the Main Basin salt concentrations, but does add some salt mass to the system. The amount of added salt accounts for the salinity of the water being recharged, which varies seasonally and annually, and the amount recharging the aquifers.

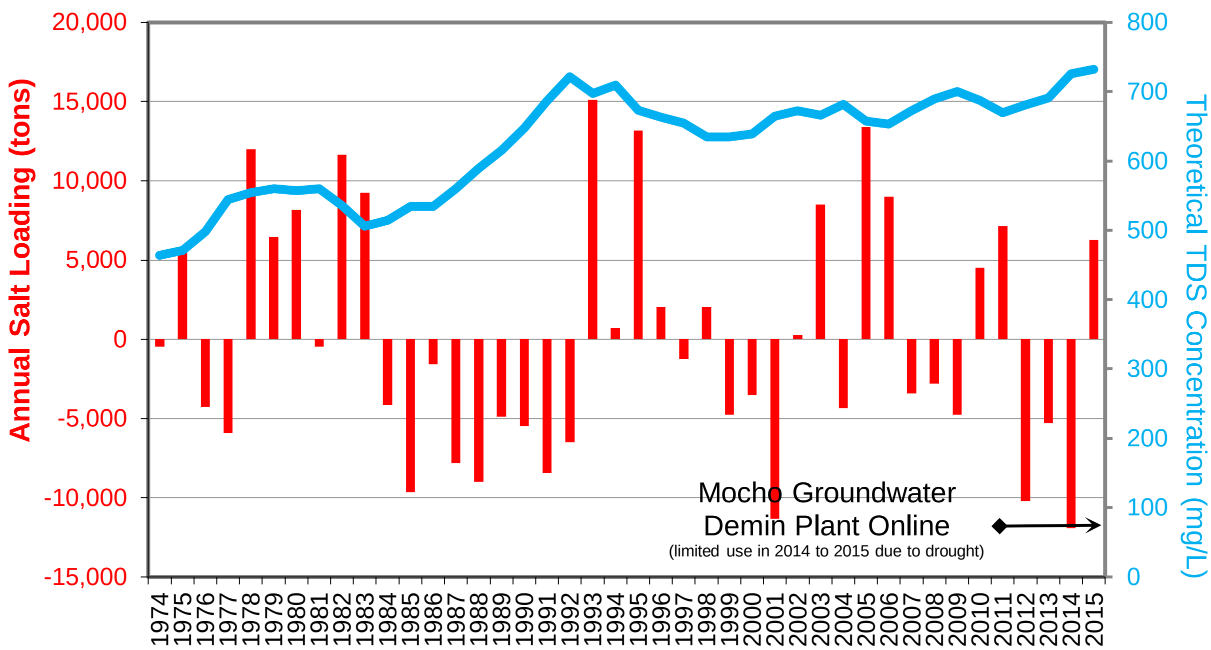
While theoretical, the calculations provide insights into the processes of salt addition and removal both geographically and temporally. **Figure 2-34** illustrates the results from 1974 to 2015 of the theoretical salt loading calculations in terms of annual salt loading and TDS concentrations. The graphs indicate considerable variability in salt loading from year to year.

In interpreting this graph, it should be noted that the salt loading is presented as mass (tons) coming into or leaving the basin. The theoretical TDS concentration curve is expressed as a concentration which accounts not only for the mass of salt, but also the volume of groundwater in storage. Hence, an apparent increase in concentration can be synchronous with negative salt loading (i.e., decrease of salt mass) if the volume of groundwater is decreased with lower groundwater levels.

The theoretical TDS concentration generally increases during drought conditions, primarily due to a corresponding decrease in the volume of groundwater in storage. Such an increase is noted during the drought of the late 1980s and early 1990s. Predicted theoretical concentrations are relatively stable between drought cycles. Notably, the severe drought conditions over the last few years corresponded to only a slight rise in the theoretical concentration due, in part, to management activities implemented by Zone 7.

As described in **Section 5**, Zone 7 prepared a SMP in 2004 and has implemented salt management actions; the initiation of the MGDP is indicated on **Figure 2-34**.

Figure 2-34: Main Basin Salt Loading and Theoretical TDS Concentration (1974 to 2015 WYs)



2.3.8.4 Nitrate Concentrations in the Basin

The Zone 7 groundwater quality monitoring program addresses nitrate as one of the inorganic constituents of concern; accordingly, Zone 7 conducts numerous analyses for nitrate concentrations in the basin similar to those presented above for TDS concentrations. **Figure 2-35** shows chemographs of nitrate (as N) for the period 1974 to 2015 (using the same wells as presented for TDS in **Figure 2-31**). All nitrate concentrations are presented with a vertical axis from 0 to 45 mg/L; the 10 mg/L concentration is highlighted as the Basin Plan Water Quality Objective. Nitrate concentrations are graphed for fifteen selected wells from the Fringe and the Main Basin Subareas; an inset map shows the well locations.

Beginning at top left on **Figure 2-35** and reviewing clockwise, the six hydrographs along the top of the figure show nitrate concentrations from 1974 to present along the subareas of the northern Fringe Management Area (Dublin, Bishop, Camp, May, Cayetano, Spring). All six graphs represent the Upper Aquifer because the Lower Aquifer is not present in these subareas. For all six graphs except May Subarea, concentrations are below 10 mg/L and trends area generally steady over the long term. The graph for the May Subarea shows a significant increase in nitrate with concentrations varying in recent years between about 25 and 45 mg/L. As discussed below, this area has been identified in the Nutrient Management Plan (NMP, *Zone 7, 2015c*, **Attachment E**) as one of ten local Areas of Concern (AOCs). Similarly, the nitrate graph for the Mocho I Subarea (remaining graph for the Fringe Management Area) at lower right also shows nitrate in excess of the Basin Plan Objective; this area, too, has been identified as an AOC.

There are eight selected wells on **Figure 2-35** that represent nitrate trends in the Main Basin, including Mocho II, Amador East and West, Bernal, and Castle Subareas. Of the Main Basin wells on **Figure 2-35**, four show nitrate concentrations for only the Upper Aquifer (blue line) and two show nitrate concentrations only for the Lower Aquifer (red lines). Two additional wells provide information on both aquifer zones.

Review of the Main Basin hydrographs indicates that the two easternmost key wells (Mocho II Upper and Lower) show relatively steady nitrate trends with concentrations generally around 10 mg/L for both the Upper Aquifer and Lower Aquifer. Several of the other nitrate graphs are relatively short, but indicate nitrate levels below 10 mg/L. Two wells show long histories for the Upper Aquifer in the Amador East and Amador West Subareas. The nitrate concentrations in the Amador East Upper Key Well are variable, but show a long-term decline in nitrate that likely reflects wastewater and salt management in the basin. The Amador West Upper Key well indicates nitrate concentrations that generally are less than 10 mg/L. The nitrate graph for the Castle Fringe Subarea (lower left) also indicates nitrate concentrations generally less than 10 mg/L with no discernable trend in the data.

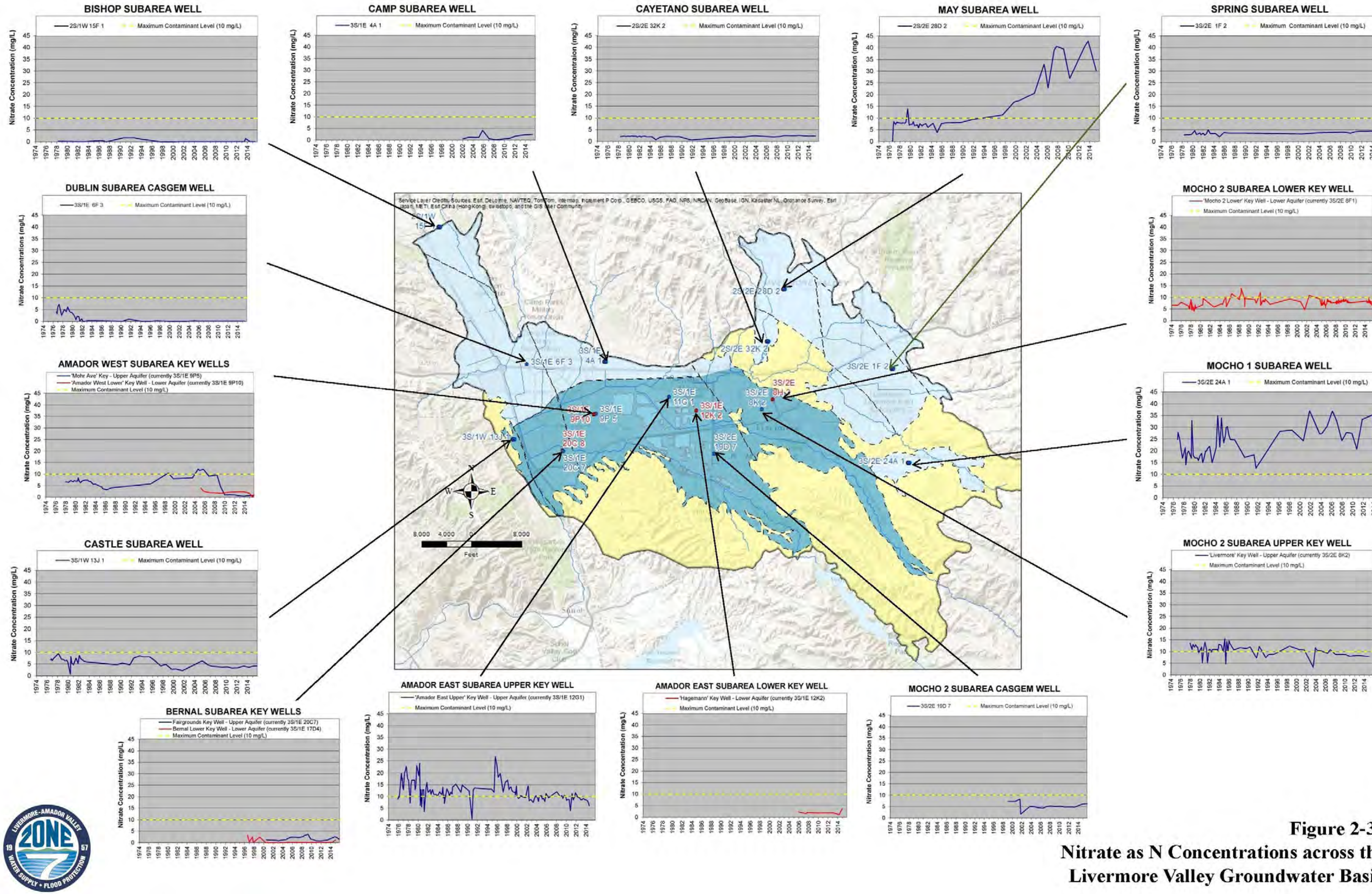
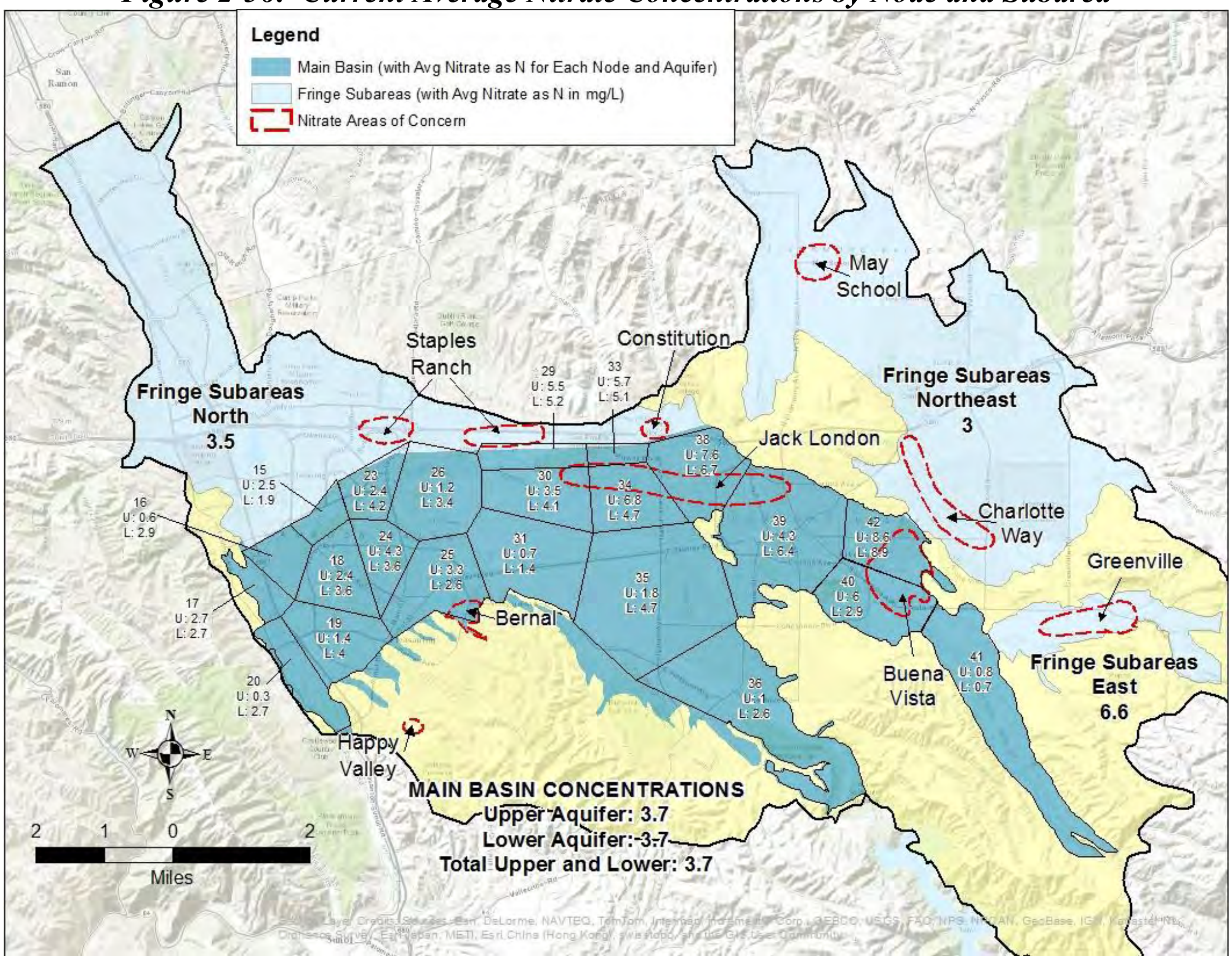


Figure 2-35
Nitrate as N Concentrations across the Livermore Valley Groundwater Basin

Each year, Zone 7 calculates the average nitrate concentrations for several areas in the Fringe Management Area and for the Main Basin Management Area nodes (both upper and lower aquifers) using groundwater quality contours based on actual measured monitoring data. The 2015 WY results are shown in **Figure 2-36**. In the Main Basin, the total average nitrate (as N) concentration for 2015 is 3.7 mg/L for both the upper and lower aquifers. In the Fringe Management Area, average concentrations range from 3 to 6.6 mg/L. All concentrations are below the basin objective of 10 mg/L; however, there are certain localized areas (―Nitrate Areas of Concern” on **Figure 2-36**) where the nitrate concentration exceeds the Basin Plan Water Quality Objective, which is the Maximum Contaminant Level (MCL).

Figure 2-36: Current Average Nitrate Concentrations by Node and Subarea



Current Nitrate Concentrations in the Upper Aquifer

The NMP identified ten local AOCs in the Upper Aquifer where nitrate (as N) has been detected at concentrations above the MCL of 10 mg/L. These hot spots are shown above in **Figure 2-36** and are also contoured in Annual Reports (for example *Figure 6-5* in the 2015 WY Annual

Report). The descriptions below characterize each hot spot and identify potential sources of nitrate:

1. **Happy Valley** – This unincorporated, unsewered area has been subdivided into 1- to 5-acre lots and developed with rural residences relying on domestic wells for water supply. There are currently about 100 septic tanks or onsite wastewater treatment systems (OWTS) in use in Happy Valley. Very little additional development has been planned for Happy Valley because Alameda County has placed a moratorium on new OWTS construction in the area due to high nitrate detections in some of the domestic wells. There are no dedicated monitoring wells in the area; however, many of the domestic wells have been tested for nitrate since 1973. In 2013, Zone 7 and Alameda County Environmental Health (ACEH) conducted voluntary testing of water samples from domestic wells in Happy Valley. Seven of the 31 wells had nitrate concentrations that exceeded the MCL. Most of the high nitrate occurrences were detected in the central portion of this enclosed subarea, which consists of only one upper aquifer.

2. **Staples Ranch** – This elongated AOC runs from west to east in the southern portion of the Camp Subarea in the eastern portions of Dublin and Pleasanton. This area was heavily farmed in the past, and then left largely as undeveloped open space until recently. It is now planned for low- to medium-density residential and commercial development with connections to the municipal sewer, water, and recycled water. While only two monitoring wells in the upper aquifer (3S/1E 5K 6 and 3S/1E 2M 3) currently have nitrate concentrations above the MCL (13.2 mg/L and 16.0 mg/L, respectively for the 2015 WY), several surrounding wells in both the upper and lower aquifers have elevated nitrate concentrations. The contamination is likely a remnant of past agricultural operations that included row crops, alfalfa cultivation, small dairy operations, and OWTS clusters. There is still some dry farming of hay in the area and a golf driving range in the eastern part with approximately 16 acres of irrigated turf. The future planned commercial development may effectively cap any potential buried nutrient sources from the historical agricultural land use, minimizing their leaching during rainfall events.

3. **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; however, recently concentrations have been fluctuating around the MCL (12.2 mg/L for 2015 WY). This area is primarily sewered, and developed as medium-density residential (about 2 to 8 dwellings per acre) with no future additional development planned. The source of high nitrate and the reason for the fluctuating concentrations has not been identified, but it is speculated that the nitrate may have been entering the Main Basin as hill-front recharge and/or subsurface inflow from the neighboring Livermore Uplands to the south. These sources are likely diminishing as urban development and associated sewering spreads into the Upland area.

4. **Jack London** – This AOC extends from the eastern portion of the Mocho II Subareas to the northeastern portion of the Amador Subarea. The eastern portion is primarily sewered medium-density residential while the western portion is sewered commercial (including the Livermore airport) with little future development currently planned. A horse boarding

facility operates in the most western part. Portions of this nitrate plume date back to at least the 1960s. Several wells in the upper aquifer have consistently had nitrate concentrations above the MCL (highest in 2015 WY in 3S/1E 11B 1 at 21 mg/L). The most significant nutrient contributor is believed to have been the historical municipal wastewater disposal that was practiced at several locations along this nitrate plume before the LAVWMA wastewater export pipeline was constructed. Historical and current agricultural practices, and current recycled water use are other potential nutrient loading sources for this area, although considered to be less significant.

5. **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. This area is primarily sewered commercial with little future land use development. Nitrate concentrations above the MCL have been detected in 3S/1E 1H 3 (16.6 mg/L for 2015 WY) and 3S/1E 1F2 (normally above the MCL, but at 5.79 mg/L for 2015 WY), however, elevated concentrations have also been detected in some downgradient monitoring wells. The source of the nitrate is unconfirmed, but may be from historical OWTS use and agricultural practices, and current landscape fertilizer application and/or recycled water use.

6. **May School** – The highest nitrate concentration detected in the groundwater basin is located in a well (2S/2E 28D 2) near May School Rd in the Upper Aquifer of the May Subarea at a concentration of 30.3 mg/L in 2015. The source of high nitrate has not been identified; however, it likely comes from agricultural land use in that area. Also, this unsewered area has a concentration of rural residences on Bel Roma Rd that are served by OWTS. There are no known future development plans for the area.

7. **Charlotte Way** – This AOC exists in the western portion of the Mocho I Subarea and may commingle with the Buena Vista AOC in the eastern portion of the Mocho II Subarea. The area is primarily sewered and developed as medium-density residential. There is no future development planned for the area. Elevated nitrate concentrations have been detected in at least three wells, but have historically been greatest in 3S/2E 14A 3 (12.0 mg/L in the 2015 WY) and 3S/2E 3K 3 (13.1 mg/L in the 2015 WY). The cause is believed to be historical OWTS, fertilizer applications, and other agricultural land uses that no longer exist in the area, but continue to have impacts on groundwater quality.

8. **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. This area is primarily unsewered low- to medium-density residential, vineyard and winery land uses with some future vineyard and winery development planned. The concentration in 3S/2E 22B 1, near the proximal end of the plume, fluctuates above and below the MCL, but has been above the MCL for the last few years (19.8 mg/L for the 2015 WY). The potential sources of the nitrate are existing OWTS and historical agricultural practices, livestock manure, and composting vegetation. There are over 100 OWTS still in use near the proximal end of the plume, documented historical poultry ranching, and crop and floral farming along Buena Vista Avenue.

9. **Greenville** – This Fringe Management Area East AOC, located near the corner of Greenville Road and Tesla Road, is primarily developed as unsewered low-density residential, vineyard, and wineries. Additional vineyard and winery uses are planned for this AOC in the South Livermore Valley Specific Plan. The highest concentration of nitrate recorded in this area was 37 mg/L in 2001 WY in 3S/2E 24A 1 (22.6 mg/L for 2015 WY). The source of nitrate in this area is unconfirmed, but believed to be from historical chicken farming, and other agricultural land uses located up-gradient. There is concern for the potential increase in onsite wastewater disposal from the future commercial development planned for this area.

10. **Mines Road** – This AOC is represented by a single well; 3S/2E 26J 2, located in the southern portion of the Main Basin upper aquifer 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. The reason for the fluctuations are unknown, but may be related to agriculture and changes in precipitation. This area is primarily unsewered low-density residential with little future development planned.

Current Nitrate Concentrations in the Lower Aquifer

In the Lower Aquifer, nitrate was detected above the MCL in only three areas:

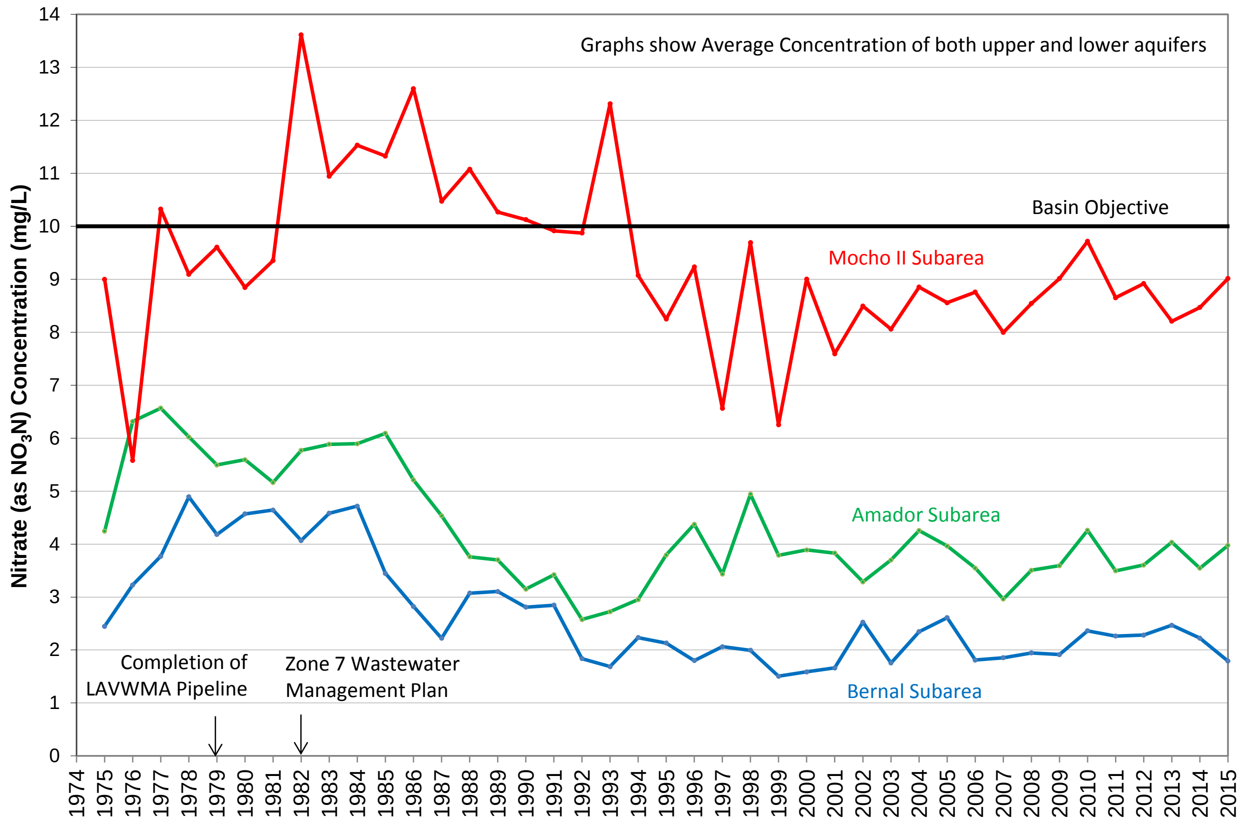
1. **Jack London** – While smaller in extent than the AOC for the Upper Aquifer, the general location of this AOC also underlies the shallow nitrate plume, suggesting communication between the Upper Aquifer and the Lower Aquifer. For the 2015 WY, only one well had nitrate concentrations above the MCL (3S/2E 8H 3 at 11.1 mg/L); however, two other wells were just below the MCL (3S/2E 8F 1 at 9.5 mg/L and 3S/2E 9P 1 at 9.8 mg/L).

2. **Buena Vista** – The general location of this AOC underlies the Buena Vista nitrate plume in the Upper Aquifer, also suggesting that nitrate from the Upper Aquifer has migrated into the Lower Aquifer. For the 2015 WY, the only well with a concentration above the MCL was 3S/2E 15B 1 at 13.9 mg/L, but two other wells (3S/2E 15E 2 at 9.0 mg/L and 3S/2E 16A 3 at 9.7 mg/L) were just below the MCL.

3. **Southern Portion of Amador Subarea** – Nitrate was detected in one well above the MCL (3S/1E 19D 9 at 11.5 mg/L) in this area. There is no corresponding concentration of nitrate above the MCL in the Upper Aquifer; however nitrate was detected at a slightly elevated concentration in a shallower well in the same nested set (6.12 mg/L in 3S/1E 19D 7). The source of this nitrate is unknown, but may come from historical agricultural land use in the vicinity.

Figure 2-37 shows graphs of historical average nitrate concentrations (measured as N) for each of three subareas in the Main Basin Management Area. The graphs indicate that nitrate concentrations decreased in all three subareas shortly after the completion of the LAVWMA pipeline and Zone 7‘s WWMP, and have remained relatively constant since the mid-1990s and within basin objectives.

Figure 2-37: Historical Average Nitrate (N) Concentrations by Subarea



2.3.8.5 Nutrient Loading

The nitrate loading and assimilative capacity of the basin was studied as part of the NMP. Groundwater nitrate concentrations are good indicators of nutrient contamination, and graphing concentrations versus time can indicate whether nitrate conditions are changing or stable. Given the variability of nitrate in the environment, Zone 7 uses estimates of nitrogen loading to evaluate long-term nitrate trends. The primary nitrogen sources and losses assumed in the NMP are shown in **Table 2-8** below.

The NMP estimated the future annual nitrogen loading and removal from all of these components for average hydrologic conditions. Annual nitrogen loading from each known source was estimated and summed spatially using GIS software. The results were then applied to a Zone 7-developed spreadsheet model to predict future nitrate concentrations for each basin area, taking into account planned land use changes and expansions of recycled water use. The model results predict that average nitrate concentrations will decrease over time in the Main Basin and northeast Fringe Management Areas, and will increase only slightly in the north and east fringe basin areas.

Table 2-8: Sources and Losses of Nitrogen in Groundwater

NITROGEN SOURCES	NITROGEN LOSSES
Stream Recharge	Soil Processes
Rainfall Recharge	• Denitrification
Pipe Leakage	• Soil texture (absorption)
Subsurface Inflow	• Plant Uptake
Horse Boarding (manure)	Groundwater Pumping
Rural (OWTS and livestock manure)	Mining Export
Winery (OWTS and process water)	Subsurface Outflow
Applied water (well water & recycled)	
Fertilizers (agriculture and turf)	

2.3.8.6 Municipal Wastewater and Recycled Water TDS and Nitrate Concentrations

The two largest wastewater collection and treatment works are operated by the City of Livermore and DSRSD, which treat over 99% of the wastewater in the Valley. Both of the publicly-owned treatment works produce secondary-treated effluent, which is exported from the Valley through the LAVWMA export pipeline, and tertiary-treated recycled water, which is used primarily for urban landscape irrigation. Currently, none of the recycled water is used for groundwater replenishment.

As summarized in **Table 2-9**, approximately 5,600 AF of the 17,736 AF of the recycled water produced in the Valley was recycled and used for landscape irrigation in the 2015 WY. This use of recycled water represents conservation of groundwater storage, assuming that the irrigation demand would have been met with groundwater. In 2015 WY, the City of Livermore produced and applied about 2,401 AF of the recycled water while DSRSD generated and used about 3,186 AF. About 71% (1,698 AF) of the recycled water produced by Livermore was applied over the Main Basin; the remainder was applied on areas outside of the Main Basin, primarily on Fringe and Upland Management Areas north of the Main Basin. All of DSRSD's recycled water was applied on areas north of the Main Basin.

Table 2-9: Recycled Water Volumes (AF) for the 2015 WY

	LWRP	DSRSD	Total
Wastewater Influent	6,812	10,924	17,736
Treated Effluent Exported via LAVWMA	4,686	7,839	12,525
Total Volume Recycled	2,401	3,186	5,587
Recycled Volume-Main Basin**	1,698	0	1,698

* Does not include Zone 7 Demin Plant discharge to LAVWMA via DSRSD
** Only the portion of recycled water which was applied over Main Basin landscapes.

The recycled water from both wastewater plants meets the Title 22 water quality standards for irrigation uses. While salt and nutrients are the primary constituents-of-concern for wastewater and recycled water applications over the Main Basin, other constituents-of-emerging-concern (CECs) would need to be considered if recycled water was used in aquifer recharge projects. **Table 2-10** presents the concentration ranges of salts (measured as TDS) and nitrogen compounds in the applied recycled water during the 2015 WY.

Table 2-10: Recycled Water Quality (mg/L, except where noted) for the 2015 WY

Compound	**LWRP**	**DSRSD**
SALTS		
Total Dissolved Solids (TDS)	640 - 730	599 - 820
NITROGEN COMPOUNDS		
Nitrogen (as NO_3)	ND - 0.15	ND – 2.28
Nitrogen (as NO_2)	0.75 - 1.5	0.63 - 3.47
Total Kjeldahl Nitrogen (TKN)	52 - 60	25 - 40
Nitrogen Loading (lbs/AF)	**142 - 164**	**69 - 111**

Zone 7 assumes that all of the salt mass in the applied water is carried downward by the percolate and eventually reaches groundwater. This leads to a conservative (potentially high) estimate of the salt loading attributed to their applications. About 1,547 tons (approximately 10%) of the Main Basin's gross salt loading (15,189 tons) was attributed to recycled water use over the Main Basin during the 2015 WY. However, if potable water supplies had been used for this irrigation demand, the salt loading would have been about 992 tons or only about 555 tons less. Usually this difference is significantly less than what is removed by Zone 7's MGDP.

The three nitrogen compounds in the table above represent the nitrogen content potentially available for conversion to nitrate as the water percolates through the soil. The bottom row of the table shows the total nitrogen loading (in pounds of nitrogen per AF) from all nitrogen loading. As mentioned previously, this methodology over-states nitrogen loading to groundwater in that it ignores nitrogen removal through soil denitrification and plant uptake processes. These conservative loading calculations simply provide a relative framework for historical comparison of nitrogen sources in the basin.

2.3.8.7 Other Applied Wastewater

A small amount of untreated wastewater is also discharged to the Main Basin as leachate from the VA Hospital wastewater treatment ponds located in southern Livermore, from other onsite domestic wastewater systems (septic systems), and from leaking wastewater and recycled water pipelines that run throughout the Groundwater Basin. Estimated volumes for the 2015 WY are presented in **Table 2-11**.

Table 2-11: Wastewater Volumes (AF) for the 2015 WY

	VA Hospital*	Septic Tanks*	Pipe Leakage**	Total
Wastewater Leachate	50	80	400	530

* Estimated
** Calculated. Includes leakage from sanitary sewer and recycled water pipes

The contribution to the Main Basin groundwater supply (530 AF) was estimated using –typical” wastewater flows from domestic septic systems, an estimate for the VA Hospital ponds, and the pipe leakage calculation described in **Section 2.4**. No significant changes have occurred in land uses or septic system densities over the Main Basin that would change the estimated water contribution from these sources in recent years.

Table 2-12 below presents the estimated concentration ranges of salts (measured as TDS) and nitrogen compounds in the applied wastewater for the 2015 WY.

Table 2-12: Wastewater Quality (mg/L, except where noted) for the 2015 WY

Compound	**VA Hospital**	**Septic Tank Leachate**	**Pipe Leakage**
SALTS			
Total Dissolved Solids (TDS)	460 - 860	500-700	640 - 820
NITROGEN COMPOUNDS			
Nitrogen (as NO_3)	7.7 - 16	ND - Trace	ND – 2.28
Nitrogen (as NO_2)	ND	ND - Trace	0.63 – 3.47
Total Kjeldahl Nitrogen (TKN)	–2 - 8	50-90*	–32 - 60
Nitrogen Loading (lbs/AF)	**10 - 32**	**136 - 245**	**–87 - 164**

* Estimated

The three nitrogen compounds in the table represent the nitrogen content potentially available for conversion to nitrate as the water percolates through the soil. The bottom row of the table shows the total nitrogen loading (in pounds of nitrogen per AF) from all three. Again, this methodology over-states nitrogen loading to groundwater in that it ignores nitrogen removal through soil denitrification and plant uptake processes. These conservative loading calculations simply provide a relative framework for historical comparison of nitrogen sources in the basin.

2.3.8.8 Additional Inorganic Constituents of Concern

Boron

Boron is a naturally-occurring element typically found at very low concentrations in groundwater from the Livermore Valley Groundwater Basin. While there is no MCL for boron, the US Environmental Protection Agency (USEPA) has identified a Health Reference Level (HRL) of 1.4 mg/L. Boron also becomes a problem for irrigated crops when present at levels above 1 or 2 mg/L, depending on the crop sensitivity.

Current Concentrations of Boron in the Upper Aquifer

Boron occurs at elevated concentrations (up to 34 mg/L) in the Upper Aquifer in two areas of the groundwater basin:

1. Elevated boron concentrations extend along the Dublin-Bernal and Camp-Amador boundaries. The highest localized concentration of boron in this area has been relatively stable and was detected near the center of this area in 3S/1E 4J 5 at a concentration of 10.6 mg/L in the 2015 WY (compared to 12 mg/L in the 2014 WY).

2. Elevated boron concentrations were also detected in the eastern portion of the valley in the May, Spring, Mocho I, and Mocho II Subareas. The highest concentration detected was in the northern portion of this area in 2S/2E 27P 2 at 34 mg/L in the 2015 WY (compared to 32.9 mg/L in the 2014 WY).

The source of boron is unknown but may be from natural alkali/marine sediments. It should be noted that the boron detected in the western portion of the basin is primarily along the Arroyo Las Positas and lower Arroyo Mocho. It is likely that the source of this boron may be from the high-boron groundwater in the eastern portion of the Valley that has discharged into the Arroyo Las Positas in the North Livermore area and flowed downstream to the Arroyo Mocho, recharging into the Amador Subarea along the way.

Current Boron Concentrations in the Lower Aquifer

In general, boron concentrations are relatively low in the Lower Aquifer; detections are typically less than 1 mg/L. However, boron was detected above 2 mg/L in three Lower Aquifer wells in the 2015 WY as follows:

1. Boron was detected in one well in the eastern portion of the Mocho II Subarea: 3.34 mg/L in monitoring well 3S/2E 23E 2 (compared to 2.51 mg/L in the 2014 WY in the same well).

2. Boron was also detected above 2 mg/L in two monitoring wells near Hopyard Well No. 9 in the northern portion of the Bernal Basin: 2.56 mg/L in 3S/1E 17D 4 (also 2.56 mg/L in the 2014 WY) and 3.18 mg/L in 3S/1E 17D11 (compared to 2.49 mg/L in the 2014 WY). However, concentrations in Hopyard 9 itself have always been below 0.6 mg/L.

The source of boron is unconfirmed, but may originate in localized natural alkali/marine sediments or vertical migration through the leaky aquitard from the Upper Aquifer.

Chromium

Chromium is also a naturally-occurring element found in the Livermore Valley Groundwater Basin and is generally derived from the Franciscan Assemblage, which contains Serpentinite that tends to be rich in magnesium, chromium, and nickel. While total chromium has always been included in the groundwater sampling program, it is being examined in more detail for compliance with a recent MCL of 0.01 mg/L for hexavalent chromium (Cr VI), established in July 2014. To be conservative, the Groundwater Quality Program assumes that the total chromium concentration is exclusively Cr VI.

Current Concentrations of Chromium in the Upper Aquifer

Chromium has been encountered in four areas in the alluvium above the new MCL of 0.01 mg/L, described below from west to east:

1. A small plume of elevated chromium exists in the Dublin Subarea in the vicinity of DSRSD's wastewater disposal facility. The maximum concentration of chromium was 0.03 mg/L in 3S/1E 6N 2.

2. There are four wells with elevated concentrations of chromium along the northern boundary of the Camp Subarea near the border with the Tassajara Formation bedrock. The highest concentration was detected in 3S/1E 2M 3 at 0.023 mg/L. This chromium may be entering the alluvium as hill-front recharge and/or subsurface inflow from the neighboring Tassajara Formation and Contra Costa Group bedrock to the north.

3. Two wells in the Mocho II Subarea have chromium concentrations above the MCL (3S/2E 15R17 at 0.012 mg/L and 3S/2E 15M 2 at 0.018 mg/L). Both of these appear to be isolated as concentrations in other nearby wells are below the MCL.

4. Chromium was detected in three wells in the Mocho I Subarea, the highest of which was detected in 3S/2E 12C 4 at 0.122 mg/L.

Current Concentrations of Chromium in the Lower Aquifer

Chromium was encountered in three areas in the Lower Aquifer above the new MCL of 0.01 mg/L, described below from west to east. These elevated concentrations did not correspond with areas of elevated concentrations in the upper aquifer.

1. Chromium was detected above the MCL in two wells in the northern portion of the Amador Subarea (0.013 mg/L in COL 5 and 0.012 mg/L and 3S/1E 12 H 4). Elevated chromium concentrations close to the MCL were also detected in several other wells in this area, most notably in Stoneridge 1 at 0.008 mg/L.

2. Elevated concentrations of chromium above the MCL were detected in two supply wells in the central portion of the Mocho II Subarea (0.011 mg/L in 3S/2E 9P 1 and 0.012 mg/L in 3S/2E 16C 1).

3. Chromium was also detected just above the MCL in two wells near the boundary between the Mocho I and Mocho II Subareas (0.011 mg/L in 3S/2E 14B 1 and 0.014 mg/L in 3S/2E 10Q 2).

2.3.8.9 Toxic Sites

Zone 7 documents and tracks sites where groundwater has been impacted from anthropogenic sources and identifies those that pose a potential threat to drinking water. Zone 7 also coordinates closely with lead agencies to ensure protection of beneficial uses. Information is gathered from state, county, and local agencies, as well as from Zone 7's well permitting program and the California State Water Resources Control Board's (SWRCB's) GeoTracker website, and compiled in a GIS database. This tracking program is designated the Toxic Sites Surveillance (TSS) Program and is described in the Zone 7 Annual Reports.

Each site in Zone 7's TSS Program has been assigned a Zone 7 number, which corresponds to a file number containing reports or other information about the site. In addition, all sites are reviewed and given a priority designation (high, moderate, or low) based on the threat they pose to groundwater. For example, a site is designated as high priority if contamination at the site is present in groundwater at concentrations greater than the MCL and a water supply well is within 2,000 ft down-gradient of the site, or it is shown that drinking water or surface water will likely be impacted by the contamination at the site. High Priority sites are typically located in the Main Basin where Zone 7 and their retailer's wells are located. However, if another type of supply well (domestic, industrial, agricultural, etc.) located outside of the Main Basin is impacted or threatened the same criteria would apply.

In general, the TSS Program has found two types of contamination threatening groundwater in the Livermore Valley Groundwater Basin:

- **Petroleum-based fuel products -** including total petroleum hydrocarbon as gasoline (TPHg), TPH as diesel (TPHd), benzene, toluene, ethylbenzene, xylene (collectively known as BTEX), and fuel oxygenates, such as MTBE and tertiary-butyl alcohol (TBA). California has assigned clean-up standards (*Title 22, California Code of Regulations*) for the BTEX compounds and fuel oxygenates. However, a clean-up standard for total petroleum (TPHg or TPHd) has not officially been established.

- **Industrial chemical contaminants** – including the chlorinated solvents tetrachlorethylene (PCE), trichloroethylene (TCE), and their degradation by-products, such as vinyl chloride (VC) and dichloroethene (DCE). PCE is common in the dry cleaning business, and TCE is commonly used as a degreaser for the electronics and automotive industries. Both PCE and TCE have an established MCL of 5 micrograms per liter (µg/L) (*California Code of Regulations, Title 17, Section 64444*).

In the 2015 WY, Zone 7 tracked the progress of 45 active sites where contamination has been detected or is threatening groundwater. Nine of these active sites have a contaminant plume which 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 the potential impact on potable groundwater supplies. Zone 7's database also contains 268 other contamination cases that have been either —Closed" or classified as —No Action Required" because they have been sufficiently cleaned up and/or they pose minimal threat to drinking water supplies. Eleven cases were closed in the 2015 WY. Six cases have closure requests that were still being considered at the end of the 2015 WY. One new case was added to the Zone 7 database in the 2015 WY.

The locations of all the toxic sites are provided in the Annual Reports on three detailed maps that also show each toxic site's proximity to the Valley's municipal water wells. These maps are included in the 2015 WY Annual Report (*Zone 7, 2016c*, included in **Attachment B**, see *Section 12.5*). The Annual Reports also contain a summary for each of the active sites including the case status, its priority, and which agency is responsible for providing oversight on the case. It also identifies the contaminants of concern for each case and provides brief notes regarding the case.

2.3.9 Land Subsidence

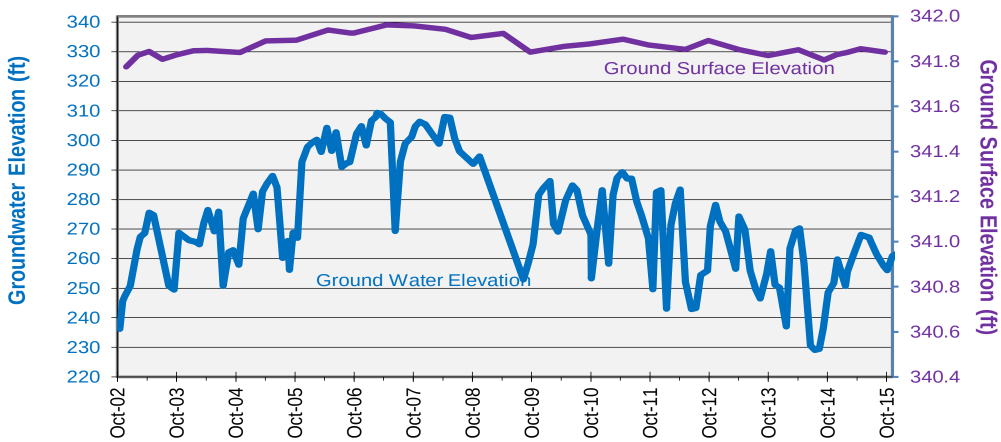
For the Livermore Valley Groundwater Basin, land surface may exhibit changes in elevation over time due to several mechanisms such as: 1) regional tectonism; 2) localized shrinking and swelling of expansive soils in the upper 15 to 50 feet; and 3) changes in cyclical groundwater levels. Land surface elevations have been monitored in Zone 7‘s groundwater basins for over 60 years, with no evidence of inelastic land subsidence occurring; however, the data collected have revealed small seasonal fluctuations as well as larger cycles of elevation gains and losses that correlate with groundwater elevations trends. These elastic surface elevation fluctuations have generally been confined to a range of 0.3 feet per cycle.

In 1994, Zone 7 commissioned Altamont Land Surveyors, Inc. to identify possible downward ground movement over the Main Basin by investigating the history of published benchmark elevations. For the study, the results were reviewed from several level survey circuits, which were run periodically across the Main Basin between 1947 and 1980. The study found that certain Main Basin benchmarks experienced downward movement of up to -0.4 feet between 1947 and 1965, followed by nearly full elevation recovery by 1974. The benchmarks once again showed full elevation recovery in 1980 following the 1977 drought *(Altamont Land Surveyors, 1994,* included in **Attachment J**).

Work on Zone 7‘s WMP and EIR in 2002 precipitated Zone 7‘s current detailed Land Surface Elevation Monitoring Program as described in **Section 4.7**. The adoption of the WMP EIR in 2005 required that this program continue. The monitoring information provided the technical basis for Zone 7 to use historic low groundwater levels as a conservative operating guide to avoid inelastic (permanent) land surface elevation changes.

The Zone 7 Land Surface Elevation Monitoring Program encompasses Zone 7‘s production wellfields and includes a network of approximately 60+ elevation benchmarks spanning the Bernal and Amador Subareas within the Main Basin and reference benchmark points located in bedrock outside of the alluvial basin. The Land Surface Elevation Monitoring Program is conducted semi-annually and results are presented in Zone 7 Annual Reports. **Figure 2-38** illustrates the variation in land surface elevations observed near the Mocho Wellfield from 2002 through the 2015 WY.

Figure 2-*38*: Surface Elevation and Groundwater Levels at Mocho Wellfield



The most recent Land Surface Elevation Monitoring Program results, based on surface elevation monitoring conducted at about 40 benchmarks between Fall 2014 and Fall 2015, are provided in the 2015 WY Annual Report (included in **Attachment B**).

Cal Engineering & Geology (CE&G) completed a Ground Movement Study for Zone 7 in June 2015 which synthesizes existing information about ground surface movement, including changes in ground surface elevation. The Ground Movement Study found that ground surface monitoring points rise and fall on the order of 0.025 to 0.050 feet on an annual basis. These elevation changes were detected in areas with unconsolidated sediments. The ground surface elevation changes decreased towards the basin margins and were not detected, or were insignificant, in bedrock. Some of this movement may be due to whether the benchmarks are fixed to ground surface features or supported deeper into the ground. Benchmarks have shown little or no surface elevation movement whereas less permanent survey points, such as chisel marks, spikes, or brass disks in roadways have shown 3 to 10 times more movement. Groundwater levels are being managed to remain above historic lows and ensure that any surface elevation changes are elastic (*CE&G, 2015*).

In September 2016, a satellite-based SqueeSAR analysis of historical ground deformation in the Livermore and Pleasanton area was completed for Zone 7 by TRE ALTAMIRA Inc. (TRE). The study was based on an analysis of interferometric synthetic aperture radar (InSAR) data from three different satellites over a 24-year period, from 1992 to 2016. The study involved analysis of 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 (*TRE, 2016,* included in **Attachment I**). The study results correlated well with topographic surface measurements taken within the same time period and found that land elevation changes occurred at deformation rates in the Livermore and Pleasanton area ranged from -2.01[3] to 1.38 inches per year (in/yr) (-0.17 to 0.02 ft/yr) from 1992 to 2016.

[3] Negative numbers indicate a decline in surface elevation and positive numbers indicate a rise in surface elevation.

Seasonal deformation was up to 0.57 inches (0.05 ft), and was largest over the Mocho II Subarea in Livermore (*TRE, 2016*). Seasonal movement was also detected in the Bernal and Amador Subareas in Pleasanton. Results of the study supported the elastic nature of the deformation indicated by local monitoring points. Again, no inelastic deformation was detected.

2.3.10 Surface Water – Groundwater Interaction

2.3.10.1 Overview

In general, groundwater does not interact directly and dynamically with surface water in the Livermore Valley Groundwater Basin, and surface water-groundwater interaction does not function as interconnected surface water systems as defined in the GSP regulations. Bottoms of the surface water channels are above the water table and provide recharge to the groundwater system where sufficiently permeable sediments occur beneath the arroyos. Wet reaches of the arroyos are correlated to discharge of surface water to the channel from mining operations or for conjunctive use. Surface water remains in several reaches of surface streams in the basin where surficial clay deposits impede groundwater recharge. Nonetheless, groundwater does not generally contribute to baseflow along surface water reaches in the basin.

One exception is the seasonal springflow associated with the alkali sink at Springtown (introducted in **Section 2.1.4** and summarized below). Another possible exception is the interaction of groundwater and surface water in gravel mining areas, where the water table is exposed in gravel quarries. In these areas, groundwater does not contribute to baseflow, but a surface water-groundwater connection must be recognized. A final area for consideration of surface water-groundwater interaction is an area of shallow groundwater associated with prehistoric wetlands. Surface water-groundwater interaction at these three locations are discussed in more detail below.

The prehistoric Livermore Valley encompassed two major landscapes. These included extensive dry grasslands crossed by permeable, rapidly drained arroyos in the southern valley; a portion of this area is now characterized by extensive aggregate mining with managed surface water-groundwater interactions. In addition, the prehistoric valley included two extensive wetland complexes. These included the salt-influenced Springtown Sink in the northeastern Fringe Management Area, which exists today and is associated with seasonal alkaki wetlands and a groundwater dependent ecosystem. In addition, the historical Pleasanton marsh complex (with springs, open water, seasonal wetlands, willow thickets, and freshwater marshlands) previously existed in the westernmost basin.

2.3.10.2 Springtown Alkali Sink

The Springtown Sink, described in **Section 2.1.4**, remains an area of surface water-groundwater interaction, albeit reduced in area from its historical extent by suburban development and associated stream channel alterations for flood control in the 1960s and 1970s (including deepening of Altamont Creek). Areas north and east of the sink have not experienced significant residential development, although overland flow of surface water into the sink has been locally concentrated by historical construction of roads and ditches. Groundwater within the sink originates as recharge from precipitation and surface runoff, and also as underflow from the Altamont Uplands east of the groundwater basin. Groundwater generally flows south to the inferred Tesla fault zone, southwest of the sink, which apparently hinders flow and results in shallow groundwater conditions in the sink. Historical widening and deepening of Altamont Creek resulted in lower groundwater levels and shortening of the time that surface pools persist. As a result, ponded water is seasonal and is typically dry in late summer.

The significance of the Springtown Alkali Sink as a groundwater dependent ecosystem is recognized. The sink supports an alkali-saline wetland habitat with a mound and swale topography including alkali ponds with salt-tolerant plants and pools supporting vernal pool biota. Springtown Alkali Sink is habitat for over a dozen Federally-listed, state-listed or state-listed-as-sensitive plant and animal taxa and includes plant communities that are globally or regionally rare or otherwise degraded. It is also designated as Critical Habitat for vernal pools and some vernal pool species, and portions of the watershed are designated Critical Habitat for California red-legged frog, by the US Fish and Wildlife Service. Recognized as such, most of the alkali sink and adjacent creeks are protected either as Preserves of the City of Livermore or conservation easements, or are owned and managed by the Zone 7 Water Agency or the Federal Communications Commission.

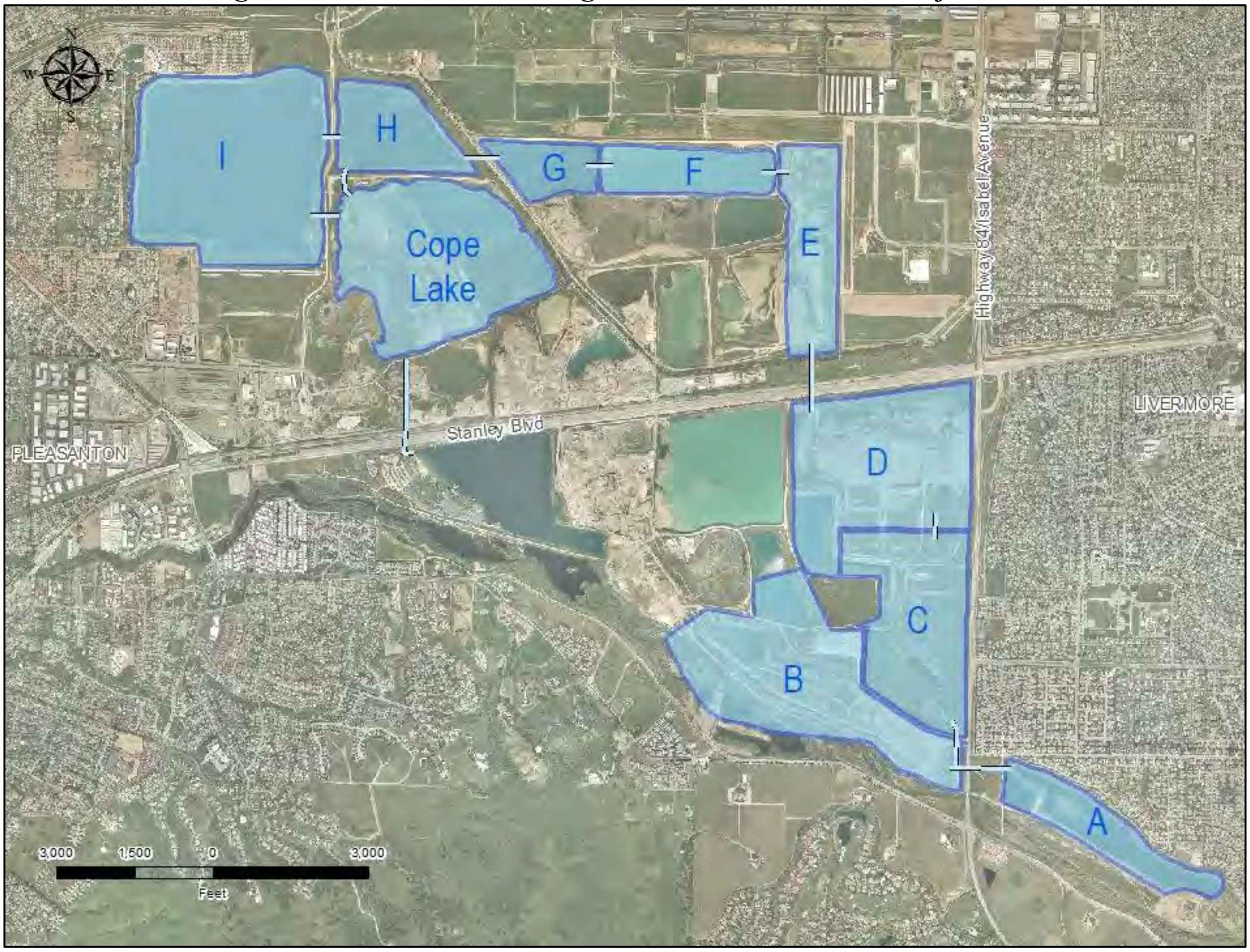
Restoration of the sink is a designated project of the Bay Area Integrated Water Resources Management Plan (IRWMP). Sponsored by the Alameda County Natural Resources Conservation Service (with collaboration by Zone 7), the *Altamont and Las Positas Creeks/Springtown Alkali Sink Restoration Project* would implement proactive control of habitat-damaging and rapidly-spreading weeds in portions of Altamont Creek, Arroyo de las Positas, and the sink. This will restore native vegetation, prevent adverse impacts to endangered species, and initiate long-term restoration and management planning.

2.3.10.3 Mining Areas

Aggregate mining has been conducted in the central portion of the valley (Amador Subarea) since the nineteenth century. In the mid-1970s, the gravel producers at the time commissioned a quarry reclamation plan to establish mining and land reclamation policies. The mining plans included settling ponds, filled areas, and wet pits. Zone 7 worked closely with the mining companies in developing the quarry reclamation plan in order to provide groundwater recharge and conveyance through the mining area. This resulting Chain of Lakes reclamation plan involves implementation of the mining area reclamation to include a series of wet pits that will be owned and operated by Zone 7 for flood control and managed aquifer recharge. Full implementation of the Chain of Lakes by Zone 7 is not expected before 2058 when the mining operations are projected to be completed.

Figure 2-39 shows the current mining areas and future Chain of Lakes. The Arroyo Valle channel is located along the southern perimeter of the mining area, while the Arroyo Mocho channel has been directed through the middle of the mining area.

Figure 2-39: Current Mining Area and Future Chain of Lakes



Currently, Zone 7 and the mining companies actively cooperate in groundwater and surface water monitoring (see **Section 4.4**) and management of water in the mining area to allow mining while also providing groundwater conveyance and recharge. Activities related to groundwater - surface water interactions include, for example, transfers of water between pits and dewatering of groundwater from current mining pits with subsequent release for arroyo recharge.

Ongoing mining and reclamation is changing to some degree the connection between upper and lower aquifers and surface water, as some areas are capped or filled (thus reducing connection), and as excavation of wet pits effectively creates surface water ponds. However, no groundwater-dependent ecosystems exist in the mining area and the surface water pits are not identified for specific beneficial uses in the Basin Plan. Releases of water for recharge along the arroyos have resulted in dry season flows in the arroyos; however, these are flows are relatively warm and not equivalent to cool pre-mining flows that could support some native species.

2.3.10.4 Historical Pleasanton Marsh

The prehistoric Pleasanton marsh complex extended over thousands of acres, including much of the Bernal and Castle Subareas and extending north into the Dublin Subarea and east into the Amador Subarea. The existence of the marsh complex reflected the limited outlet of the

Livermore-Amador Valley along Arroyo de la Laguna, resulting in shallow groundwater levels and ponding of floodwater. Substantial groundwater flow through gravelly deposits associated with the arroyos and extensive clay sediments resulted in confined, artesian conditions in this area. In the nineteenth century, the Pleasanton marsh was rapidly converted to arable land through widespread construction of drains. In the mid-twentieth century, suburban development and associated stream channel alterations for flood control has effectively drained the area, which is now extensively urbanized (see land use map **Figure 1-7**).

Arroyo de la Laguna is situated along the western edge of the Livermore-Amador Valley (and the former Pleasanton Marsh) and extends southward into the Sunol Valley Groundwater Basin, where it joins Alameda Creek. In the late 1800s, the pre-development groundwater levels and hydraulic gradients caused groundwater to flow across the basin and naturally exit the basin as surface outflow (baseflow) into the Arroyo de la Laguna. Early groundwater development has contributed to lowering of groundwater levels in the areas; as a result, groundwater levels have generally been below the point (about 295 ft msl) where groundwater would naturally flow into the Arroyo de la Laguna (see historical hydrograph, **Figure 2-22**).

The Arroyo de la Laguna is habitat for the Western pond turtle, a California species of special concern. In addition, the lower Alameda Creek provides salmonid habitat. However, the presence of these species does not necessarily signify a groundwater-dependent ecosystem linked to groundwater in the Livermore-Amador Valley; as noted above, groundwater levels typically are below the point at which groundwater would flow into the arroyo. The Arroyo de la Laguna currently may have dry season flows, mostly reflecting urban return flows from lawn watering and other municipal uses.

The current monitoring network for Surface Water is included in **Section 4.3**.

2.4 Water Budget

2.4.1 Overview of Methodology

Zone 7 uses data from its ongoing monitoring programs to develop a groundwater budget on an annual basis. This section provides an overview of water budget methodologies and presents detailed discussions of the current water budget with inflows, outflows, and change in storage; historical water budget conditions and sustainable yield; operational groundwater storage; surface water supplies; and factors affecting Zone 7‘s ability to operate the basin within the sustainable yield into the future (projected water budget conditions).

The Water Budget has been evaluated by Zone 7 for every year since 1974, providing 42 years of information to track sustainability. The water budget is compiled on a water year basis (from October 1 to September 30). While the regulations for GSPs indicate use of annual storage change between seasonal high conditions (likely to occur in spring), use of autumn groundwater storage has proved effective and accurate in the Livermore Valley Basin. Examination of the change in the annual low levels allow for a more accurate prediction of any trends for change in storage to fall below the operational storage guidelines established by Zone 7 for sustainable management.

The Water Budget is developed using two independent methodologies. The first method, referred to as the Hydrologic Inventory (HI), involves an accounting of all inflows and outflows and derivation of the change in storage as the residual of the water budget equation. The groundwater inflow and outflow components of the HI are listed in **Table 2-13**. Each component is derived independently, either directly from the monitoring program results or calculated using the results of a monitoring program.

Table 2-13: Groundwater Inflow and Outflows

INFLOWS	**OUTFLOWS**
Rainfall Recharge	Municipal Pumping • Zone 7 • By Others
Stream Recharge	
Applied Water Recharge	
Subsurface Groundwater Inflow	Agricultural Pumping
Pipe Leakage	Mining Use
	Groundwater Basin Overflow

To compute cumulative storage change, the HI method uses the volume difference between annual groundwater inflows and groundwater outflows to calculate a running total of basin storage. The difference is the net recharge, which is added to (or subtracted from) the previous year's ending storage value to arrive at the current year's ending storage value. The results assume that storage at the beginning of the 1974 WY was 212 thousand acre-feet (TAF) (from *DWR, 1974*).

The second method, termed the Groundwater Elevation (GWE) method, uses groundwater level data and storage coefficients for the Main Basin. Specifically, the Main Basin is divided into polygonal areas referred to as nodes (**Figure 2-15**). Each node has its own set of hydrogeologic parameters, such as storage coefficient, nodal thickness, and nodal area. The saturated thickness of the node is calculated using the nodal thickness, average groundwater elevations from the fall semiannual measuring event, and storage coefficient. The groundwater storage of each node is then calculated by multiplying the saturated thickness by the total area of the node. The total Main Basin groundwater storage is equal to the sum of all the nodal storage values for the 22 nodes in the Main Basin. GWE storage calculations before 1992 were calculated assuming a constant storage coefficient for the entire node (i.e., without differentiating between aquifers). However, starting in 2007, average groundwater elevations for each of the nodes and aquifers were calculated using *ArcGIS Spatial Analyst.*

Results of the two methods are compared with regard to total change in groundwater storage for the Main Basin; such comparison has allowed periodic re-examination and refinement of water budget computations. For example, for the past several years, the groundwater storage volumes calculated with the GWE method were typically higher than those measured with the HI method, starting at about the 2007 WY. Because the HI method is based on a running total, the difference between the two methods increased with time until it was about 25 TAF at the end of the 2014 WY.

For the 2015 WY Annual Report, Zone 7 staff assessed and revised the GWE and HI methods. Revision of the GWE method involved changes in use of monitoring data from specific mining area ponds in developing the Upper Aquifer groundwater contours on which the GWE calculations are based. Revision of the HI calculation method included the following steps:

1. Recalibrating the Areal Recharge Model so that applied water volumes account for drought conservation over the last three years.
2. Revising the Areal Recharge Model to calculate the total rainfall runoff that flows to each stream reach.
3. Revising the stream recharge calculations to include the rainfall runoff totals from the Areal Recharge Model. Previously they included only rough estimates for rainfall runoff based on rainfall and upstream flows,
4. Raising the maximum-allowable stream recharge rates for the Arroyos Valle and Mocho.

The improvements have resulted in better agreement between the results of the two methods going back to 2005. Following the revisions, the total difference between the two methods is about 2 TAF at the end of the 2014 and 2015 WYs, a substantial improvement from the difference reported previously. Staff will continue to evaluate both methods for other ways to improve accuracy and reduce uncertainty.

2.4.2 Current Groundwater Budget

2.4.2.1 Overview

This section presents the current (2015 WY) groundwater budget for the Main Basin and provides a description of how the inflow and outflow components are derived. The groundwater budget is completed by using the HI method to compute change in groundwater storage and then checked with the GWE method.

2.4.2.2 Inflow Components

Inflow components described below include stream recharge, rainfall recharge, applied water recharge, subsurface groundwater inflow and pipe leakage. For comparative purposes, long-term sustainable averages also are provided for inflow components; the sum of these is estimated at about 13,400 AF annually (*Zone 7, 1992*).

Areal (including Rainfall) Recharge

Zone 7 has developed a soil-balance, root-zone, spreadsheet model (―Areal Recharge Model") to estimate rainfall recharge, as well as rainfall runoff to streams, applied water recharge; and agricultural groundwater pumping for the Main Basin. Model parameters include rainfall, evapotranspiration, soil moisture capacity, and irrigation efficiency, and account for land use, growing season, source water type (municipal, groundwater, or recycled water), and runoff location (stream reach). This model has been refined over the years in an effort to resolve the difference between the HI and the GWE methods for calculating storage. For the 2015 WY analysis, the model was modified to also calculate the daily rainfall runoff to streams, which were used as stream inflows as part of the stream recharge calculations. Also some model parameters used to calculate applied water recharge (e.g., irrigation efficiencies and irrigation runoff) were adjusted to account for outdoor conservation during the last few drought years (2013 to 2015). For these three years, actual municipal deliveries were considered.

The updated areal recharge spreadsheet model was used to calculate rainfall and applied water recharge for the 2015 WY. The resulting annual recharge volumes are shown in **Table 2-14** below.

Table 2-14: Areal Recharge Components

SOURCE	2015 WY (AF)	SUSTAINABLE AVERAGE (AFY)
Rainfall Recharge	3,735	4,300
Applied Water Recharge	1,629	1,600
TOTAL RECHARGE	5,364	5,900

Rainfall recharge for the 2015 WY was about 87% of the sustainable average, which corresponds closely to overall rainfall in the Valley, which was 93% of normal. While applied water recharge was above the Sustainable Average of 1,600 AF (which was calculated in the 1990s), it is about 80% of the mathematical average of the historical applied water recharge total, reflecting the drought conservation considerations applied to the Areal Recharge Model.

Stream Recharge

Stream recharge is categorized into the following three components:

- **Natural stream recharge** - runoff from rainfall into the streams, including both urban and rural runoff from the watershed, which naturally recharges the basin‘s aquifers through the streambeds.

- **Artificial stream recharge** – aquifer recharge resulting from Zone 7-purchased SWP water being released from the SBA or from Lake Del Valle (both operated by DWR) into the arroyos for the purpose of augmenting the natural stream recharge, maintaining habitat along Arroyo del Valle, or as an alternate method of delivering water to ACWD.

- **Arroyo Valle Prior Rights recharge** – aquifer recharge resulting from SWP or local water released from the SBA or Lake Del Valle to the Arroyo del Valle to fulfill Zone 7 and Alameda County Water District‘s (ACWD‘s) Arroyo del Valle water rights requirements. The amount released is based on the amount that would have occurred if Lake Del Valle had not been constructed and is only required when Zone 7 and ACWD have local water stored in the lake.

Zone 7 calculates streambed recharge for each stream reach by subtracting all stream outflows (e.g., flow at the downstream end of the reach and any diversions from the stream) from all inflows (flow entering the upstream end of the reach, diversions into the stream, and rainfall runoff). The three primary recharge streams (Arroyos Valle, Mocho, and Las Positas) have gages upstream and downstream of the reaches along which recharge occurs (see **Figure 2-4** for stream gage locations).

One of the most difficult inflows to calculate is rainfall runoff into each reach which, in the past, was estimated using a regression formula based on rainfall totals and stream flow at various gage stations. For the 2015 WY, Zone 7 revised the Areal Recharge Model described above to calculate total daily rainfall runoff volumes into each stream reach. The Areal Recharge Model and streambed recharge spreadsheets were re-run retroactively to calculate the rainfall runoff totals and streambed recharge for each year back to the 2007 WY, when the storage volume estimates calculated by the GWE and HI methods previously began to diverge.

Also in the past, streambed recharge calculations included a cap on the maximum recharge rate for reach based on synoptic data. For the 2015 WY analysis, Zone 7 significantly raised the cap on maximum recharge to account for the time delay between upstream and downstream flows and for overbank flows that recharge the groundwater basin during high-rainfall events. While this change did produce some very high apparent daily recharge rates during rainfall events, especially on the Arroyo Valle, the average monthly recharge rates were within range.

These changes to the Areal Recharge Model and streambed calculation spreadsheets described above ensure a mass conservation of rainfall. In this manner, rainfall will either be accounted for as rainfall recharge or as rainfall runoff into streams. Also, by eliminating the cap on the maximum stream recharge rate, all rainfall runoff into the streams will be accounted for as either recharge or discharge flow from the reach.

Stream recharge volumes for the 2015 WY are presented in **Table 2-15** below.

Table 2-15: Stream Recharge Components

SOURCE	**2015 WY (AF)**	**SUSTAINABLE AVERAGE (AFY)**
Natural Stream Recharge	6,822	5,700
Arroyo Valle Prior Rights	0	900
Artificial Stream Recharge	4,648	5,300
TOTAL RECHARGE	11,470	11,900

While the 2015 WY was characterized by near-normal rainfall, natural stream recharge was estimated above the sustainable average. Zone 7 plans to re-assess the sustainable averages using the revised Areal Recharge Model in its future Groundwater Sustainability Plan efforts. Water releases were not made in the 2015 WY for Zone 7 and ACWD‘s Arroyo Valle Prior Rights because the total streamflow in the Arroyo Valle below Lake Del Valle exceeded the natural streamflow that would have occurred had the dam not existed.

Subsurface Groundwater Flow

Subsurface inflow, which occurs primarily in the Upper Aquifer from the Fringe Management Area to the Main Basin Management Area, is estimated based on gradients across the Main Basin boundaries, aquifer structure, and the hydraulic conductivities of the aquifer sediments. Subsurface inflow into the Main Basin is only thought to be significant from the Dublin and Camp Subareas, although some subsurface flow into the Main Basin may occur across the southern Bernal Subarea boundary from the Uplands Management Area. Prior to 2000, water levels were used to create rough estimates of subsurface inflow across boundaries; however, since the 2000 WY, Zone 7 has simply reported it as 1,000 AF per year because of the low variation and minor significance of this component.

Subsurface basin overflow, which also occurs primarily in the Upper Aquifer, tends to discharge into the Arroyo De La Laguna and flows out of the basin to the San Francisco Bay through Alameda Creek when water levels are above elevation 295 ft msl in this portion of the Bernal Subarea. For the entire water year, water levels in wells near the Arroyo De La Laguna remained below 295 ft msl. Consequently, there was an assumption that no basin overflow from the upper aquifer into the Arroyo De La Laguna occurred during the 2015 WY.

Subsurface Groundwater flow volumes for the 2015 WY are presented in **Table 2-16** below.

Table 2-16: Subsurface Groundwater Flow

SOURCE	2015 WY (AF)	AVERAGE (AFY)
Subsurface Inflow (estimated)	1,000	1,000
Basin Overflow	0	-100
TOTAL SUBSURFACE FLOW (NET)	1,000	900

Pipe Leakage

In the 2012 WY, Zone 7 staff began estimating the volume of water leaking from all underground water pipes into the Main Basin. Zone 7 estimates pipe leakage from water supply and sewage pipes into the Main Basin by using the following formula where pipe age is between 10 and 70 years old:

Leakage [gpd] = Pipe length [mile] x 50 [gpd/mile/yr] x (Pipe Age [yr] – 10).

The formula is based on the assumption that pipe leakage does not start until the pipe is at least 10 years old, after which it leaks at a rate of 50 gallons per day per mile (gpd/mi) for each year above 10 years old, up to a maximum of 3,000 gpd/mi; see discussion in *Section 4.2.5* of the Annual GWMP Report for the 2012 WY (*Zone 7, 2013*).

For the 2015 WY, total pipe leakage into the Main Basin is estimated at 1,133 AF.

2.4.2.3 Outflow Components

Zone 7 Groundwater Pumping

Table 2-17 shows groundwater pumping by Zone 7 for the 2015 WY. Zone 7 operates ten municipal supply wells in four wellfields. As shown, in the 2015 WY Zone 7 pumped 2,558 AF of groundwater (including 645 AF for DSRSD). This accounts for about one third of all municipal groundwater pumped from the Main Basin. Most of the groundwater pumped by Zone 7 was from the Amador Subarea (2,252 AF) with the remainder coming from the Bernal Subarea (306 AF).

Table 2-17: Zone 7 Groundwater Pumping

ZONE 7 PUMPING BY WELLFIELD	2015 WY (AF)
Amador Subarea	2,252
*Mocho wellfield**	1,228
Chain of Lakes wellfield	390
Stoneridge Well	634
Bernal Subarea	306
Hopyard wellfield	306
TOTAL PUMPING	2,558

* Includes 645 AF of groundwater pumped for DSRSD

Historically, Zone 7's annual groundwater pumping has varied with the availability of imported surface water and the capacity to treat that surface water. In general, Zone 7 operates its municipal supply wells for salt management, demand peaks, and compensation for a shortage or interruption in its surface water supply or treatment. Zone 7 pumps only water that has been recharged as part of its artificial recharge program using its surface water supplies. The decision of which well(s) to pump is based on pumping costs, pressure zone needs, delivered aesthetic water quality issues, salt management needs, local groundwater levels, and demineralization facility capacity. Although reduced groundwater pumping may have a positive impact on groundwater storage and delivered water quality, increased groundwater pumping has a beneficial impact on the basin's salt loading because much of the salt in the pumped groundwater eventually leaves the basin as wastewater export.

Groundwater Pumping by Others

Zone 7 compiles pumping data for all large capacity wells within the Main Basin. This includes daily and monthly pumping totals from the retailers. Records of other pumping wells are obtained from well owners when available. Pumping volumes from significant wells without meters are estimated from utility records or from the associated land use (e.g., crop type and number of acres irrigated).

In addition to Zone 7's ten municipal wells, Cal Water operates 12 wells in the Livermore area, and in Pleasanton, the City of Pleasanton operates 3 wells and SFPUC operates 2 wells. (see **Figure 2-18** for the relative locations of the municipal supply wells). Production volumes from the non-Zone 7 municipal and other supply wells (total pumped minus the discharge-to-waste during well start-ups) for the 2015 WY are presented in **Table 2-18** below.

Table 2-18: Groundwater Pumping By Others

PUMPING BY OTHERS	2015 WY (AF)	AVERAGE (AFY)
City of Pleasanton	2,775	3,500
Cal Water	2,012	3,070
DSRSD†	645	645
SFPUC	309	450
Fairgrounds	268	310
Domestic Wells**	112	200
Golf Courses**	243	227
Agricultural Pumping**	590	400
TOTAL	6,954	8,802

*Average based on annual Groundwater Production Quota
** Estimated
† Pumped by Zone 7 for DSRSD

Mining Area Losses

As shown in **Table 2-19***,* mining area losses for the 2015 WY totaled about 3,843 AF. Mining area evaporation (3,143 AF) accounts for a large portion of the losses and is second only to Municipal Pumping as an outflow component in the annual HI calculation. Zone 7 calculates the total monthly evaporative losses for the water bodies exposed to the atmosphere by mining operations (also referred to as mining ponds in this report) using the net difference between total rainfall and estimated evaporation over the total pond area.

Table 2-19: Mining Area Demand Components

DEMAND COMPONENT	2015 WY (AF)	AVERAGE (AFY)
Mining discharges to stream	0	700
Mining area evaporation	3,143	3,200
Gravel mining operations	700	700
TOTAL MINING AREA LOSSES	3,843	4,600

Mining activity losses also include groundwater lost due to export of moist gravels and groundwater that has been pumped from the quarry pits and discharged into a stream without subsequent recharge. The volume of this exported groundwater varies over time depending on the stage of mining in any given pit and the demand for aggregate resources. When the permitted gravel extraction operations are complete (currently envisioned for 2058), the associated operational groundwater losses (i.e., pit dewatering, gravel washing, and moisture export) will be eliminated.

2.4.2.4 Change in Groundwater Storage and Total Storage

The HI method was applied to compute the change in groundwater storage from the end of the 2014 WY to the end of the 2015 WY. This resulted in a calculated increase of total storage of about 6 TAF, from 209 to 215 TAF. Application of the GWE method resulted in a calculated increase of total storage of about 2 TAF, from 209 TAF at the end of the 2014 WY to 211 TAF at the end of the 2015 WY. As shown in **Table 2-20,** the total groundwater storage for the Main Basin is calculated by averaging the storage estimates from the GWE and HI methods.

Table 2-20: Groundwater Storage Summary (in Thousand AF)

Storage Calculation Method	**End of 2014 WY**	**End of 2015 WY**	**Change in Storage**
Groundwater Elevations (GWE)	209	211	2
Hydrologic Inventory (HI)	209	215	6
TOTAL STORAGE (avg of GWE & HI)	209	213	4

2.4.2.5 Estimated Groundwater Budget for the Fringe Management Area

The HI method was used to estimate a groundwater budget for the Fringe Management Area in an average water year (i.e. using average annual precipitation data). A summary of the groundwater budget for the Fringe Management Area is presented in **Table 2-21.** The methods described above were used to estimate Inflow and Outflow components. The number and listed uses of known wells located within the Fringe Management Area were used to estimate groundwater pumping by others. There is no pumping by Zone 7 or the retailers from the Fringe Management Area. Information such as crop type and irrigated acreage was used in conjunction with the Areal Recharge Model to estimate pumping by agricultural users and golf courses within the Fringe Management Area.

Table 2-21: Estimated Groundwater Budget for Fringe Management Area in an Average WY

Components	**(AF)**
Inflow	**6,921**
Stream Recharge	1,299
Rainfall Recharge	2,722
Pipe Leakage	545
Applied Water Recharge	2,355
Outflow	**6,921**
Zone 7 Pumping	0
Retailer Pumping	0
Agricultural Pumping	210
Golf Courses	392
Domestic Wells	126
Subsurface to Streams	5,193
Subsurface to Main Basin	1,000

2.4.2.6 Estimated Groundwater Budget for the Uplands Management Area

In general, wells within the Uplands Management Area are completed within semi-consolidated to consolidated bedrock units, have relatively low yields, and are for domestic use by de minimis extractors. Most of the precipitation that falls on the Uplands Management Area leaves the area as runoff and contributes to streams in the Fringe and the Main Basin Management Areas. With the above in mind, a simplified groundwater budget was estimated for the Uplands Management Area using average annual precipitation data from the Del Valle Plant Climatological Station (Station 17, 15.95 inches mean annual precipitation). A conservative recharge value of 3% (of mean annual precipitation) was used to estimate the combined rainfall and stream (minimal) recharge for the Uplands Management Area. The number and listed uses of known wells located within the Uplands Management Area were used to estimate groundwater pumping by domestic users. Information such as crop type and irrigated acreage was used to estimate pumping by agricultural users within the Uplands Management Area. A summary of the simplified groundwater budget for the Uplands Management Area is presented in **Table 2-22.** On average, there is roughly five times as much recharge in the uplands than groundwater pumping.

Table 2-22: Estimated Groundwater Budget, Uplands Management Area, Average WY

Components	**(AF)**
Inflow	**1,110**
Rainfall/Stream Recharge	1,110
Outflow	**217**
Agricultural Pumping	25
Domestic Wells	192

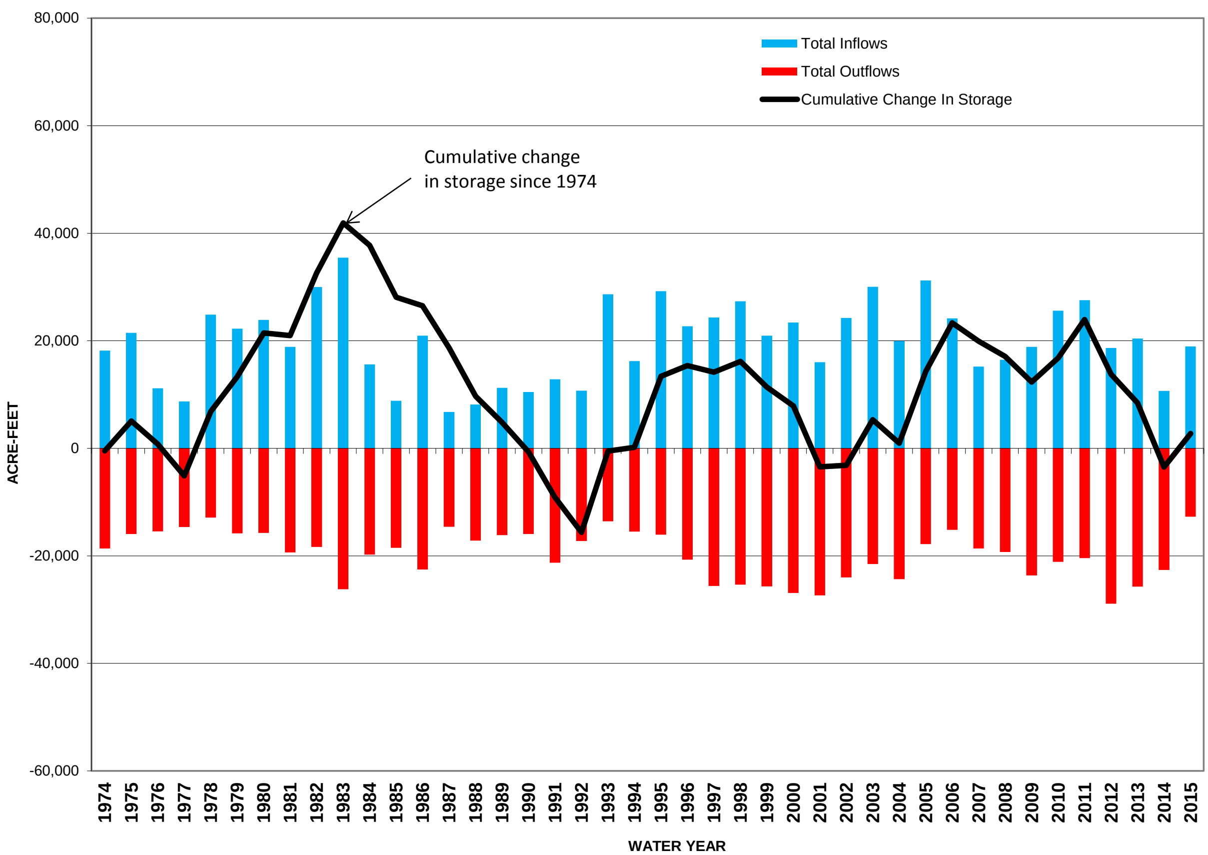
2.4.3 Historical Groundwater Budget

The Water Budget has been evaluated using the above-described methodologies for every year since 1974. The HI is updated and presented in the Annual WY Reports.

Figure 2-40 presents annual inflows (blue), outflows (red) and the cumulative change in groundwater storage from the 1974 WY through the 2015 WY. Beginning in about 1974, the basin had recovered from the historic lows in the early 1960s to more average water level conditions as a result of the Zone 7 conjunctive use program. Since that time, annual changes in groundwater storage have responded to wet and dry periods. However, only in the drought conditions of the 1990s did the cumulative change in basin-wide groundwater storage persist below the 1974 storage levels for multiple consecutive years. Even in the recent drought conditions, changes in groundwater storage have been managed and conditions in the 2015 WY brought the cumulative storage curve slightly above the 1974 volumes.

Figure 2-40 demonstrates the net results of Zone 7's groundwater supply management activities since 1974 for the Main Basin. As shown by the graph, any given year may have an imbalanced inflow and outflow, but with adaptive management, long-term sustainability is achievable; in this case, for 42 years.

Figure 2-40: Main Basin Sustainability



Using the water budget described above, along with water level contour mapping in the Main Basin, Zone 7 has estimated the amount of Groundwater in Storage from 1974-2015 (see **Figure 2-30**). During the 2015 WY, groundwater supplies stored locally in the Main Basin increased by approximately 4,000 AF. As a result, the 2015 WY ended with an estimated 213,000 AF of groundwater in total storage and 85,000 AF in operational (available above historic lows) storage. This represents about 67% of the Main Basin‘s operational storage capacity.

2.4.4 Maintaining Sustainable Yield

Overall, Zone 7 maintains the sustainability of the groundwater basin through the following actions:

- Monitoring the long-term natural groundwater budget;
- Importing, artificially recharging, and banking surface water to meet future demands;
- Implementing a conjunctive use program that maximizes use of the storage capacity of the groundwater basin;
- Limiting long-term groundwater pumping to sustainably manage the basin;
- Maintaining sustainable long-term groundwater storage volumes, even when total outflows exceed the natural sustainable supply;
- Promoting increased and sound recycled water use, and;
- Identifying and planning for future supply needs and demand impacts. This is often performed using Zone 7‘s groundwater model of the basin.

Looking farther into the future, Zone 7 plans to increase its conjunctive use to keep up with growing demands. Acquisition of additional former quarries (Lakes A through H) will become the area‘s future ―Chain of Lakes" allowing enhanced artificial recharge and regional flood protection projects to be fully implemented.

In order to maintain sustainable management of the basin, Zone 7 developed target values for inflows and outflows in 1992. As defined by SGMA, sustainable yield is the amount of water that can be extracted from the groundwater basin on an annual basis without causing undesirable results (defined for this basin in **Section 3**). Given that the groundwater basin is a relatively closed basin with minor amounts of subsurface inflow and outflow, the volume of groundwater in storage can be managed within an operational storage range, using averages of each water budget component as a general method for avoiding historic lows. Because no undesirable results have been observed while operating within this storage range, average water budget targets are referred to as sustainable yield estimates for the purposes of groundwater management.

For approximating the Natural Sustainable Yield of the Basin, the average amount of groundwater annually replenished by natural recharge in the Main Basin is used including percolation of rainfall, natural stream flow, and irrigation waters, and inflow of subsurface water. As shown in **Table 2-23**, that amount was determined in 1992 to be about 13,400 AFY.

Table 2-23: Natural Groundwater Inflow Components

Supply Component	Sustainable Yield Estimate (AFY)*
Natural Stream Recharge	5,700
Arroyo Valle Prior Rights	900
Rainfall Recharge	4,300
Applied (Irrigation) Water Recharge	1,600
Subsurface Groundwater Flow	900
Subsurface Inflow	*1,000*
Basin Overflow	*-100*
TOTAL	13,400

* as calculated in *Zone 7, 1992*

As shown in **Table 2-24**, this natural sustainable yield has been the basis for an allocation of pumping amounts to the municipal pumpers, each of whom have an established Groundwater Pumping Quota (GPQ). Averages are maintained by allowing a carry-over, and groundwater use in excess of the quota and carryover is addressed with a recharge fee that covers the cost of importing and recharging additional water into the Main Basin. The balance of the natural sustainable yield is pumped for other domestic, agricultural, and gravel mining uses.

Table 2-24: Natural Sustainable Yield Demand Components

Demand Component	Sustainable Average (AFY)
Municipal pumping by retailers (GPQs)[a]	7,214
Pleasanton	*3,500*
Cal Water	*3,069*
DSRSD	*645*
Other groundwater pumping[b]	1,186
Agricultural pumping	400
Mining area losses[c]	4,600
TOTAL	**13,400**

a. Based on calendar year. Livermore has a GPQ of 31 AF but it has not been used for many years.
b. For drinking water supply
c. Includes mining area evaporation, discharges that are diverted to arroyos and flow out of the Main Basin area, and losses incurred during gravel production and export.

This practice—including artificial recharge by Zone 7 Water Agency—helps avoid a repeat of historical overdraft of the basin.

2.4.4.1 Zone 7 Artificial Recharge and Pumping

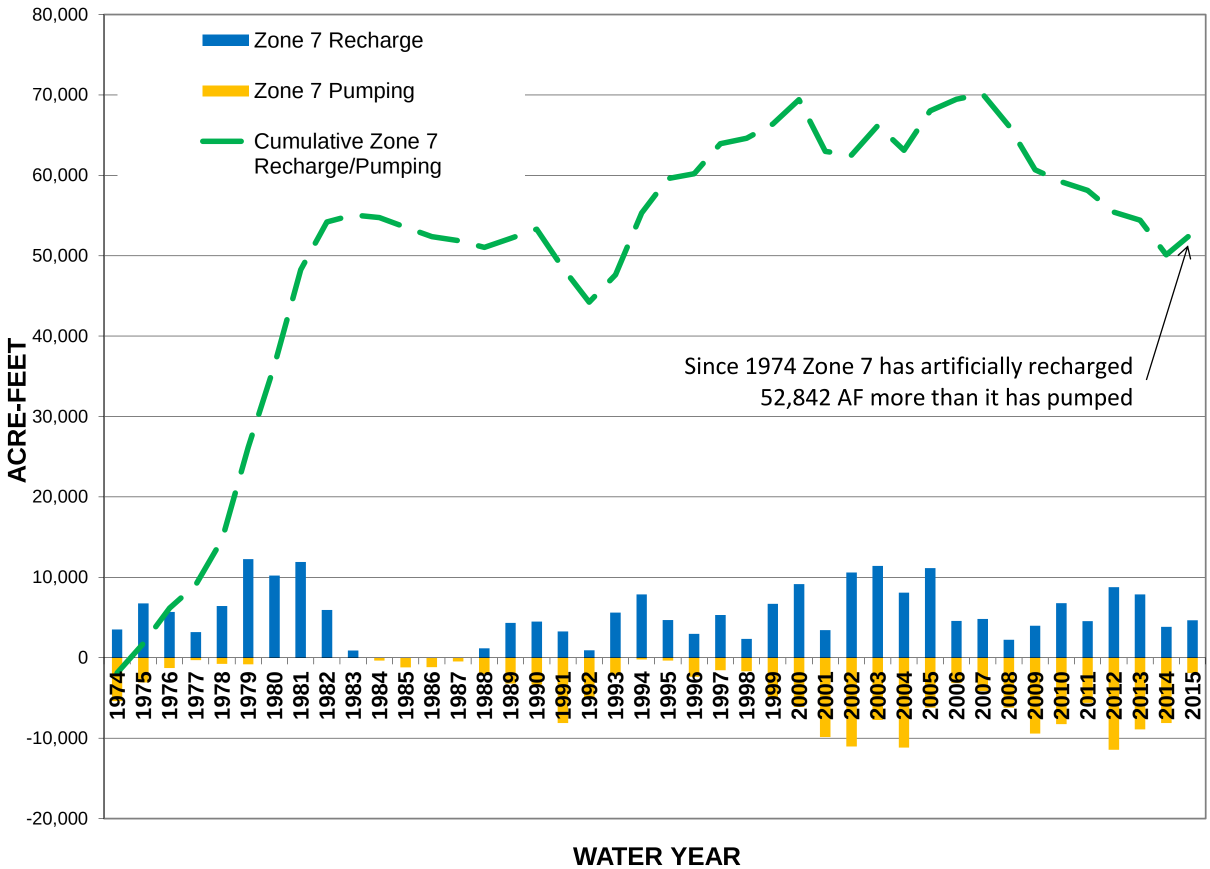
Zone 7 has been importing and recharging SWP water (artificial recharge) since the 1960s to replenish what has been pumped from the groundwater basin. Zone 7 actively embraces a conjunctive use approach to Basin Management by integrating management of local and imported surface water supplies with the management of local conveyance, storage and groundwater recharge features, including local arroyos (which are also used as flood protection facilities during wet seasons) and two former quarry pits (Lake I and Cope Lake).

The location and timing of artificial recharge operations is also used as a water quality management tool. When practical to do so, Zone 7 prioritizes its SWP releases for recharge to occur when TDS of the source water is low. Because each AF that is subsequently pumped from the basin removes water with higher TDS, this can eventually improve the salinity of the groundwater basin, helping achieve salt management objectives. The salt removal effectiveness of the conjunctive use program is related to the difference in the TDS of recharge and pumped water and the annual volumes involved.

The historical artificial recharge for the Main Basin has averaged about 5,300 AFY. Without this recharge, average Natural Sustainable Yield Demands would have outpaced the Natural Sustainable Yield Supply components. However since 1974, Zone 7 has imported and recharged about 220,000 AF to keep the basin sustainable.

Since 1974, Zone 7 has artificially recharged over 52,800 AF more water than it has pumped. The annual put and takes are depicted on **Figure 2-41** below along with the cumulative net results.

Figure 2-41: Zone 7 Recharge and Pumping 1974-2015



2.4.4.2 Imports and Surface Water Supplies

Zone 7 ensures that local water supplies (e.g., groundwater) are not depleted by importing approximately 80% of the Valley‘s water supply (delivered to Zone 7‘s retailers and agricultural customers) and recharging the Main Basin with surplus surface water when available (artificial recharge). Accordingly, availability of imported surface water supplies is the major factor affecting Zone 7‘s ability to operate the basin within the sustainable yield.

Zone 7‘s surplus surface water supplies, which are accounted for by calendar year, come from the following sources:

- **State Water Project (SWP deliveries via the South Bay Aqueduct [SBA])** - As a SWP contractor, Zone 7 imports supplies from the SWP through the SBA. As of 1998, Zone 7 has had an annual maximum SWP contract amount of 80,619 AFY referred to as the ―Table A Contract Amount." However, actual SWP deliveries are usually allocated in any given year by DWR at a lower level based on numerous factors, including hydrologic conditions. Currently, the long-term reliable yield of the SWP is approximately 60% of the Table A amount (48,370 AFY). This should increase if the California Water Fix is implemented by the State.

- **Arroyo Valle Water Rights (Lake Del Valle)** – Zone 7 has temporary water rights for a portion of the natural flows into Lake Del Valle. Accordingly, Zone 7 coordinates releases from the reservoir into the Arroyo Valle to maintain downstream flows and recharge through the streambed at the levels that would have occurred had the reservoir not been constructed. Additional releases of Arroyo Valle water can be made from the lake when such water is available for Zone 7. Maintaining minimum flows is a condition of Zone 7‘s water rights permit for the Arroyo Valle water and allows Zone 7 to use other portions of Arroyo Valle water for supply to its treatment plants and for supplemental aquifer recharge. Zone 7 is currently pursuing the permanent rights to this surface water source.

- **Byron-Bethany Irrigation District (BBID)** - Zone 7 has a contract with Byron-Bethany Irrigation District (BBID) for up to an additional 5,000 AFY of supplemental water made available to Zone 7 as a transfer of BBID‘s pre-1914 water rights water when surplus supplies are declared by BBID. When available, it is delivered upon request to Zone 7 through the SBA and can be used to supply Zone 7‘s artificial recharge program as well as Zone 7‘s water treatment plants. This water is only available in years when BBID declares a surplus is available for the transfer and approvals from DWR and the US Bureau of Reclamation are received. It was not available in the 2015 WY.

- **Kern Groundwater Basin (storage rights only)** - Zone 7 has purchased water storage rights in the Semitropic Water Storage District (78,000 AF) and in the Cawelo Water District (120,000 AF) groundwater basins in Kern County. These rights give Zone 7 the ability to remotely store surplus SWP water when available. When Zone 7 is ready to use the water locally; it can import that quantity of SWP water through an exchange procedure within the SWP system.

- **Yuba Accord –** In 2008, Zone 7 entered into a contract with DWR to purchase additional water under the Lower Yuba River Accord (Yuba Accord). The contract was amended in November 2014 to cover the period from October 2015 through 2020. New pricing would be negotiated at that time. There are four different Components (types) of water available; Zone 7 has the option to purchase Component 2 and Component 3 water during drought conditions, and Component 4 water when Yuba County Water Agency has determined that it has water supply available to sell. Zone 7 estimates the average yield from the Yuba Accord to be 850 AFY. In the 2015 Calendar Year (CY), Zone 7 received 276 AF.

- **Multi-Year Pool –** In 2013 and 2015, DWR implemented the Multi-Year Water Pool Demonstration Program, intended to facilitate the transfer of water between SWP contractors and to serve as an alternative to the under-used Turnback Pool Program. This program remains a pilot program. Zone 7 participated in the Multi-Year Pool in 2013 and 2015, and expects to participate in 2016.

- **Dry Year Transfer Program –** The State Water Contractors, an organization composed of contractors of the SWP, facilitates the purchase of water from the Feather River Watershed for transfer to SWP contractors during dry years. This is an optional program, and in 2015 Zone 7 opted out of this program.

Table 2-25: Supplemental Sources for the 2015 Calendar Year

Source	Available in 2015 CY (AF)	Used in 2015 CY (AF)	Carry-Over to 2016 CY (AF)
State Water Project	25,239	13,218	12,021
Table A (20% Allocation for 2015)	16,124	4,402	11,722
Article 56	9,115	8,816	299
Lake Del Valle (AV Water Rights)	2,994	2,861	133
BBID	0	0	0
Kern Groundwater Basin	92,202	17,813	74,389
Semitropic	72,018	12,784	59,234
Cawelo	20,184	5,029	15,155
Other		-1,057	
Kern transfer to San Luis Reservoir		-1,333	1,333
Yuba		276	
TOTAL	120,435	32,835	87,876

Other highlights for 2015 include:

- Zone 7's treated surface water made up 77% of regional potable water deliveries in the 2015 WY, just above the annual average of 75%.

- Due to the drought, Zone 7 recovered a record amount of water from storage banks, Semitropic and Cawelo (12,784 and 5,029 AF, respectively).

- Also because of the severe drought, Zone 7 curtailed its artificial recharge program early in the year, only releasing 3,924 AF to the local arroyos for the entire 2015 CY.

- Superb conservation by the Valley‘s residents, businesses and public agencies during the 2015 CY resulted in about 36% reduction in Valley-wide demand from the 2013 CY level.

- 1,333 AF of the 17,813 AF of water received from the Kern Groundwater Basin was sent to San Luis Reservoir for carryover to the 2016 CY.

2.5 Projected Water Budget and Future Management

Zone 7‘s imported water supplies have decreased in reliability over the years as SWP reliability has declined. Furthermore, Zone 7 expects continued growth in population; while these are evaluated in Zone 7‘s 2016 Water Supply Evaluation (WSE) Update and Urban Water Management Plan (UWMP), projected increases in demand are difficult to predict given unknowns related to ultimate levels of conservation.

In evaluating project water supply and demand, the WSE Update and UWMP considered climate change. Recognizing that most of the Zone 7 supply is SWP water, the Zone 7 UWMP used the scenarios in the 2015 SWP Delivery Capability Report to account for climate change impacts based on 2025 emissions level and a 15 centimeter sea level rise. Accordingly, these impacts have been incorporated into Zone 7‘s water supply planning efforts. Zone 7 has also evaluated the impacts of climate change to local water supplies for the WSE Update. This analysis utilized Cal-Adapt, the web-based climate adaptation planning tool developed by the State of California to help local planners. In planning, Zone 7 has incorporated potential changes in local rainfall due to climate change, including a decline in average annual rainfall.

The WSE Update also evaluated water supply alternatives or potential future water supply projects that could be used to make up for the decreased reliability from existing supplies and to meet demands from growth. These alternatives are listed below. Zone 7 expects that a portfolio of these alternatives will be needed to meet future supply shortfalls. Conservation is an important part of Zone 7‘s future water supply portfolio and is reflected as demand reduction, which is incorporated in the Retailers‘ demands.

In developing the WSE Update, Zone 7 staff (with input from Retailers) identified three major options, including:

- **California WaterFix:** Zone 7‘s current long-term contract for a Table A amount of 80,619 AFY represents most of Zone 7‘s normal supply and is thus critical to the overall water supply reliability. Zone 7 is working closely with DWR and other water agencies, environmental groups, regulatory agencies and fish agencies to address the declining reliability of the SWP. Efforts have culminated in the California WaterFix, which would create a dual conveyance system in the Sacramento-San Joaquin Delta and restore 8,000 AFY of SWP water to Zone 7.

- **Bay Area Regional Desalination Project (BARDP):** In addition to its existing desalination projects, Zone 7 is participating in evaluating a regional project. BARDP is a joint venture among Zone 7 and four other Bay Area water agencies (Contra Costa Water District [CCWD], East Bay Municipal Utility District [EBMUD], San Francisco Public Utilities Commission [SFPUC], and Santa Clara Valley Water District [SCVWD]), working together to investigate the feasibility of a regional brackish water treatment facility in eastern Contra Costa County. Zone 7 could potentially receive 5,600 AFY.

- **Potable Reuse:** The Tri-Valley area has used recycled water for irrigation and other non-potable uses for decades. Use of purified recycled water as a future potable water supply is currently under consideration as a joint effort by Zone 7 and the four Retailers. Options being evaluated include groundwater recharge/injection, surface water augmentation, and connection upstream of the Zone 7 water treatment plants.

2.6 Groundwater Model

2.6.1 Model Description

Zone 7 maintains a numerical groundwater model of the basin for predicting the consequences of proposed groundwater basin management actions. The model, originally created in Visual MODFLOW, has been converted to Groundwater Vistas and uses MODFLOW packages (e.g., NWT, MT3D) to perform the modeling calculations. In 2006, Zone 7 and HydroMetrics WRI (HydroMetrics) reevaluated, recalibrated, and revised the model as described in the Annual Report for the Groundwater Management Program – 2005 WY (*Zone 7, 2006d)*.

The active part of the groundwater model encompasses the Amador, Bernal, Bishop, Camp, Castle, Dublin, and Mocho II Subareas of the Basin. The groundwater model has been used for water supply well siting and planning (*Zone 7, 2003*). More recently, for Zone 7's Water Supply Evaluation (*Zone 7, 2011c*), the groundwater model was used to identify the maximum amount of groundwater Zone 7 could pump using existing wells during a six year drought without going below historic lows.

2.6.2 Groundwater Model Update and Improvements

In December 2013, DWR awarded Zone 7 a Proposition 84 Local Groundwater Assistance Program grant of $200,000 to update the groundwater model so that it can better evaluate future groundwater management and salt mitigation strategies. The approved scope of work for the project includes:

- Converting the model software from MODFLOW SURFACT to MODFLOW NWT

- Incorporating the MODFLOW Streams and Lakes Packages
- Adding additional layers to the model that represent hydrostratigraphic boundaries identified in recent geologic studies
- Recalibrating the model using both water elevation and salt concentration datasets
- Running up to three scenarios to test the operation of the model and its ability to optimize Zone 7's maximum pumping capacity under various drought conditions

One of the primary goals of updating the Zone 7 groundwater model has been to recalibrate it using current and historic TDS concentrations so that there will be more confidence in the results of future model runs conducted to evaluate TDS impacts and mitigation feasibilities. This update project's completion date was extended to March 2016 to allow new data from the ongoing drought to be incorporated along with some recent software updates.

The model was used to predict the impacts that Zone's planned groundwater pumping would have on groundwater levels if the drought continued for two additional years. In addition to modeling for groundwater flow, the model has also been used to evaluate and simulate salt loading impacts and the siting effects of a second Zone 7 groundwater demineralization plant planned for construction in the future.

Documentation for the model, as well as applications and results, will be provided in a report (including appendices) to DWR, *Groundwater Model for Groundwater and Salt Management in the Livermore Valley Groundwater Basin: Updates, Calibration, and Application,* expected to be completed in early 2017.

3 Sustainable Management Criteria

The GSP regulations (including requirements for an Alternative Plan) establish a specific process for groundwater management, introducing numerous new terms and criteria for development of thresholds and objectives. While it is recognized that these terms have not yet been incorporated into Zone 7 policies and actions, the Agency's current groundwater management practices are highly consistent with the SGMA process. Further, the guiding basin management objectives from the Zone 7 GWMP can be readily translated into SGMA terminology; they cover each of six Sustainability Indicators[1], as defined by the regulations. This section re-states Zone 7's groundwater management goals and objectives and shows how they relate to requirements under SGMA. These objectives are then incorporated into this Alternative Plan as sustainability criteria.

In addition to the affirmation of current sustainable management goals and objectives, two additional SGMA terms are defined for this Alternative Plan: *undesirable results* and *minimum thresholds*. These two terms are defined for each applicable Sustainability Indicator and the Zone 7 Management Areas. Additional information on Sustainability Indicators and the goals and objectives for this Alternative Plan are provided in the sections below.

3.1 Sustainable Management Goal

The sustainable management goal for this Alternative Plan is to continue to operate the Livermore Valley Groundwater Basin within its sustainable yield[2] and to manage the groundwater resources for the prevention of significant and unreasonable (1) lowering of groundwater levels, (2) reduction in basin storage, (3) degradation of groundwater quality, (4) inelastic land subsidence, or (5) depletion of surface water supplies such that beneficial uses are adversely impacted. These five goals are similar to Sustainability Indicators[3] as defined by GSP regulations. If the sustainability indicators occur at significant and unreasonable levels (as determined by local GSAs), the indicators are defined by regulations as undesirable results.

Zone 7 also has a stated goal of managing the local groundwater resources to provide a reliable water supply and to protect the resource for all beneficial uses. These goals are complementary and provide the guiding principles for groundwater management of the Livermore Valley Groundwater Basin.

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[1] GSP regulations define six sustainability indicators including (1) lowering of groundwater levels, (2) reduction in basin storage, (3) seawater intrusion, (4) degradation of groundwater quality, (5) inelastic land subsidence, and (6) depletion of surface water supplies such that beneficial uses are adversely impacted (§351(ah) and 10721(x)).

[2] Sustainable Yield is defined by SGMA as the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result.

[3] As shown in Footnote above, the six sustainability indicators defined in the regulations also include seawater intrusion. As the Livermore Valley Groundwater Basin is not a coastal basin subject to seawater intrusion, this sustainability indicator is not applicable to the Alternative Plan.

3.2 Basin Management Objectives and Sustainable Management Objectives

To meet the sustainable management goals, Zone 7 has developed and/or adopted a series of policies, ordinances, and basin management objectives that have expanded over time to adapt management actions to groundwater conditions. The primary objectives of the Zone 7 groundwater management program are to provide for:

- control and conservation of waters for beneficial future uses,
- conjunctive use of groundwater and surface water,
- importation of additional surface water, and
- use of the groundwater basin to store imported surface water for subsequent recovery during drought periods.

In Zone 7's 2005 GWMP, a series of basin management objectives (BMOs) were identified as the guiding principles for basin management decisions. Those objectives addressed five sustainability indicators and remain relevant to this Alternative Plan. Because seawater intrusion is not a relevant issue for this inland basin, no objective or sustainability indicator is needed. These primary BMOs implemented by Zone 7 in the GWMP are repeated below, along with the sustainability indicator that relates to each of the BMOs:

- Monitoring and maintenance of groundwater levels through conjunctive use and management of regional water supplies (equivalent to the Sustainability Indicators for lowering of groundwater levels and depletion of storage):
    - maintain the balance between the combination of natural and artificial recharge and withdrawal,
    - maintain water levels high enough to provide emergency reserves adequate for worst credible drought and unplanned import outages,
    - store surface water supplies in the groundwater basin for use during emergencies and drought-related shortages,
    - allow for gravel mining by optimizing groundwater levels while maintaining adequate reserves for municipal supply, and
    - prevent overdraft that would otherwise occur from too much pumping (maintain total pumping at or below sustainable/safe yields);

- Groundwater quality monitoring and management, including tracking and addressing any water quality degradation (equivalent to the Sustainability Indicator for groundwater quality degradation):
    - protect and enhance the quality of the groundwater,
    - halt degradation from salt buildup (offset current and future salt loading),
    - reduce flow of poor quality shallow groundwater into deep aquifers,
    - offset impacts of water recycling and wastewater disposal through integrated SMP,
    - recharge with relatively low TDS/hardness imported or storm/local surface water,

  - manage quality on a regional basis as measured at municipal wells (such as those operated by both the retail water agencies and Zone 7), protecting and improving groundwater quality within the Main Basin (as protecting and improving groundwater quality within the Main Basin (as described in **Section 3.3.3**), and
  - minimize threats of groundwater pollution through groundwater protection;

- <u>Monitor and prevent inelastic land surface subsidence</u> from occurring as a result of groundwater withdrawals (equivalent to the Sustainability Indicator for prevention of inelastic land subsidence):
  - protect the storage capacity of aquifer,
  - maintain water levels above historic lows,
  - monitor and minimize any identified impacts of gravel mining on the Upper Aquifer by encouraging the implementation of mitigation measures by mining companies, and
  - monitor benchmark elevations and shift pumping to other wells if inelastic subsidence is detected;

- <u>Monitor and manage changes in surface flow and surface quality</u>, especially as they affect groundwater levels or quality, or are caused by groundwater pumping in the basin (equivalent to the Sustainability Indicator for prevention of depletion of surface water):
  - augment stream flow through artificial recharge releases to improve groundwater supply and quality, and
  - monitor and protect recharge capacity of local arroyos.

Consistent with these GWMP BMOs and sustainability objectives, Zone 7 Board of Directors has also adopted the 2004 SMP, the 2015 NMP and specific policy resolutions related to the protection of the groundwater basin through wastewater management including:

- Water Quality Policy (Resolution 03-2494)
- Wastewater Management Policy (Resolution 1037)
- Prohibition against use of septic tanks for new development zoned for commercial or industrial use (Resolution 1165).

Finally, Zone 7 Board of Directors has also adopted the Reliability Policy for Municipal and Industrial (M&I) Water Supplies (Resolution 04-2662). In November 2012, Zone 7's Board updated the reliability goals, which affect the quantity and urgency of new supply wells needed by Zone 7 as development occurs in the basin. These refined goals are summarized below.

- ***Goal 1.*** Zone 7 will meet its treated water customers' water supply needs, in accordance with Zone 7's most current Contracts for M&I Water Supply, including existing and projected demands as specified in Zone 7's most recent Urban Water Management Plan (UWMP), during normal, average, and drought conditions, as follows:

  - At least 85% of M&I water demands 99% of the time
  - 100% of M&I water demands 90% of the time.

- ***Goal 2:*** Provide sufficient treated water production capacity and infrastructure to meet at least 80% of the maximum month M&I contractual demands should any one of Zone 7's major supply, production, or transmission facilities experience an extended unplanned outage of at least one week.

3.3 Sustainability Indicators

This section provides an examination of the Sustainability Indicators in the Livermore Valley Groundwater Basin. As demonstrated in **Section 2** of this Alternative Plan, the basin has not experienced undesirable results over the last several decades (and for at least 10 years) as a result of sustainable groundwater management. Potential conditions that would be considered undesirable results are examined for each sustainability indicator below. Also provided is a minimum threshold for each of the indicators. Although previously undefined in terms of SGMA, Zone 7 already applies these minimum thresholds to track the performance of groundwater management activities and to trigger the need for future management actions to avoid undesirable results.

Because the basin has not experienced undesirable results over several decades, quantification of minimum thresholds is conservative. As more information is developed on undesirable results, thresholds may be modified to be either more or less stringent over time, consistent with the Agency's adaptive management approach. In general for the Livermore Valley Groundwater basin, the five applicable undesirable results can be measured by four metrics: groundwater levels, aquifer storage, water quality, and land surface elevation changes. Significant and unreasonable impacts to the beneficial uses of groundwater could occur if: 1) groundwater elevation lowering is chronic (e.g., pumping causes levels to remain below historic low levels even with recovery efforts), 2) groundwater storage cannot be recovered over time with the available cyclical replenishing supplies due to land subsidence (aquifer contraction) or loss of artificial recharge capacity, and/or 3) water quality impacts render the groundwater unsuitable for beneficial uses with reasonable treatment. Detailed information on each is provided below.

3.3.1 Groundwater Levels

Significant and unreasonable chronic lowering of water levels is defined by SGMA as an undesirable result; therefore, groundwater levels are analyzed as a sustainability indicator. As a supplier of municipal water supply, Zone 7 has numerous policies and objectives relating to the maintenance of water levels in the basin and regularly measures a network of monitoring wells. In brief, Zone 7 balances the basin water levels for numerous objectives including minimizing impacts of high water levels on gravel mining operations, retaining storage capacity for recharge of available imported supplies, maintaining groundwater emergency reserves for worst credible drought and unplanned import outages, and keeping water levels sufficiently high to support beneficial use of the numerous groundwater wells in the basin. Zone 7 has installed wells throughout the Main Basin Management Area, thereby providing flexibility to manage pumping to meet then-current local water level targets using an adaptive management approach.

3.3.1.1 Definition of Undesirable Results (Water Levels)

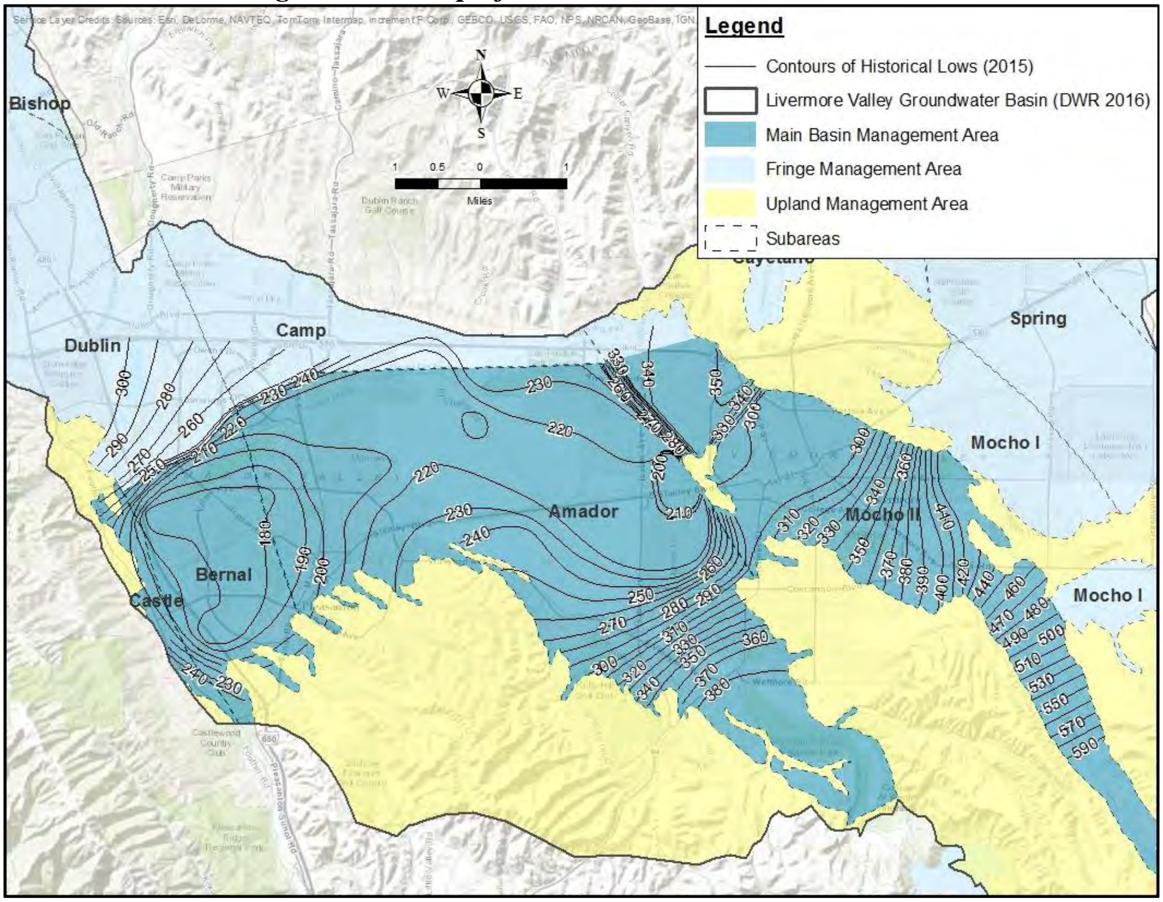
Given the reliance on groundwater for water supply in the absence of imported water, basin wells require protection from significant and unreasonable chronic lowering of regional water levels. If lowering of regional water levels resulted in wells no longer capable of supporting their beneficial uses, that condition is viewed as an undesirable result under SGMA. This undesirable result may be experienced as water levels falling below pump intakes, falling below the top of screens, and/or reductions in well yields. These conditions could be triggered by the concurrence of a multi-year drought combined with severe cutbacks on imported supply and/or exacerbated by prior over-pumping in the groundwater basin. Such conditions could produce loss of water supply for basin customers and a need for supplemental supplies at a time when they may be unavailable. Zone 7 already has policies and practices in place to avoid this undesirable result.

For municipal wells, the loss of one well in a wellfield – or even multiple wells for a short amount of time – might be compensated through a short-term redistribution of pumping or purchase of supplemental supplies, if available. Zone 7 has an ongoing policy of re-distributing pumping in areas of even short-term declines to mitigate local impacts. In addition, Zone 7 targets areas for artificial recharge near wellfields and plans to establish new wellfields in areas where levels routinely stay well above historic lows in order to maintain its policy of operating the basin above historic lows. However a systemic failure of wellfields or the long-term loss of wells would be an undesirable result. For domestic wells where alternative supplies may not be available, the loss of even one well could cause an undesirable result if the well could no longer support its beneficial use. Management and oversight in primarily rural, domestic wells is adaptive to ensure that local land owners use groundwater responsibly and the potential for contamination is minimized.

3.3.1.2 Minimum Thresholds

For several decades, Zone 7 has operated the basin to remain above historic low levels throughout the Main Basin Management Area. To quantify these levels, a composite map of historic lows has been prepared by Zone 7 for management purposes. That map was introduced in **Section 2.3.4.2** of this Alternative Plan (**Figure 2-23**) and is reproduced below as **Figure 3-1** for reference.

Figure 3-1: Map of Historic Lows in Water Levels



The relationship of historic lows to well construction in municipal wellfields was examined in Zone 7's 2003 Well Master Plan. That plan evaluated numerous alternatives for new Zone 7 wellfields in order to meet future demands when imported water supply allocations are reduced or during water supply emergencies. As with current wellfields and their operations, new Zone 7 wellfields are to be sited and operated to optimize groundwater recovery while maintaining basin water levels above historic lows most of the time and minimizing drawdown in other basin wells. Zone 7 wells are capable of pumping at or below historic low levels in localized areas if the need arises, but the Agency's goal is to only do so on a temporary basis under extreme conditions. More typically, the Agency will employ the adaptive management of reassigning pumping to wells in other subareas to minimize local impacts at any given well.

As discussed in **Section 2.3.4.2** (Historical Groundwater Levels) and shown by **Figure 2-22**, Zone 7 operates the supply wells to be within a range significantly higher than historic lows – even during the 1970s, 1990s, and recent droughts. Although average conditions (normal and dry) would not warrant pumping below historic lows, drawdown would be adaptively managed to ensure that any localized dip below historic low would be reviewed and, if appropriate, addressed with a recovery plan. Factors such as transmissivity and the ability to recharge the subarea would be considered in the recovery plan, as would the length of time allowed below historic low during recovery.

Other areas of the Main Basin Management Area where private supply wells (primarily small irrigation wells) are generally located have water levels that remain high due to conjunctive use and low pumping volumes locally. Those around the municipal pumping centers would be expected to be the first wells impacted by declining water levels, but given that most of these wells are within a water purveyor service area and only supply a small landscape demand, municipal water would be available to replace the minor lost well supply. Therefore, the map of historic lows is determined to be a conservative minimum threshold to alert the potential for water levels affecting the beneficial use of wells. Under extreme conditions, such as a prolonged drought or full loss of imported water due to an earthquake in the Sacramento Delta, water levels may be drawn below the historic low surface in some areas; these would be evaluated for a recovery plan. This is a part of Zone 7's adaptive management strategy for long-term groundwater sustainability and is demonstrated by the drought recovery periods in the hydrographs of the key wells within the Main Basin Management Area (**Figure 2-21**).

As shown on **Figure 3-1**, historic low levels are estimated for the northern Fringe Management Area where most of the subsurface inflow is estimated to occur. Undesirable results associated with less inflow from the Fringe Management Area to the Main Basin can be avoided if water levels are maintained at or above these mapped levels. Accordingly, historic low levels are adopted as minimum thresholds for this portion of the Fringe Management Area as a management tool.

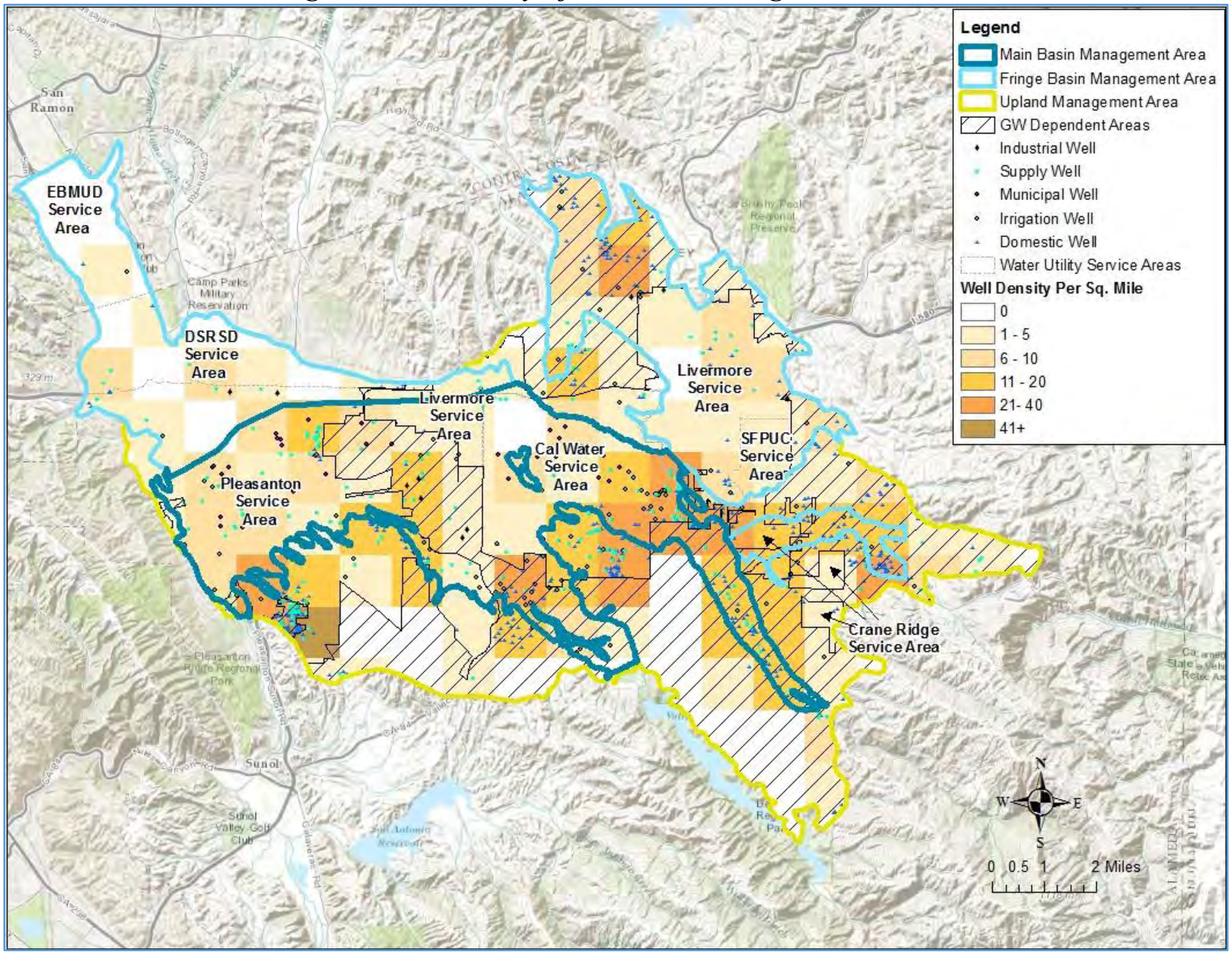
Outside of the Main Basin Management Area, continuous aquifers may not be present and historic lows have not yet been determined; however, water level hydrographs from various representative wells indicate that water levels have not fluctuated significantly over time; in addition, no areas of significant downward trends have been identified (see **Figure 2-21**). Nonetheless, over-pumping in these areas could locally impact beneficial uses of private wells, especially in areas with a relatively high density of wells or in groundwater dependent areas. The density of wells and groundwater dependent areas were described in **Section 1** of this Alternative Plan and shown in **Figure 1-6**; that figure is reproduced below as **Figure 3-2** to further evaluate the potential for the beneficial use of wells to be impacted. If it is determined that wells in subareas outside of the Main Basin Management Area are experiencing loss of beneficial uses, then review of conditions will be initiated and, if appropriate, a recovery plan will be created.

For the southern portion of the basin in the Upland Management Area, several general areas contain a relatively high density of wells. The highest density of wells (more than 40 wells per square mile) outside of the Main Basin occurs in the southwestern corner of the Upland Management Area in an area referred to as Happy Valley. This unincorporated, unsewered area has been subdivided into 1 to 5 acre lots and developed with rural residences relying on domestic wells for water supply. Declining water levels have not been identified in the Happy Valley area (or elsewhere) in the Upland Management Area. Very little additional development has been planned for the Happy Valley because Alameda County has placed a moratorium on new OWTS construction[4] in the Happy Valley area due to high nitrate detections in some of the domestic

[4] There are currently about 100 OWTS in Happy Valley. Many of the domestic wells have been tested for nitrate since 1973. In 2013, Zone 7 and ACEH conducted voluntary testing of water samples from domestic wells and identified 7 of 31 wells with elevated nitrate concentrations above the MCL in the central portion of the area. Zone 7

wells. Currently, there are ongoing discussions between City of Pleasanton and Alameda County Local Agency Formation Commission (LAFCO) for the incorporation of Happy Valley into the City limits and/or the expansion of city water and sewer services to the Happy Valley parcels.

Figure 3-2: Density of Wells in Management Areas



Additional areas with wells in the Upland Management Area include areas north and south of Arroyo Valle where land use consists of low density residential and irrigated agriculture (vineyards) (see land uses on **Figure 1-7**). Many of the wells north of Arroyo Valle, but in the Upland Management Area, are in the Cal Water Service Area and are not dependent on groundwater as a sole source of supply (**Figure 3-2**). The medium well density area south of Arroyo Valle, known as Ruby Hill Vineyard Estates, is composed primarily of 20-acre vineyard estates, each having a domestic well serving a single-family residence. The primary irrigation supply for the vineyards is imported to this area via the SWP and is served under untreated water contracts with Zone 7.

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incorporated this issue in its 2015 Nitrate Management Plan (NMP) (see *Figure 2-15* in the NMP) as an area of concern.

Wells in the Fringe Management Area are concentrated in the eastern and northeastern portions of the basin. To the east, wells are located in South Livermore on parcels along and near Tesla Road where low density residential development, irrigated vineyards, and a minor amount of commercial development (primarily ―boutique" wineries) occur (see land uses on **Figure 1-7**). The well use here is mostly domestic supply as the agricultural irrigation water is supplied via the SWP under untreated water contracts with Zone 7. To the northeast, a small cluster of wells are in use along and in the vicinity of May School and Bel Roma Roads, where low density residential areas are reliant on groundwater. Neither of these areas has experienced declining water levels.

Historic low water levels have not yet been mapped for most of the areas outside of the Main Basin Management Area (with the exception of the northern Fringe Subareas included on **Figure 3-1**). To account for the uncertainty of how low water levels would be allowed to fall in these outside areas, an alternative minimum threshold has been developed. For this area, any proposed new well construction (other than replacement wells) would need to be evaluated for the higher-density well areas. Zone 7's role in permitting new wells in the basin allows an early assessment of any proposed wells to ensure that they are constructed to account for operating water levels in the basin and do not result in over-pumping for any localized area of well clusters. Through its assigned authority to administer the Alameda County Water Wells Ordinance within the Zone 7 service area, Zone 7 can require, at its discretion, that a permit application be accompanied by a certified CEQA analysis supporting that the new well and its use would not significantly impact the local water levels. This requirement would reduce the uncertainty associated with new well constructions and pumping impacts in these areas.

In addition to the evaluation process for new wells outside of the Main Basin Management Area, Zone 7 has authority to conduct numerous additional management actions to mitigate undesirable results for water level declines. Some of these actions include increased conjunctive use, provision of an alternative water supply, and/or a pumping (or replenishment) assessment. All of these options would be considered in any recovery plan that may be developed.

3.3.2 Groundwater Storage

Significant and unreasonable depletion of groundwater storage is defined by SGMA as an undesirable result; therefore, groundwater storage is analyzed as a sustainability indicator. As described in **Section 2.3.4.3**, the total groundwater storage volume for the Main Basin Management Area is estimated at 254,000 AF. In order to avoid undesirable results, Zone 7 generally operates the basin such that groundwater in storage remains between this ―full basin" volume and the historic low water levels. Historic low water levels are estimated to represent conditions where about one-half of the total storage volume is actively managed and used (i.e., approximately 126,000 AF. As explained above, historic low water levels are used as a minimum threshold for the Main Basin Management Area for the sustainability indicator of water levels; however, if one well or wellfield pumps below historic low, this may not impact the overall operational storage minimum. By using historic lows as the initial indicator, Zone 7 ensures that the Main Basin Management Area operates above the bottom of the operational storage thereby ensuring that groundwater storage is protected by two thresholds. The storage below the Operational Storage (the upper 126,000 AF) is known as Reserve Storage and is estimated at 128,000 AF (**Figure 3-3**). Zone 7's operations assume that this Reserve Storage is unavailable during non-emergency conditions.

The same BMOs and sustainability criteria for the maintenance of water levels in the basin also apply to groundwater storage. Specifically, Zone 7 manages the groundwater within the limits of operational storage to maintain adequate supplies and prevent overdraft (i.e., operate within the sustainable yield of the basin). Causes and impacts of undesirable results relating to depletion of groundwater storage is described below, followed by discussion of the minimum thresholds established to guide groundwater basin management.

3.3.2.1 Definition of Undesirable Results (Storage)

Significant and unreasonable depletion of groundwater in storage occurs when the loss of storage is chronic and cannot be recovered over time with the available cyclical replenishing supplies. For the Livermore Valley Groundwater Basin, this undesirable result would be accompanied by water levels falling significantly below historic lows across most of the basin as well as storage volumes in the basin being reduced into the Reserve Storage in a non-emergency condition.

Causes and locations of potential undesirable results associated with lowering of groundwater levels were described in **Section 3.3.1.1** above and are not repeated here. Zone 7 plans its operations to avoid operating the basin at or near historic lows during normal conditions to account for dry years or drought conditions. **Sections 2.4.4** and **3.2** describe Zone 7's general operating conditions. By operating the Main Basin Management Area above historic lows in normal or dry years, the undesirable results of storage depletion are avoided.

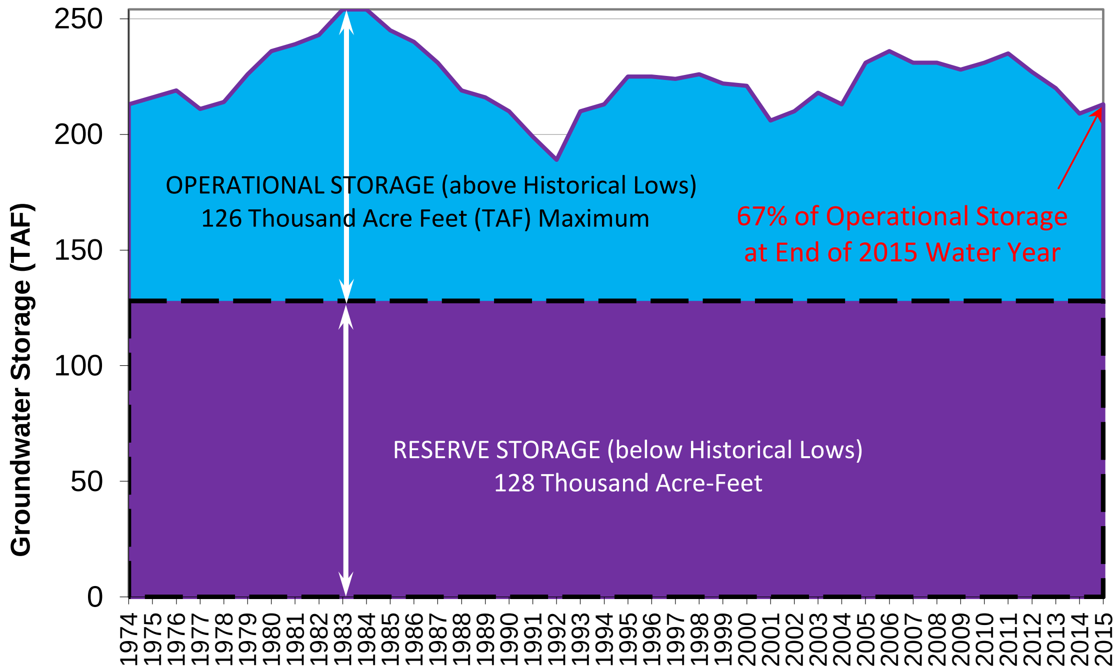
Under emergency conditions, Reserve Storage may need to be accessed. In this case, any undesirable result of using the Reserve Storage is related to whether the storage loss could be recovered at some time in the future. Emergency conditions will be evaluated on a case by case basis to determine if they create undesirable results and can be evaluated by the monitoring networks and computer modeling that Zone 7 has already put into practice.

Loss of storage in the Fringe and Upland Management Areas would not have the same detrimental effect on operational storage as in the Main Basin Management Area. Hydrographs (**Figure 2-21**) and relatively low pumping volumes (**Tables 2-21 and 2-22**) suggest that the current operational ranges in the Fringe and Upland Management Areas are low. Nonetheless, depletion of storage in the Fringe and Upland Management Areas would be associated with lower water levels and may include the undesirable results discussed for that sustainability indicator above (**Section 3.3.1**).

3.3.2.2 Minimum Threshold

Zone 7 may choose to take action and trigger a recovery plan in any given subarea if the historic lows are exceeded for any timeframe; however, for this sustainability indicator, the minimum threshold is based on the basin storage when water levels throughout the Main Basin are at historic lows. This storage volume, which has been calculated as 128,000 AF (GWMP, 2005), is shown on **Figure 3-3** as the threshold between "operational" and "reserve" storage.

Figure 3-3: Operational Storage in Main Basin Management Area



As illustrated above, groundwater in storage has remained above 200,000 AF over the last 40 years except during the drought conditions of the early 1990s. Historic lows were observed in many of the Main Basin wells during drought conditions in 1962 and 1966, which accounts for the operational storage and minimum threshold being set at a lower level.

Should an emergency condition arise where Reserve Storage would be accessed, then a recovery plan would be developed that includes specific, and time-relevant, recovery actions that address the emergency conditions. For example, should an earthquake cause loss of imported supplies for three years, a plan would be evaluated and implemented that ensures that recovery would be initiated as soon as imported water deliveries were restored or an alternative water supply could be ascertained.

3.3.3 Groundwater Quality

Consistent with adaptive management principles, Zone 7 has actively responded to numerous groundwater quality issues over time in the Livermore Valley Groundwater Basin. **Section 2.3.8** provides a characterization of groundwater quality and changes in quality in space and time since 1974, while **Section 4.6** presents the Zone 7 Groundwater Quality Monitoring Program. Although numerous groundwater quality challenges have arisen during this time period, Zone 7 has been able to address each issue, preventing or reducing significant and unreasonable degradation of groundwater quality. This section discusses undesirable results and minimum thresholds in terms of the following groundwater quality issues:

- TDS and Salt Loading
- Nitrate and Nutrient Loading
- Additional Inorganic Constituents of Concern
- Toxic Sites

In general, elevated concentrations for these constituents are:

- localized,
- being actively managed,
- often elevated due to ambient sources or historical conditions in the basin,
- not affecting beneficial uses at primary drinking water wells (municipal wells) in the Main Basin Management Area (are reasonably treatable), and
- not caused or exacerbated by basin-wide management for sustainability.

Elevated occurrences of these constituents – even if detected above water quality objectives in a local, private well – are not used to define undesirable results in terms of sustainable yield for this basin. Nonetheless, Zone 7 is committed to working adaptively with regulatory agencies to ensure protection of the groundwater basin to meet beneficial uses. Such ongoing programs either led by or coordinated with Zone 7 are summarized throughout this Alternative Plan (see **Sections 1.3.4, 1.3.5, and 1.3.6**. See also **Section 5**).

Sustainability criteria are based on water quality BMOs adopted by Zone 7 in its GWMP and affirmed in subsequent documents. For groundwater quality, the following sustainability criteria apply:

- <u>Groundwater quality monitoring and management</u>, including tracking and addressing any water quality degradation:
    - protect and enhance the quality of the groundwater,
    - halt degradation from salt buildup (offset current and future salt loading),
    - reduce flow of poor quality shallow groundwater into deep aquifers,
    - offset impacts of water recycling and wastewater disposal through integrated SMP,
    - recharge with relatively low TDS/hardness imported or storm/local surface water,
    - minimize threats of groundwater pollution through groundwater protection.

Overall, the criteria above support a primary sustainability strategy, which is also included as a BMO in the GWMP; that strategy is to manage groundwater quality on a regional basis as measured at municipal wells (such as those operated by both the retail water agencies and Zone 7), while protecting and improving groundwater quality within the Main Basin Management Area. This strategy serves as the basis for the definition of undesirable results for groundwater quality.

3.3.3.1 Definition of Undesirable Results (Quality)

For groundwater quality, two criteria represent undesirable results. First, undesirable results are defined as the loss of beneficial uses as measured in basin municipal wells that provide drinking water supply in the Main Basin Management Area. This result would be caused by degradation of the Lower Aquifer with TDS, key inorganic constituents, and/or toxic substances such that levels in municipal wellfields cannot be managed to provide drinking water supply. Second, undesirable results in the Fringe Management Area and Upland Basin Management Area are defined as the loss of beneficial uses due to contamination when treatment is not possible or practicable. Many of the subareas outside of the Main Basin Management Area already have poor water quality, so the focus has been set on preventing widespread contamination that would further limit beneficial uses. Zone 7 already has a program where private well owners can request to have their well water tested in the Zone 7 laboratory (for more on Zone 7's water quality program, see **Section 2.3.8**).

Total Dissolved Solids (TDS) and Salt Loading

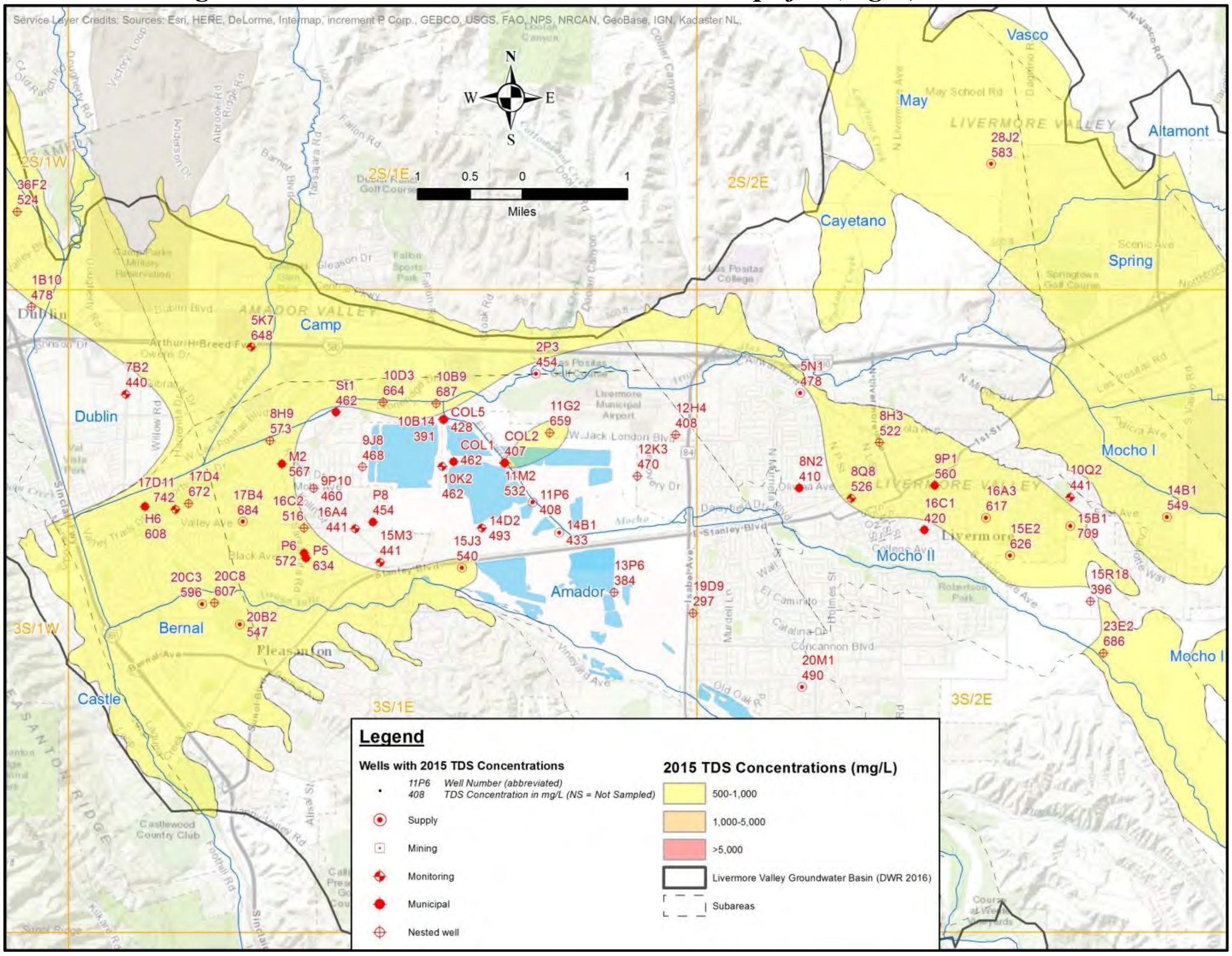
Undesirable results include degradation of groundwater quality associated with an increase in TDS in the Lower Aquifer such that beneficial use of municipal wellfields are adversely impacted beyond basic treatment or blending. Key criteria include drinking water standards; the recommended secondary MCL (based on aesthetics, such as taste and odor) for TDS is 500 mg/L. In addition, the local RWQCB Basin Plan water quality objective for TDS for the Main Basin is 500 mg/L (or ambient, whichever is lower). For the Fringe and Upland Management Areas, the water quality objective is 1,000 mg/L (or ambient, whichever is lower).

The cause of groundwater conditions leading to an undesirable result includes salt loading. As documented in **Section 2.3.8.3**, addition of salts to the Main Basin occurs through natural stream recharge, artificial stream recharge, subsurface groundwater inflow, pipe leakage, and applied water (irrigation) recharge. Fringe Management Areas are affected by addition of salts from relatively high-TDS natural stream recharge and subsurface groundwater inflow (reflecting marine sediments in the watersheds), return flows from irrigation, and also locally by salt loading from OWTS and recycled water use.

As discussed in **Section 4.6**, TDS concentrations are measured in 233 wells throughout the basin by means of the Zone 7 Groundwater Quality Monitoring Program. TDS concentrations are tracked through chemographs (**Figure 2-31)** and contoured for both upper and lower aquifers; these analyses are evaluated on an annual basis. TDS concentrations generally meet the Basin Plan Objective of 500 mg/L, but have risen above that level in several wells in the southeastern basin.

TDS concentrations in the Lower Aquifer are documented in the 2015 WY GWMP Annual Report and reproduced below for reference. As shown on the map, concentrations are generally between 300 mg/L (central basin) and 700 mg/L (along the edges of the Main Basin). Even though some inflow from the Upper Aquifer is likely occurring from the Fringe Management Area, these concentrations are managed through blending, increased artificial recharge with lower TDS imported water, and wellhead demineralization. Although some municipal wells are in areas where TDS concentrations exceed the Basin Plan Objective of 500 mg/L, groundwater quality is improved through blending for drinking water supplies. As such, undesirable results are not occurring with respect to TDS.

Figure 3-4: TDS Concentrations in Lower Aquifer (mg/L), 2015 WY



If TDS concentrations in the Main Basin Management Area rise to levels causing undesirable results, potential effects involve the aesthetics of municipal and domestic supply (including hardness) that may prompt purchases of bottled water for drinking and water softeners.

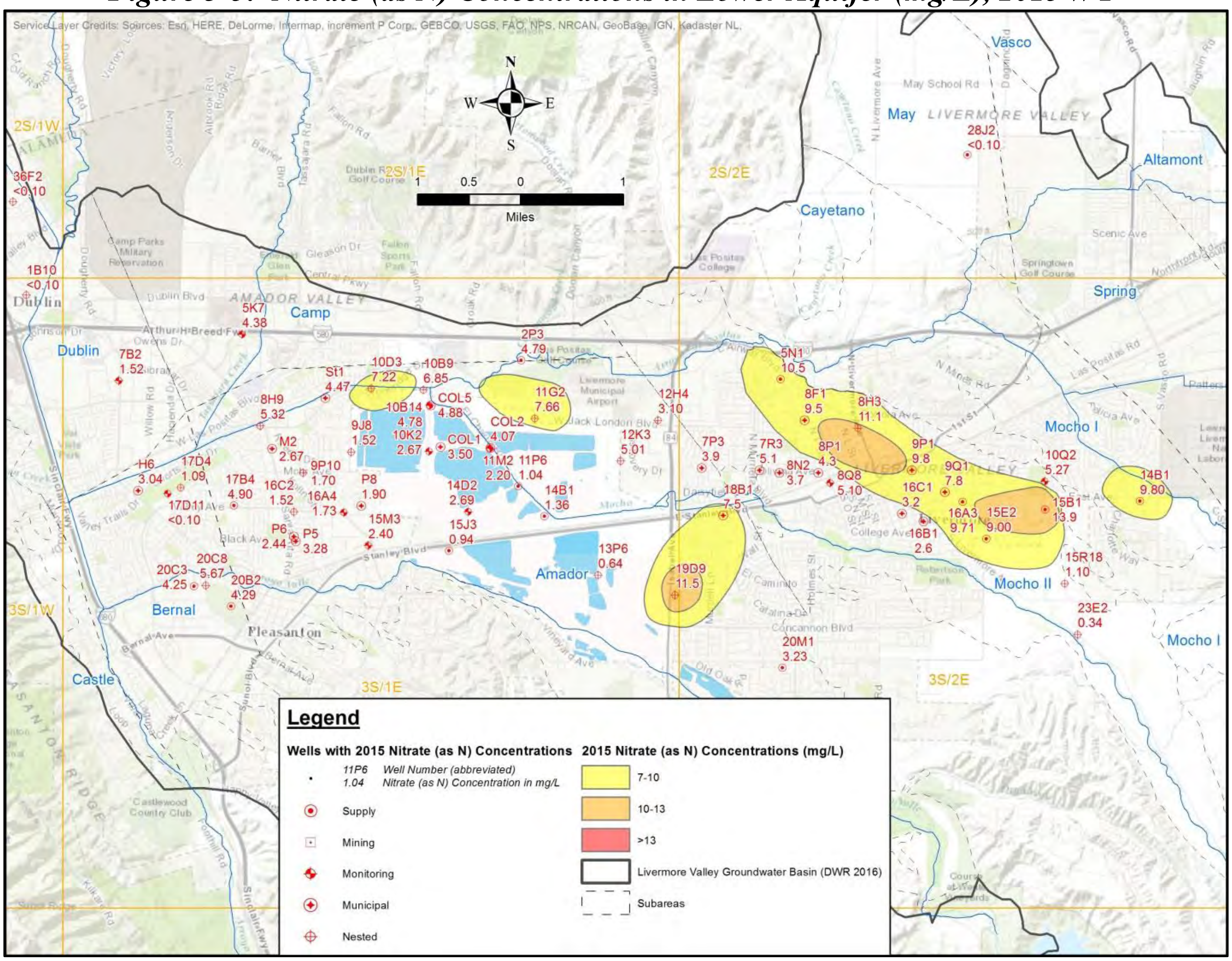
TDS generally exceeds 500 mg/L in areas outside the Main Basin Management Area, and locally it exceeds 1,000 mg/L. If TDS concentrations were to rise above 1,500 mg/L in supply wells, the wells may become unusable for drinking water purposes without significant investment, or could impact the health of sensitive livestock and crops. Based on historical trends and existing TDS in the Fringe and Upland Management Areas, it is not anticipated that TDS would deviate much from observed levels.

Nitrates and Nutrient Loading

Undesirable results associated with nitrates would be related to exceedances in municipal wells of the State's primary MCL for nitrate (as N) in drinking water (10 mg/L) such that beneficial uses are adversely impacted. This MCL is health based and also represents the Basin Plan Objective for the basin. With regard to nutrient loading, Zone 7 tracks nutrient concentrations in groundwater, primarily nitrate and phosphate, and has developed a NMP. In general, nitrate is the only nutrient that has had a significant impact on groundwater quality and there is not a nutrient loading problem throughout the groundwater basin. Nitrate problems are local and have been identified in terms of ten local Areas of Concern (AOCs) (see **Section 2.3.8.4**).

Nitrate concentrations are shown for the period 1974-2015 by 15 chemographs on **Figure 2-35**. In general, the Lower Aquifer meets the MCL, although the Mocho II Subarea Lower Key Well has experienced a few exceedances (up to 14 mg/L) over time. Nitrate concentrations are tracked and mapped annually; the most recent contour map for nitrate concentrations in the Lower Aquifer is shown in **Figure 3-5** below. This map illustrates the localized areas of elevated nitrate including the area of the Mocho II Subarea Lower Key Well. As shown on the map, no elevated nitrate concentrations have been detected in municipal wells and no undesirable results are occurring. Further, elevated nitrate has not been detected in municipal wells during the sustainable period of 1974-2015.

Figure 3-5: Nitrate (as N) Concentrations in Lower Aquifer (mg/L), 2015 WY



The causes of nitrate as a local undesirable result are documented in detail in the descriptions of the AOCs in **Section 2.3.8.4**. While a few areas are believed to have been caused by historical municipal wastewater practices, most high concentrations are caused by historical or ongoing use of OWTS and agriculture use including crop and livestock operations (e.g.; vineyard fertilizers, cattle, poultry, horse stables) and leaching of decaying vegetation. The occurrence and causes of these nitrate AOCs is based on historical groundwater quality and ongoing sampling through the Zone 7 Groundwater Quality Monitoring Program, plus Zone 7 investigations of local nitrate sources (including nitrate balances), and the Zone 7 NMP.

If undesirable nitrate concentrations affected beneficial uses in municipal wellfields, potential health effects could occur (particularly for infants and pregnant women). Municipal wellfields have a rigorous groundwater sampling protocol as required by drinking water permits issued by the SWRCB, Division of Drinking Water to ensure that elevated nitrate concentrations are not present in drinking water supplies.

Additional Inorganic Constituents of Concern

Zone 7 has identified two additional inorganic constituents of concern that have the ability to impact water quality over a broad area: boron and hexavalent chromium. Although arsenic has been detected in a few select wells at levels that exceed MCLs, these occurrences are isolated and do not appear to present a significant threat to groundwater quality as a whole. Nor has there been any observed migration of the arsenic to adjacent wells. Nonetheless, arsenic is included in the suite of analytes routinely tested by the Zone 7 laboratory and stored in the agency's water quality database.

Boron

As discussed in **Section 2.3.8.8**, boron is a naturally-occurring element; in the Livermore Valley Groundwater Basin, elevated concentrations likely are caused by natural process affecting alkali/marine sediments (particularly prevalent in eastern watersheds). High-boron groundwater occurs in the eastern portion of the basin and, where detected in the western portion, probably has migrated along the Arroyo Las Positas and Arroyo Mocho. While there is no MCL for boron, the USEPA has identified a Health Reference Level (HRL) of 1.4 mg/L, indicating health issues. Boron also becomes a problem for irrigated crops when present at levels above 1 or 2 mg/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 relevant Zone 7 BMO is to manage quality on a regional basis as measured at municipal wells (such as those operated by both the retail water agencies and Zone 7), protecting and improving groundwater quality within the Main Basin.

The occurrence of elevated boron is based on the groundwater quality and sampling of the Zone 7 Groundwater Quality Monitoring Program. Boron occurs at elevated concentrations (up to 34 mg/L) in the Upper Aquifer in two areas of the groundwater basin. These include the eastern portion of the valley in the May, Spring, Mocho I, and Mocho II Subareas; the highest concentration detected in the 2015 WY was 34 mg/L. In addition, elevated boron concentrations extend along the Dublin-Bernal and Camp-Amador boundaries; the highest localized concentration of boron in the 2015 WY was 10.6 mg/L. In general, boron concentrations are relatively low in the Lower Aquifer and municipal wells (typically less than 1 mg/L, but with some detections of about 2 or 3 mg/L in monitoring wells). These detections may originate in localized natural alkali/marine sediments or vertical migration through the leaky aquitard from the Upper Aquifer. As documented in the Zone 7 2015 WY GWMP Annual Report (**Attachment**

B), no municipal wells have detected elevated boron concentrations above the HRL and no undesirable results are occurring.

If elevated boron concentrations were detected in levels in municipal wellfields above the HRL and crop sensitive levels, boron could affect beneficial uses (drinking water and agriculture). Potential effects include potential health issues of excessive boron in drinking water from municipal wells and potential adverse effects on sensitive crops and landscaping.

Hexavalent Chromium

As discussed in **Section 2.3.8.8**, hexavalent chromium (CrVI) was recently added as a constituent of concern when the primary MCL was reduced from 0.050 mg/L to 0.010 mg/L effective July 1, 2014. Chromium (Cr) is a heavy metal that occurs naturally throughout the environment, including the Livermore Valley Groundwater Basin, and may be associated with serpentinite-containing rock or chromium containing geologic formations. The relevant Zone 7 BMO is to manage quality on a regional basis as measured at municipal wells (such as those operated by both the retail water agencies and Zone 7), protecting and improving groundwater quality within the Main Basin.

The occurrence of elevated CrVI in the Basin is based on the groundwater quality and sampling of the Zone 7 Groundwater Quality Monitoring Program. To be conservative, the Groundwater Quality Monitoring Program assumes that the total chromium concentration is exclusively CrVI. As documented in **Section 2.3.8.8**, elevated chromium has been encountered in four discrete areas in the Upper Aquifer (located in the Dublin, Camp, Mocho I, and Mocho II Subareas) and in three areas in the Lower Aquifer (Amador, Mocho I, and Mocho II), although the areas in the Upper and Lower aquifers do not correspond. Elevated chromium has been detected in two supply wells in addition to monitoring wells.

Given the occurrence of locally elevated chromium concentrations in the Livermore Valley Groundwater Basin, including supply wells, potential effects include potential health issues of excessive chromium in drinking water. To protect municipal drinking water supply wells, the Groundwater Quality Monitoring Program provides regular monitoring data on chromium. When excessive concentrations are detected in as few as a single municipal supply well, Zone 7 (with approval of the Division of Drinking Water) blends water produced from the affected wells with other sources of water as needed to minimize any potential risk of MCL exceedance in delivered water. This protects the municipal drinking water use of groundwater consistent with Zone 7 management objectives and avoids the condition of undesirable results.

Toxic Sites

As discussed in **Section 2.3.8.9**, multiple toxic sites—where groundwater has been contaminated from anthropogenic sources—pose a potential threat to drinking water. Primary responsibility for toxic site regulation, investigation, monitoring, and remediation lies with Federal and State agencies. Nonetheless, these sites are addressed by Zone 7 in its BMO to minimize threats of groundwater pollution through groundwater protection and its ongoing sustainable groundwater management. This includes its Toxic Sites Surveillance (TSS) Program wherein Zone 7 gathers information on toxic sites from state, county, and local agencies, as well as from Zone 7's well permitting program and the SWRCB’s GeoTracker website. The information is compiled in a GIS database, which serves as a basis for inter-agency coordination.

In general, the TSS Program has found two basic causes of contamination threatening groundwater in the Livermore Valley Groundwater Basin, releases of petroleum-based fuel products (e.g., from gas stations) and releases of industrial chemical contaminants (e.g., dry cleaners and electronics and automotive industries). As of 2015, Zone 7 was tracking 45 active sites where contamination has been detected or is threatening groundwater. Nine of these active sites have a contaminant plume which 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 the potential impact on potable groundwater supplies. Zone 7’s database also contains 268 other contamination cases that have been either ―Closed” or classified as ―No Action Required” because they have been sufficiently cleaned up and/or they pose minimal threat to drinking water supplies.

Federal and State agencies establish the criteria for specific contaminants (e.g., in terms of MCLs) and also determine the status of specific contamination sites. These criteria provide the quantification for definition of undesirable results. Potential effects include health issues if groundwater from drinking water supply wells contains excessive concentrations; persistence of contamination problems would have adverse impacts on potential land uses and property interests.

3.3.3.2 Minimum Thresholds

Total Dissolved Solids (TDS) and Salt Loading

Salt loading to the Main Basin is quantified through Zone 7’s salt loading calculations; this provides an annual estimate of salt loading to the groundwater volume of the Main Basin in tons. Recognizing that salt addition and removal changes from year to year, Zone 7 strives for no long-term net loading. The theoretical salt loading calculations also are used to estimate Main Basin TDS concentrations; these conservative (worst-case) estimates indicate that TDS concentrations are relatively stable at about 700 mg/L (noting that increases in TDS may reflect decreases in groundwater storage). TDS concentrations are tracked in 233 wells through the Zone 7 Groundwater Quality Monitoring Program (see **Section 4.6**). As shown in **Figure 2-32**, measured TDS concentrations average 671 mg/L in the Upper Aquifer and 500 mg/L in the Lower Aquifer, with an average of 588 mg/L for the entire volume. Average TDS concentrations across the Fringe Management Area range from 820 to 1,247 mg/L, and as shown in **Figure 2-31** chemographs, have been steady since 1974.

In addition, Zone 7 recognizes the potential for basin groundwater conditions to cause undesirable results in terms of TDS at specific municipal wells and wellfields. The recommended secondary MCL/RWQCB Basin Plan water quality objective (500 mg/L TDS) serves as a minimum threshold for potential undesirable results; this is consistent with state and federal standards for drinking water quality. Trends toward that threshold or exceedances trigger management responses by Zone 7 in collaboration with the Retailers. The responses can involve short-term actions including further investigation (e.g., resampling or investigation of causes) and reduction of pumping of the affected well along with redistribution of pumping or provision of other supplies to maintain a high-quality supply to customers. Longer-term actions include the salt management strategies identified in the Zone 7 SMP, such as artificially recharging the Basin with low TDS imported water when available; pumping and delivering additional groundwater to customers so more salts are exported as wastewater; and operating the Mocho Groundwater Demineralization Plant. Overall, the minimum thresholds will protect groundwater quality for beneficial uses and users of groundwater and, given reliable high quality water supply, will protect land uses and property interests.

Nitrates and Nutrient Loading

For nitrates, the concentration of 10 mg/L for nitrate (as N) serves as the minimum threshold for potential undesirable results for the Main Basin and Fringe Management Area. This threshold is based on the Federal and State primary (health-based) MCL for drinking water, and is the same as the RWQCB Basin Plan objective. It also is consistent with use of the secondary MCL and Basin Plan objective for TDS. In defining high nitrate AOCs, Zone 7 has applied this threshold to as few as a single well (Mines Road AOC).

As shown in **Figure 2-36**, nitrate concentrations in the Main Basin average 3.7 mg/L and in the Fringe Management Areas, average concentrations range from 3 to 6.6 mg/L. These indicate overall compliance. **Figure 2-35** shows chemographs of nitrate over time; these generally show do not show water quality deterioration; nonetheless, local problems have occurred. These have been identified and documented by Zone 7 through its Groundwater Quality Monitoring Program and the NMP, which assesses current and projected future nutrient loading to the groundwater basin (including loading from planned recycled water use). The NMP also addresses the ten local AOCs. These are being addressed through 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 Alameda County Environmental Health (ACEH) on its management program for OWTS. In one case, Alameda County has imposed a moratorium on additional OWTS. Overall, the minimum threshold will protect groundwater quality for beneficial uses and users of groundwater (most notably domestic well owners). Such protection of rural water supply will support land uses and property interests, although a local moratorium on OWTS may require some landowners to seek alternatives to OWTS (e.g., local community wastewater systems).

Additional Inorganic Constituents of Concern

The two additional inorganic constituents of concern are boron and hexavalent chromium. Information supporting definition of minimum thresholds for these constituents in provided in **Section 2.3.8.8**.

Boron

For boron, the threshold defining undesirable results is 1.4 mg/L. This is a conservative, agricultural supply threshold that protects sensitive crops and landscaping plants. It also is protective of human health. While there is no MCL for boron, the USEPA has identified a Health Reference Level (HRL) of 1.4 mg/L. Boron is a naturally-occurring constituent, but its distribution can be affected by basin-wide management activities. Management actions for boron are included in the salt management strategies identified in the Zone 7 SMP, such as artificially recharging the Basin with low boron imported water when available; pumping and delivering additional groundwater to customers so boron is exported as wastewater; and operating the Mocho Groundwater Demineralization Plant.

Hexavalent Chromium

For CrVI, the concentration of 0.010 mg/L serves as the minimum threshold for potential undesirable results for the Main Basin and Fringe Management Area. This threshold is based on the Federal and State primary (health-based) MCL for drinking water. Use of this threshold is consistent with use of the primary MCL for nitrate and the secondary MCL for TDS. Some uncertainty exists with regard to concentrations of CrVI specifically; Zone 7's Groundwater Quality Monitoring Program has been monitoring total chromium without distinction of trivalent chromium (CrIII) (a required nutrient with very low toxicity) from CrVI, which is more toxic. To be conservative, the Groundwater Quality Monitoring Program assumes that the total chromium concentration is exclusively CrVI. As noted above, this threshold is defined as applicable to a single municipal well.

Toxic Sites

The minimum thresholds for specific contaminants are the MCLs established by Federal and State agencies. Federal and State agencies also determine the status of a contamination site; for example, when concentrations in monitored wells are sufficiently reduced or a volume of groundwater is sufficiently remediated that a site can be ―closed." While primary responsibility for toxic site regulation lies with Federal and State agencies, Zone 7 provides collaborative support (including its TSS Program) that successfully aids in remediation of contamination sites and prevention of the spread of contaminant plumes. This support helps protect beneficial use of groundwater for municipal and domestic drinking water supplies, with an ancillary positive effect on potential land uses and property interests.

3.3.4 Land Subsidence

As documented in **Section 2.3.9**, no inelastic land subsidence has occurred in the Livermore Valley Groundwater Basin during the current 13-year monitoring period nor anytime covered by two historical research efforts: 1992-2016 (*TRE, 2016)* and 1947-1980 *(Altamont Land Surveyors, 1994*). Zone 7 Water Agency has an on-going Land Surface Elevation Monitoring Program, and has defined undesirable results and a minimum threshold, as described below.

3.3.4.1 Definition of Undesirable Results

Because alluvial aquifers are present under the urban area of the Livermore Valley Groundwater Basin, inelastic subsidence would represent a potential undesirable result, with several potential effects on beneficial uses and users of groundwater and on land uses and property interests. These include:

- Potential differential subsidence affecting the gradient of surface drainage channels, locally reducing the capacity to convey floodwater and causing potential nuisance ponding and seepage; the westernmost Valley is crossed by a system of engineered stream channels and canals the grades of which are constructed and maintained to minimize flooding problems.

- Potential differential subsidence affecting the grade of other infrastructure such as transportation facilities; the western Valley is urbanized, crossed by two interstate highways and BART.
- Potential subsidence around a pumping well, disrupting wellhead facilities or resulting in casing failure.
- Potential non-recoverable loss of groundwater storage as fine-grained layers collapse.

While no significant subsidence has occurred in the Basin, Zone 7 Water Agency has recognized subsidence as a potential undesirable result and has responded through its 2005 GWMP and now, through this Alternative Plan as described in the next section.

3.3.4.2 Minimum Threshold

The 2005 GWMP includes BMOs including one that specifically addresses land surface subsidence. This BMO, implemented by Zone 7 over the past ten years, called for monitoring and prevention of inelastic land surface subsidence as a result of groundwater withdrawals and specified that Zone 7:

- Protect the storage capacity of the aquifers,
- Maintain water levels above historic lows,
- Monitor and minimize any identified impacts of gravel mining on the upper aquifer by encouraging the implementation of mitigation measures by mining companies, and
- Monitor benchmark elevations and shift pumping to other wells if inelastic subsidence is detected.

The minimum threshold for land subsidence defined herein is an extension of the GWMP BMO that specifies *prevention*. Through its scientific investigations, Zone 7 has established that no inelastic land surface subsidence has occurred in over 60 years. Therefore, no maps and graphs are possible showing the extent and rate of land subsidence in the basin. Nonetheless, Zone 7 recognizes that ground surface elevations could be affected by several mechanisms such as expansion and shrinking of soils in the vadose zones due to change in moisture contents, tectonic deformation, and groundwater level changes in alluvial basins.

The processes defining land subsidence potential throughout the Basin (when and where) were investigated in detail in the Zone 7 WMP (in its *Section 2.4.1*), with particular focus on inelastic deformation potential associated with groundwater pumping. The WMP analysis indicated that the potential for inelastic (permanent) subsidence increases as groundwater levels approach historic lows; therefore, it was concluded that historic low water elevations could be used as a guide for prevention (**Attachment H**).

The WMP precipitated the start of Zone 7's current Land Surface Elevation Monitoring Program which includes 60+ elevation benchmarks spanning the Bernal and Amador Subareas, with semi-annual monitoring and annual reporting (see **Sections 2.3.9** and **4.7**). Thirteen years of data collection have revealed small seasonal fluctuations as well as larger cycles of elevation gains and losses that mimic dry\wet hydrologic cycles and groundwater elevations trends. No inelastic deformation has been observed during the life of the existing monitoring program, but elastic fluctuations during the larger cycles have generally been within a range of 0.3 feet per cycle. Likewise the 2016 InSAR study by TRE (**Attachment I**) and the historical benchmark study by Altamont Land Surveyors, Inc. (**Attachment J**) found no evidence of inelastic subsidence, and quantified elastic elevation changes of up to 0.4 feet during each of their respective study periods.

Within the context of the dynamic nature of land surface movement, Zone 7's existing objective is prevention. Because there has been no inelastic subsidence observed during the historical range of water levels in the groundwater basin, the minimum thresholds are set as the historical low groundwater elevation as defined by **Figure 3-1** and a confirmed decrease of 0.4 feet of land surface in any given cycle with a goal of experiencing no inelastic subsidence spatially and temporally. If these thresholds are triggered, an analysis of the factors influencing the ground surface elevation will be undertaken. Other preventative actions may include shifting groundwater extraction to other wells and/or placing a moratorium on all new well construction in the area of concern until levels recover or the investigation determines that other factors are likely causing subsidence (such as fault movement or shallow expansive soils). Two factors fundamental to assessing and preventing the exceedence of these thresholds are: 1) land surface monitoring, and 2) groundwater level monitoring. Both are included in Zone 7's Monitoring Program (see **Section 4**).

3.3.5 Surface Water – Groundwater Interaction

As documented in **Section 2**, interconnected surface water and groundwater dependent ecosystems are limited in the Livermore Valley Groundwater Basin. Best available information includes **Figure 2-26**, which shows Spring 2015 depths to the water table across the groundwater basin. Areas of shallow (less than ten feet deep) groundwater occur along some of the major streams, reflecting managed aquifer recharge operations, and in the mining area, reflecting the excavation of wet pits. Major areas of shallow groundwater overlie Fringe Management Areas; as discussed in **Section 2.3.4**, these areas are characterized mostly by urbanization or agriculture. As documented in **Section 2.1.3**, long sections of the streams and arroyos crossing the Livermore Valley Basin are engineered channels designed and maintained to convey floodwaters.

Sections 2.1.4 (Springs and Groundwater Dependent Ecosystems) and **2.3.10.2** (Springtown Alkaki Sink) document the Springtown Alkali Sink, which may be considered a groundwater dependent ecosystem for the purposes of SGMA, although the contribution of groundwater is limited and effects are seasonal. The sink supports an alkali-saline wetland habitat with seasonal surface ponding and shallow, seasonal high-salinity groundwater. The Alkali Sink supports salt-tolerant plants, vernal pool biota, and several protected species including the Palmate-Bracted Bird's Beak, tiger salamander, and the fairy shrimp. The Alkali Sink has long been a focus of preservation and restoration efforts (including collaboration by Zone 7 with other agencies); with regard to the effects of groundwater, groundwater levels in the vicinity of the Alkali Sink have been steady since the late 1970s with no undesirable effects on the Sink.

3.3.5.1 Undesirable Results

The undesirable result would be depletion of surface water in the Alkali Sink and resulting potential adverse effects on the Alkali Sink ecosystem and protected species. Groundwater that occurs in upgradient portions of the northeastern Fringe Management Area contributes to surface water ponding in the Alkali Sink in terms of extent and seasonal persistence through the dry season. The cause of undesirable results would be a sequence of processes: increased pumping in the up-gradient area due to intensification of land uses, interception of groundwater flow, groundwater level declines near the sink, and resulting depletion of surface water.

As described in **Section 2.3.10**, the relationship of groundwater and surface water has been investigated. This included development of a three-dimensional groundwater flow MODFLOW model[5], with evaluation of surface water and runoff using the NRCS TR-55 hydrologic analysis procedures. A major goal was quantification through numerical modeling of the relative significance of surface water and groundwater contributions to the sink. Based on the modeling, a water budget was developed for the sink. This budget indicated that surface water runoff contributes significantly more inflow to the sink (885 AFY) than groundwater (63 AFY). However, the analysis indicated that groundwater is important, because it is areally dispersed and more evenly distributed through time, thus providing critical soil moisture through dry periods.

Maintenance of local groundwater levels and flow patterns is the basic criterion for avoiding undesirable results to the Alkali Sink. As shown in the groundwater elevation maps (**Figures 2-24** and **2-25**), five wells are monitored in the vicinity of the Alkali Sink; groundwater level contours are generally concentric, indicating convergence of flow from north, east and southeast. Groundwater level hydrographs in **Figure 2-21** indicate that trends in the northeast Fringe Management Area generally have been steady.

While no significant undesirable depletion of surface water has affected the Alkali Sink and its ecosystem as a result of Fringe Management Area groundwater conditions, Zone 7 recognizes such surface water depletion as a potential undesirable result and has responded with the Minimum Threshold described in the next section.

3.3.5.2 Minimum Threshold

Ongoing monitoring and management by Zone 7 have supported the maintenance of steady groundwater levels in the vicinity of the Alkali Sink, indicating no increase in surface water depletion since the late 1970s. **Figure 3-6** shows the hydrographs for two monitored wells in the immediate vicinity of the Alkali Sink. Well 2S/2E 34E 1, with a measuring point elevation of 499.73 ft msl is located at the southwestern, lower end of the sink, while Well 2S/2E 27P 2 is located more centrally with a measuring point elevation of 505.43 ft msl. Review of the hydrographs indicates that groundwater levels generally are within a few feet of the measuring point elevation and sometimes within inches.

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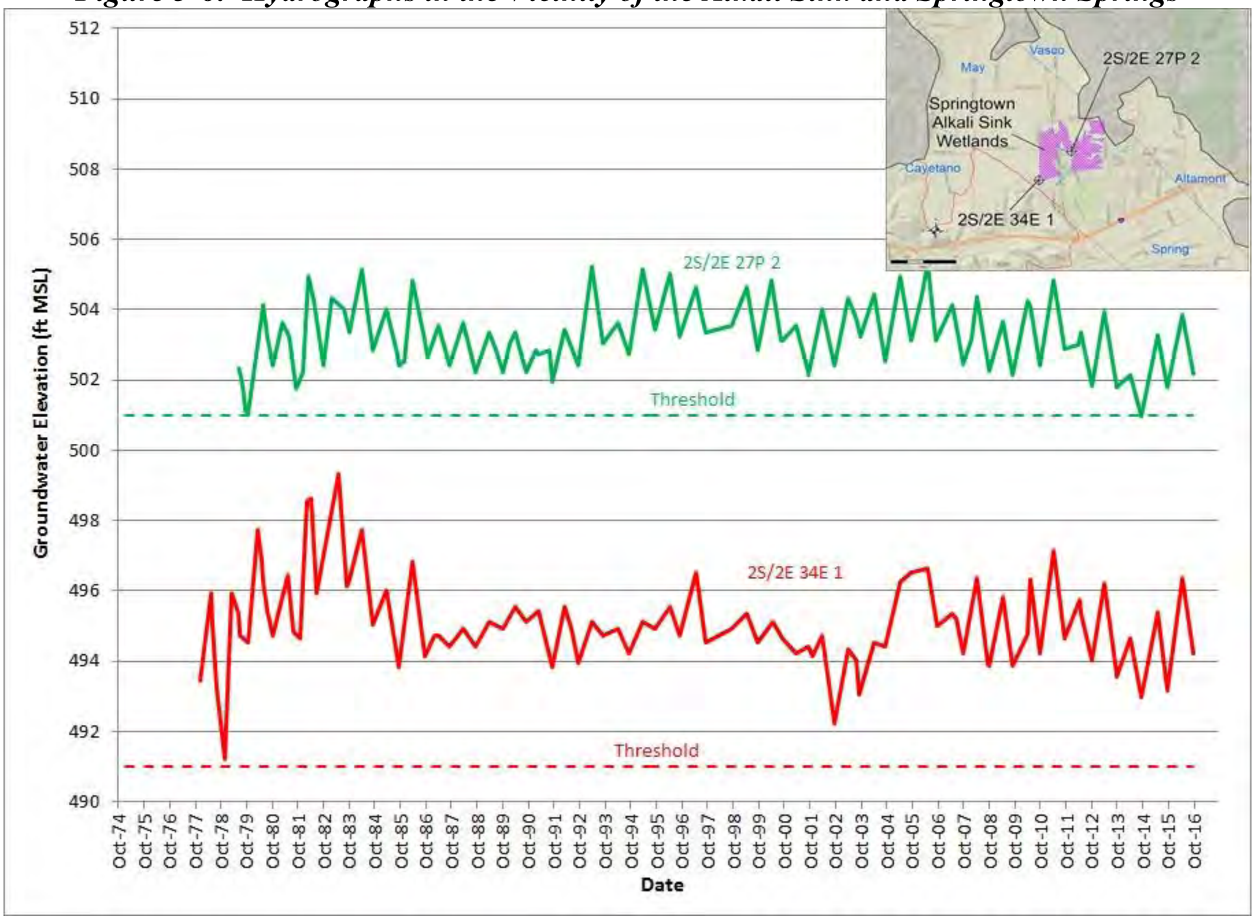
[5] Questa Engineering and Weiss Associates, Hydrologic Analysis of the Springtown Alkali Sink, Livermore, California; prepared for City of Livermore, County of Alameda and U.S. Bureau of Reclamation, November 1998.

Zone 7's role in permitting new wells in the basin allows an early assessment of any proposed wells to ensure that they are constructed to account for operating water levels in the basin and do not result in over-pumping for any localized area of well clusters. Through its assigned authority to administer the Alameda County Water Wells Ordinance within the Zone 7 service area, Zone 7 can require, at its discretion, that a permit application be accompanied by a certified CEQA analysis supporting that the new well and its use would not significantly impact the local water levels. Furthermore, water quality within this subarea is naturally poor due to the geology with increased salts and boron, and it is unlikely that there would be a request for significant well installation in the vicinity of the Alkali Sink.

Figure 3-6: Hydrographs in the Vicinity of the Alkali Sink and Springtown Springs



The minimum threshold is to avoid surface water depletion areally and temporally in the Alkali Sink and to use groundwater level measurements in the two wells in **Figure 3-6** as a reasonable proxy. Specifically, the historic minimum groundwater levels in these two wells are defined as the minimum thresholds below which surface water depletion could occur with resulting undesirable effects on the Alkali Sink. The lowest recorded groundwater elevations are 491 ft msl in Well 2S/2E 34E 1 (measured December 1978) and 501 ft msl in Well 2S/2E 27P 2 (measured September 2014). It is noted that the Zone 7 Groundwater Elevation Monitoring Program (see **Section 4.5**) provides semi-annual groundwater monitoring and annual reporting, with quantification of groundwater levels to one-hundredth of a foot.

Use of these groundwater data is justified, based on the hydrogeologic conceptual model whereby groundwater flow converges at the sink, is retarded by the Tesla Fault, and daylights as surface water. This hydrogeologic conceptual model has been supported by numerical modeling that shows a small but important groundwater inflow. While uncertainty exists with regard to specific groundwater level inflow at a particular place or time, the local hydrographs show considerable stability; in recent years, groundwater level fluctuations generally are within a range of several feet. Use of the lowest recorded groundwater elevation provides a reasonable margin for uncertainty; moreover, it is consistent with the use of the historic groundwater lows throughout the Basin.

This minimum threshold protects the groundwater/surface water interaction in the Alkali Sink. It is noted that this minimum threshold could present a potential constraint on a groundwater user or landowner in the northeastern Fringe Management Area tributary to the sink, namely, to install a new well or increase groundwater pumping and consumption such that groundwater levels decline below the threshold.

4 Monitoring Networks

4.1 Objectives

To support groundwater management activities, 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 networks is to provide sufficient information to allow for the tracking of groundwater conditions to meet the sustainability goal of the basin, including the prevention of undesirable results as defined in **Section 3**. In addition to this overall objective, specific objectives have been identified for each of the Sustainability Indicators to accomplish the following requirements:

- Demonstrate ongoing sustainability in the basin (objectives defined for the Livermore Valley Groundwater Basin in **Section 3**),
- Monitor impacts to groundwater users and beneficial uses of groundwater,
- Monitor changes in groundwater conditions relative to sustainability objectives and minimum thresholds (see **Section 3**), and
- Quantify annual changes in water budget components (§354.34 (b)).

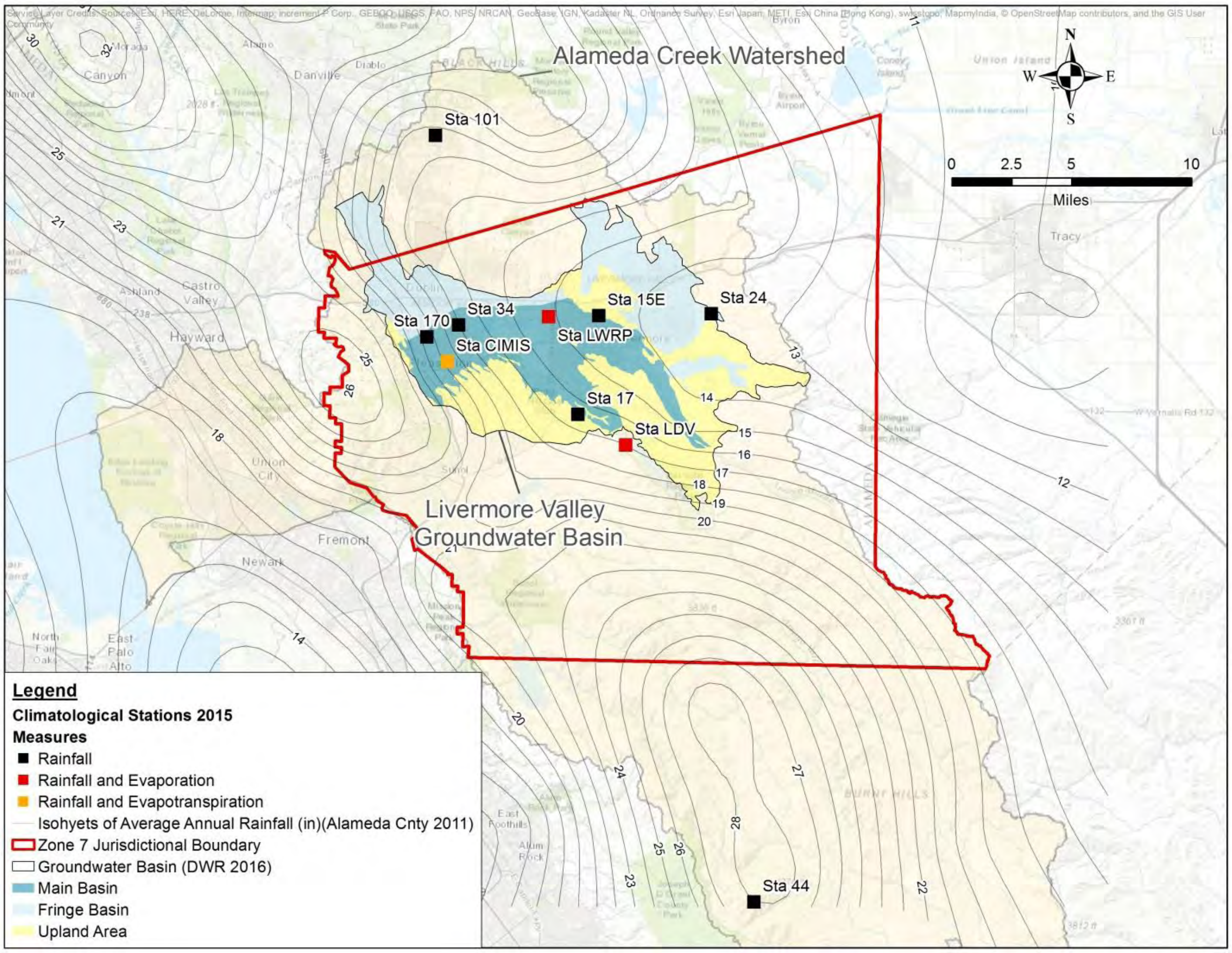
Additional monitoring objectives for each sustainability indicator are described in the following sections. The current monitoring networks have been developed to provide data of sufficient quality, frequency, and distribution to meet the objectives of this Alternative Plan. To ensure the quality of the data collected, monitoring protocols have been established (see **Appendix B**). The frequency for data collection has been developed to allow tracking of short-term, seasonal, and long-term trends of groundwater and related surface water conditions. Finally, the data management system is discussed at the end of this section.

4.2 Climate Monitoring

Zone 7's Climatological Monitoring Program tracks rainfall and evaporation in the Valley, employing a network of climatological stations. The primary objective of this monitoring network is to provide high quality basin-wide data for long-term studies, basin recharge calculations, and water management decisions. Specifically, the calculations of basin recharge are used in the annual water budget, change in groundwater storage, and the defined objectives of operational storage (see **Section 3**). Data are collected to provide short-term, seasonal, and long-term trends in local hydrologic conditions. Water year type is being incorporated into the analysis using DWR calculations for the Sacramento Valley. This hydrology is more consistent with the availability of imported supplies and generally approximates local rainfall patterns in the groundwater basin.

The Zone 7 Climatological Monitoring Program network consists of seven rainfall stations, two pan evaporation stations, and one California Irrigation Management Information System (CIMIS) station (including rainfall and evaporation) located within the Alameda Creek Watershed. **Table 4-1** (precipitation) and **Table 4-2** (evapotranspiration) list the stations and associated information including the station ID, name, type of monitoring station and mean annual precipitation or evapotranspiration (ETo). The location of the climatological stations, the watershed boundary, and average rainfall isohyets (the contours of equal annual average rainfall) are shown in **Figure 4-1**.

Figure 4-1: 2015 Climatological Monitoring Stations and Average Rainfall



There are two basic types of rainfall stations used in Zone 7"s Climatological Monitoring Program: daily record stations and recorder stations. A daily record station consists of a rain gauge at which, once-a-day, the observer measures and records the depth of rain that has fallen during the preceding 24 hours (see **Appendix B** for Standard Operating Procedures). A recorder station, which provides rainfall intensity for periods of less than 24 hours as well as daily totals, consists of a computerized-tipping-bucket rain gauge and a data recorder. These semi-continuous-reading rain gauges generally provide rainfall totals on a 15-minute frequency.

Table 4-1: List of Precipitation Stations

Alameda County STATION	Computer SITE ID	STATION NAME	LOCATION	OBSERVER	ELEVATION	STATION ESTABLISHED		MEAN ANNUAL PRECIPITATION INCHES
						DAILY RECORD	15 MIN RECORD	
15E	CM_STA 15E	NOAA LIVERMORE	WELLINGHAM DRIVE LIVERMORE	MR. RON HAFNER	480	1871	-	14.43
17	CM_STA 17	DEL VALLE PLANT	VALLECITOS ROAD LIVERMORE	ZONE 7 STAFF	640	1974	1978 to Present	15.95
24	CM_STA 24	PATTERSON PLANT	PATTERSON PASS ROAD LIVERMORE	ZONE 7 STAFF	680	1963	1969 to Present	12.77
34	CM_STA 34	MOCHO WELL FIELD	SANTA RITA ROAD PLEASANTON	ZONE 7 STAFF	340	1968	1970 to 2010	17.76
44	CM_STA 44	MT HAMILTON	LICK OBSERVATORY MT HAMILTON	LICK OBSERVATORY	4209	1881	-	23.83
101	CM_STA 101	TASSAJARA	CAMINO TASSAJARA ROAD DANVILLE	MRS. JOAN HANSEN	800	1912	-	18.48
170	CM_STA 170	ZONE 7 OFFICE	PARKSIDE DRIVE PLEASANTON	ZONE 7 STAFF	330	1986	1986 to 2005	20.38
191	CM_STA 191	CIMIS STATION	ALAMEDA COUNTY FAIRGROUNDSPLEASANTON	DWR STAFF	335	-	2004 to Present	15.85

Table 4-2: List of Evapotranspiration Stations

STATION ID	SITE ID	STATION NAME	LOCATION	OBSERVER	ELEVATION	STATION ESTABLISHED	MEAN ANNUAL ETo (in)*
LDV	CM_STA LDV-EV	LAKE DEL VALLE	ARROYO ROAD LIVERMORE	DWR STAFF	760	1969	42.81
LWRP	CM_STA LWRP-EV	LIVERMORE WATER RECLAMATION PLANT	JACK LONDON DRIVE LIVERMORE	LWRP STAFF	410	1974	46.33
191	CM_STA 191-ETO	CIMIS STATION	ALAMEDA COUNTY FAIRGROUNDS PLEASANTON	DWR STAFF	335	2004	51.05

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

Zone 7‟s Climatological Monitoring Program also contains both reference ETo and pan evaporation stations to determine water transfer to the atmosphere. Station 191 (CIMIS) is a reference ETo station, which estimates the ETo value of the water used by a well-watered, full-cover grass surface, whereas the pan evaporation stations at Lake Del Valle (LDV) and Livermore Water Reclamation Plant (LWRP) measure evaporation directly. LDV and LWRP pan evaporation data is converted to ETo using a conversion factor (ETo=Pan Evap x 0.6402). Zone 7 uses ETo to calculate evaporation from the gravel quarry ponds as well as in its applied water recharge model. The CIMIS Station‟s ETo is also used as part of Zone 7‟s Water Conservation Program to help regulate weather-based irrigation ("SMART") controllers.

4.3 Surface Water Monitoring

4.3.1 Surface Water Objectives

Zone 7 monitors streamflow in the arroyos that run though the Basin, surface area and water levels of active and inactive gravel quarry ponds located in the central part of the Basin, and water transfers from arroyos and quarry ponds to those former quarry pits that are being used for aquifer recharge. In addition, Zone 7 tracks flow from the upper Arroyo Valle watershed into Lake Del Valle and the portion of Lake Del Valle storage for which Zone 7 has water rights. The objectives of Zone 7‟s Surface Water Monitoring Program are:

- **Surface Water Level and Flow Monitoring** – Quantify inflow and outflow of surface water to/from the groundwater basin. These data are used to quantify aquifer recharge resulting from streamflows (natural and artificial) and capture of gravel quarry discharges and as input for the evaporative losses determinations. They are also used in hydraulic modeling of the watershed for flood control management purposes;

- **Surface Water Quality Monitoring** - Provide a record of water quality for the basin‟s recharge and discharge waters with which the groundwater basin‟s annual salt (TDS) loading is calculated; and

- **Del Valle Water Rights** - Satisfy the requirements of Zone 7‟s and Alameda County Water District‟s (ACWD) provisional water rights on the Arroyo Valle. This involves continuous flow monitoring and quarterly sampling at two surface water stations.

The program utilizes a network of recorder stream gauge stations and flow meters to compute the quantity of water flowing past each station, and both, semi-continuous and periodic water level measurements to track change in surface water storage. Surface areas of the water bodies are monitored using aerial photos to evaluate evaporative losses. Water samples are collected from the ten main recorder sites and significant quarry ponds at least once per year, and submitted to Zone 7‟s laboratory for analysis of metals, minerals and general properties (the same parameters that are routinely analyzed in the Groundwater Quality Monitoring Program).

4.3.2 Stream Monitoring

The current Stream Monitoring Program includes 15 stream gauge stations that record stream stage at 15-minute intervals. One of the 15 recording stations is a low-flow monitoring site while three other stations are high-flow monitoring sites (**Table 4-3**). Four of the gauges are owned and maintained by the USGS under Department of Interior „Cooperative Agreements" with Zone 7 and others. **Figure 4-2** shows the locations of the stream gauges used in the Stream Monitoring Program for the 2015 WY.

Stream stage is converted to streamflow using calibrated stage-to-flow rating curves. Stream discharge measurements are periodically conducted at each station to recalibrate the rating curve, if necessary, to maintain its accuracy. **Appendix B** contains a description of Zone 7‟s discharge measurement procedure. Records from all 15 gauge stations, including records of the rating curve corrections are stored in the Zone 7 maintained AQUARIUS Time-Series® database (**Section 4.9**), however, certain data can be viewed by the public in virtually "real-time" on WaterLog‟s StormCentral website (https://stormcentral.waterlog.com/public/Zone7).

Zone 7 calculates the basin groundwater budget (storage) using data from the gauge stations on the recharging streams (Arroyos Valle, Mocho, and Las Positas) and data from turnout flow meters that record the South Bay Aqueduct (SBA) releases made to these arroyos (**Figure 4-2**). The other gauges do not have significance for aquifer recharge, salt loading or basin outflow, and are maintained primarily for flood control study and management purposes.

In general, surface waters flowing past gauges AMNL, ALPL and AVNL, or through the SBA/Arroyo Mocho turnout, represent surface water entering the Basin that has potential for groundwater replenishment. The gravelly middle reaches of Arroyo Valle and Arroyo Mocho, and to a lesser extent, Arroyo Las Positas, offer aquifer recharge potential; whereas, downstream of gauges ALP_ELCH, AM_KB, AMP and ADVP the channels are mostly incised in clayey overburden (See **Figure 2-7**; **Section 2.1.5**) and therefore do not do not offer much recharge potential. Consequently, water flowing past these lower gauges will mostly flow out of the Valley, past ADLLV, and into Alameda Creek. For the water budget calculation, the differences between the amount of surface water entering the Basin upstream of the recharge reaches and that flowing past the gauges at the end of each respective recharge reach equates to the stream recharge components.

A small amount of groundwater discharge into the Arroyo De La Laguna has been observed along its banks when groundwater levels rise above elevation 295 ft msl in the southwestern portion of the Main Basin. In the past the amount was crudely estimated; however, with the recent restart of streamflow monitoring at ACNP, Zone 7 should be able to better quantify this basin outflow component when groundwater levels next rise above the threshold. Water losses due to evapo-transpiration and accretions from urban water runoff are accounted for separately in Zone 7‟s areal recharge calculations (see **Section 2.4.2.2**).

Table 4-3: Stream Gauge Details

Station Name	Site ID	Parameters Recorded	Data Collected By	Drainage Description	Drainage Area (mi^2)	Gauge Datum (feet)
Arroyo Valle below Lang Canyon	AVBLC	Gauge Height Water Temp	USGS Zone 7	Upland Valle Drainage Basin	130	750.00
Arroyo Valle near Livermore	AVNL	Gauge Height Water Temp	USGS	Valle below dam and SBA Releases; (regulated flow due to dam)	147	510.44
Arroyo Valle at Pleasanton	ADVP	Gauge Height Water Temp	Zone 7	Valle Drainage Basin	171	312.66
Arroyo Mocho near Livermore	AMNL	Gauge Height Water Temp	Zone 7	Upland Mocho Drainage Basin	38	746.47
Arroyo Mocho Stanley Reach near Livermore	AM_StanRch_10	Gauge Height Water Temp	Zone 7	Boundary of Mocho II and Amador Basins	49	439.00
Arroyo Mocho at Livermore	AMHAG	Gauge Height Water Temp Turbidity	Zone 7	AM before mining discharges	51	374.78
Arroyo Mocho at Kaiser Bridge	AM_KB	Gauge Height Water Temp	Zone 7	AM before confluence with ALP	60	325.47
Arroyo Mocho near Pleasanton	AMP	Gauge Height Water Temp Turbidity	Zone 7	Mocho Drainage Basin	141	323.77
Arroyo Las Positas at Livermore	ALPL	Gauge Height Water Temp Turbidity	Zone 7	Upland Positas Drainage Basin	53	460.99
Arroyo Las Positas above El Charro Road	ALP_ELCH	Gauge Height Water Temp	Zone 7	Positas Drainage Basin	75	338.82
Arroyo de la Laguna near Verona	ADLLV	Gauge Height Water Temp Spec Cond pH	USGS	Laguna Drainage Basin	403	280.00
Alamo Creek at Willow Creek Drive	AC_WCD	Gauge Height Water Temp	Zone 7	Dublin Basin	17	368.80
Alamo Canal near Pleansanton	ACNP	Gauge Height Water Temp	USGS Zone 7	Dublin Basin	39	309.00
Chabot Canal below Stoneridge Drive	CCNP	Gauge Height Water Temp	Zone 7	Dublin Basin	5	320.00
Tassajara Creek above Interstate 580	TC_580	Gauge Height Water Temp	Zone 7	Camp Basin	27	341.00

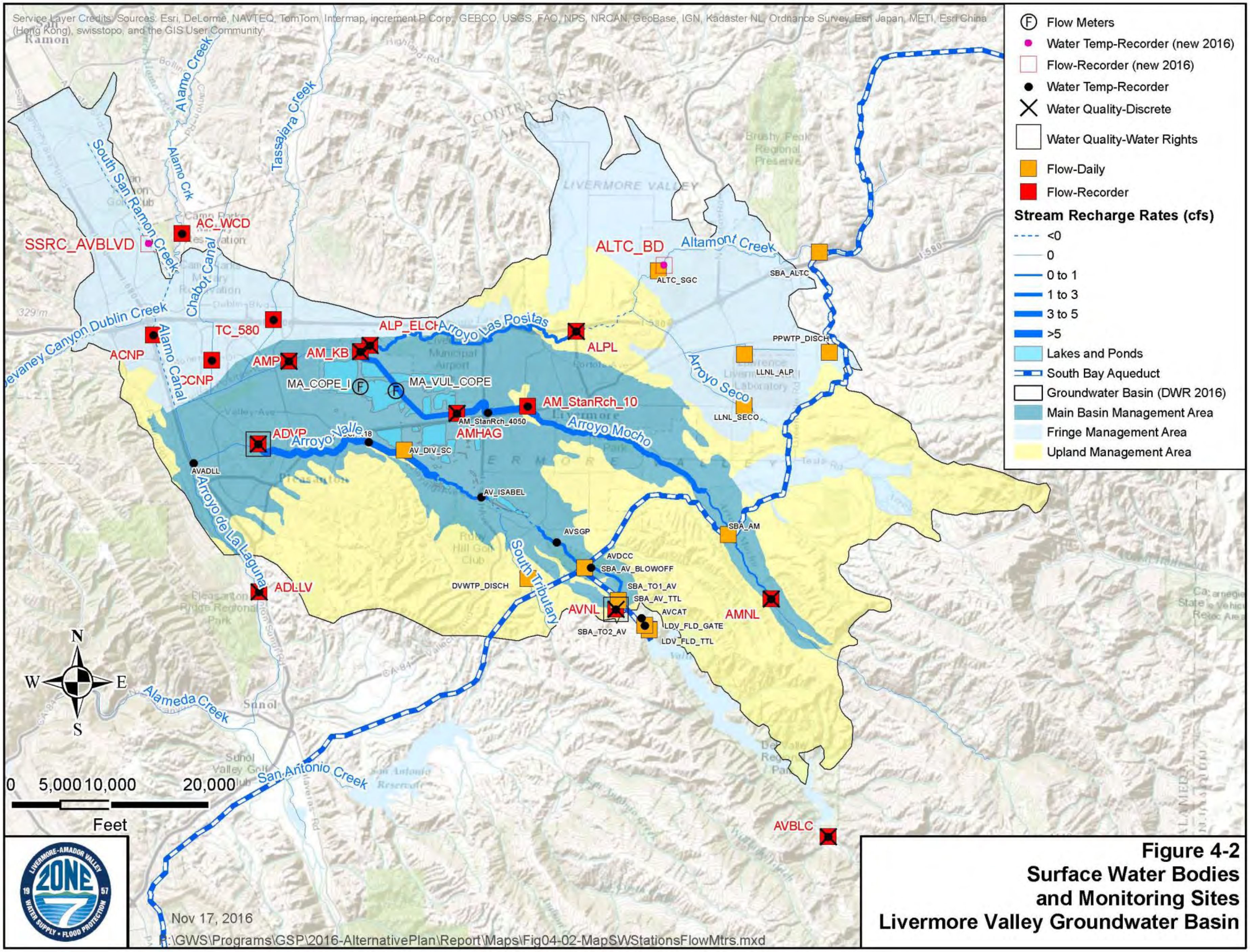


Figure 4-2
Surface Water Bodies and Monitoring Sites
Livermore Valley Groundwater Basin

4.3.3 Surface Water Quality Monitoring

Zone 7 collects surface water samples at least annually (see **Appendix B** for Standard Operating Procedures) at each of the gauge stations in the Surface Water Monitoring Program. The samples are analyzed by Zone 7"s certified laboratory for the same parameters analyzed for the Groundwater Quality Monitoring Program (see **Section 4.6**). Zone 7 also has contracts with outside labs should special sampling needs for analytes not covered under Zone"s lab arise. The sample results are combined with the steam recharge results to estimate the salt loading components from stream recharge and salt removal from groundwater basin seepage (outflow). Zone 7"s salt and nutrient loading assessments are discussed further in **Section 2.3.8**.

4.3.4 Arroyo Valle Water Rights

To maintain its surface water rights on the Arroyo Valle, Zone 7 performs continuous flow monitoring and quarterly water quality sampling at two surface water stations: ADVP and AVNL (see **Figure 4-2**).

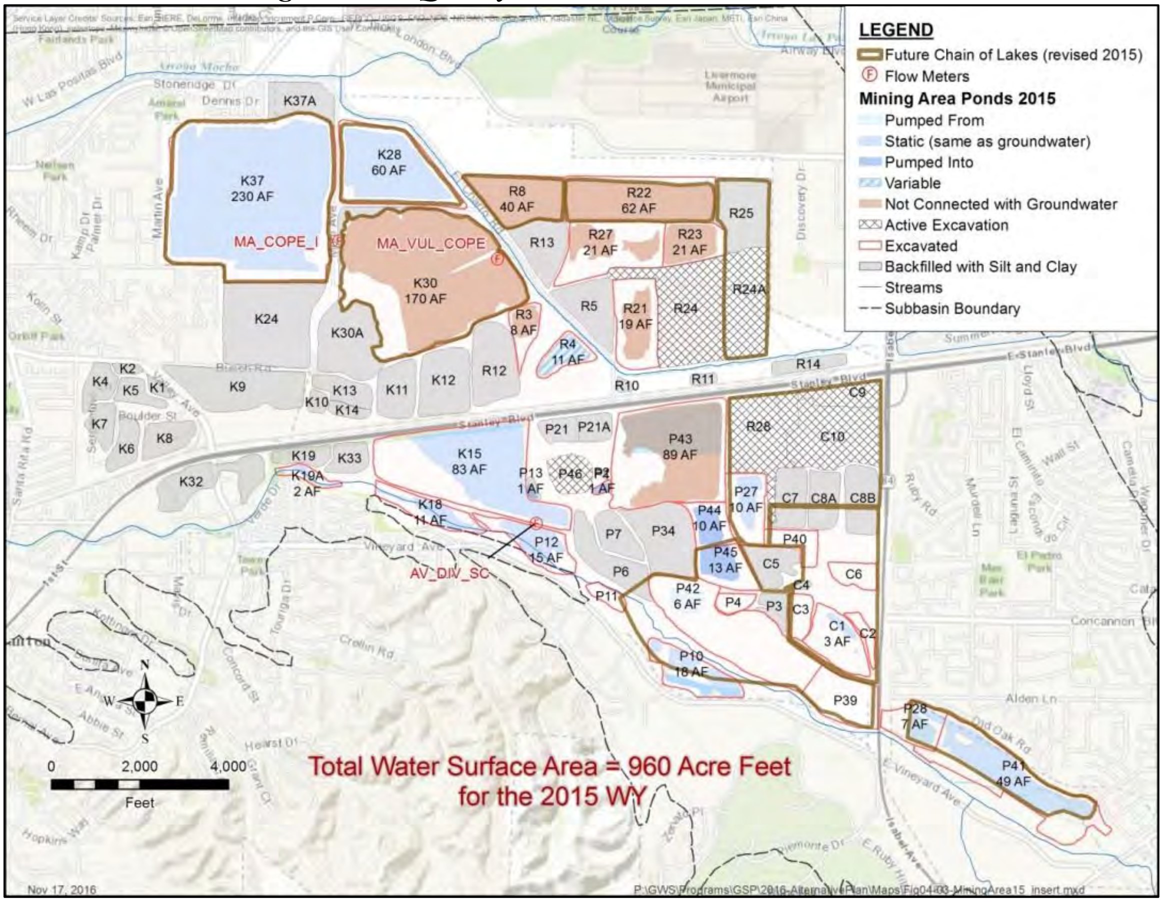
4.4 Chain of Lakes and Quarry Operations Monitoring

The Chain of Lakes and Quarry Operations Monitoring Program includes water level measurements and water quality analysis for selected mining area ponds or quarry lakes within the central portion of the Livermore Valley Groundwater Basin. The program also tracks and documents surface areas of the quarry ponds exposed for evaporation, circulation, and conveyance of water between pits, and the locations of flow barriers created by clay-lined or backfilled pits. These data factor into groundwater elevation maps, water budget analyses, groundwater quality assumptions, and groundwater model configurations and calibration. Zone 7 has been monitoring and keeping records of mining area activities since 1979.

Figure 4-3 shows the location and approximate area of each quarry pond in the monitoring program for the 2015 WY, while **Table 4-4** identifies the former and current pond/pit owners and current operators associated with each pond shown on **Figure 4-3**.

Water surface elevations in each pond are measured semi-annually using a high precision global positioning system (GPS) instrument (see **Appendix B** for details). The readings are typically taken within a week of the semi-annual groundwater monitoring well level measurements; i.e., during spring-high and fall-low groundwater levels. Based on the pit construction (e.g., lined or unlined), the current mining activity (e.g., active or inactive), and the apparent water level nature (static, perched, or pumping level), Zone 7 staff will make the determination whether the water present in the quarry pond and the measured water level are representative of groundwater at the site. If it is so determined, the water elevation results are used as additional data points for the Upper Aquifer, semi-annual contour maps.

Figure 4-3: Quarry Ponds Monitored in 2015 WY



Water quality is determined annually for each pond in the monitoring program thought to be hydraulically connected with groundwater through sampling and analysis. Zone 7‟s laboratory performs the analysis of general minerals, metals, and properties, consistent with the analyses performed for the Groundwater Quality Monitoring Program. The results are compared with previous years‟ results and neighboring monitoring well results, then archived in the same time-series database as the monitoring well results (**Section 4.9**). As with the elevation data, select water quality results are used as additional data points on the Upper Aquifer water quality contour maps created annually.

Lakes H and I, Cope Lake and Shadow Cliffs (K28, K37, K30, and K15, respectively) are key components of Zone 7‟s managed aquifer recharge operations. Their contribution to Zone 7‟s artificial recharge is quantified by accounting for inflow, outflow, evaporation, and changes in water levels.

Surface water discharges made to Cope Lake and Shadow Cliffs and transfers from Cope Lake to Lake I are metered. The meter locations are shown in **Figure 4-2**. Flow into or out of Lake H is currently more passive; water seeps into Lake H from Cope Lake, the adjacent Arroyo Mocho, and perched groundwater, and either to or from Lake I through a valved conduit that connects them. Together with Hanson Aggregates, Zone 7 plans to construct a diversion structure on the Arroyo Mocho to divert artificial flows from the SBA into Lakes H and I for additional aquifer recharge. There are also existing plans for Vulcan to connect Lake G to Lake H with a conduit as part of the mining reclamation plan for Lake G.

Table 4-4: Quarry Pond Operators and Owners

Pond Prefix*	Pond Number	Other Name	Previous Owner(s)	Current Owner	Current Operator
K	K1 thru K8, 19, 32, 33		Kaiser Sand & Gravel; Hanson Aggregates	Various	backfilled/ developed
	K9 thru 14, 24			SteelWave	backfilled
	K15	Shadow Cliffs		EBRPD	EBRPD
	K18	Lake Boris		EBRPD	EBRPD
	K28	Lake H		PGC	Hanson
	K30	Cope Lake		Zone 7	Zone 7
	K37	Lake I		Zone 7	Zone 7
R	R3, 4, 12		Rhodes & Jamieson	Vulcan	Vulcan
	R5	Lake G		PGC	Vulcan
	R8, 10, 11, 13, 14, 21, 23, 24, 24A, 27			PGC	Vulcan
	R22	Lake F		PGC	Vulcan
	R25	Lake E		PGC	Vulcan
C	C1, 2, 6	Lake C	Cal Rock	PGC	Vulcan
	C3, 4			PGC	Vulcan
	C5			CEMEX	CEMEX
	C7 thru10, R28	Lake D		PGC	Vulcan
P	P1 thru 11, 13, 21, 27, 34, 40, 43, 44, 45		Pacific Coast Aggregates; RMC/Lonestar	CEMEX	CEMEX
	P12	Island Pond		EBRPD	EBRPD
	P28, 41	Lake A		CEMEX	CEMEX
	P39,42	Lake B		CEMEX	CEMEX

* Prefix for pond names (e.g., K37)
PGC Pleasanton Gravel Company
EBRPD East Bay Regional Parks District

Mining area evaporation accounts for a large portion of the "Demand" component for the annual hydrologic inventory (HI) calculation, second only to "Municipal Pumping." Evaporative losses are estimated using the ETo calculated from the LWRP station data, estimated water surface area from aerial photos, and lake elevation/area curves developed from land and bathymetric surveys.

Water levels in Lakes H, I and Cope are recorded automatically at 15-minute intervals, using transducers or bubbler-type monitoring equipment, while Shadow Cliff‟s water levels are read from staff gauges daily by EBRPD staff. Groundwater elevations near Lake I are also recorded at 15-minute intervals using data recording transducers in piezometers to determine the head difference between the ponds and aquifer and direction of flow (recharge or discharge).

In addition to water level measurements and water quality analysis for many of the mining area ponds, Zone 7 tracks current and planned mining activities, to the extent possible. The mining activities are monitored as they relate to actual and potential groundwater impacts, such as groundwater storage losses, groundwater flow interference (i.e., capture or impediment), or risk of groundwater quality degradation. Features monitored are summarized on **Table 4-5**. The clay-lined ponds are included in the monitoring program because the water they contain mostly originates from another pit that is being dewatered.

Table 4-5: Gravel Mining Monitoring

Monitored Feature	Purpose and Use
Location and depth of excavations	Assessment of groundwater connection; include feature and form in GW model and report figures; track progress towards completion of mining.
Location and depth of dewatering operations and circulation and conveyance of water between pits	Considered in contouring of GW gradient maps; input for change in storage and salt loading/unloading calculations;
Locations of clay-linings and low permeability backfills	Assessment of groundwater connection and flow impediments; consideration for future plans; include feature in GW model.
Gravel pit and pond use	Used to determine connection with groundwater; consideration of contamination risk; consideration for future plans.
Location and quantity of discharges made to arroyos	Component of stream recharge and stream outflow; input for storage and salt loading/unloading calculations; basis for mining impact fee
Evaporative surface areas	Used to determine evapo-transpiration component; input for storage and water balance calculations;
Aggregate production	Used to estimate groundwater lost due to the export of moist gravels; basis for mining impact fee
Installation and use of onsite supply wells and soil borings	Considered in contouring of GW gradient maps; input for change in storage; include features in conceptual model and GW model.

The volume of water that leaves the Valley through discharges to the arroyos is computed by prorating the flows after accounting for any re-percolation that may occur in the arroyo. Zone 7 collects a mining impact fee for the water discharged and/or the groundwater interference caused by the mining operations. In return, Zone 7 has agreed to manage the basin water levels below elevation 310 ft msl in the upper Amador East Key Well and 300 ft msl in the upper Bernal Key Well to reduce the impact of high groundwater to the mining operation and to waive the fees whenever groundwater levels rise above these thresholds. The fee amounts are generally based on the quantity of water lost as stream outflow due to the mining company‟s discharge of pit dewatering water to the arroyo. In one case, the tons of aggregate sold by the mining company is used as a surrogate for the amount of lost groundwater in setting the mining company‟s annual fee. This mining impact fee is put into a trust fund controlled by Zone 7 and is earmarked for purchasing additional imported supplies or for the construction of facilities designed to move water around the obstructions created by the backfilled pits.

Since 2015, there has been no discharge (loss) of operations water made to the arroyos. There are currently only two gravel mining companies in operation over the groundwater basin, CEMEX and Vulcan Materials, and both are not scheduled to complete their local operations until 2042. CEMEX is currently capturing and containing all of their surplus operations water onsite while Zone 7 is capturing all of Vulcan‟s surplus operations water in Cope Lake and allowing it to drain into Lakes H and I for re-percolation back into the basin‟s aquifers.

4.5 Groundwater Elevation Monitoring

Zone 7‟s Groundwater Elevation Monitoring Program includes the measurement of groundwater levels in a sufficient number of monitoring and production wells to meet the following monitoring objectives:

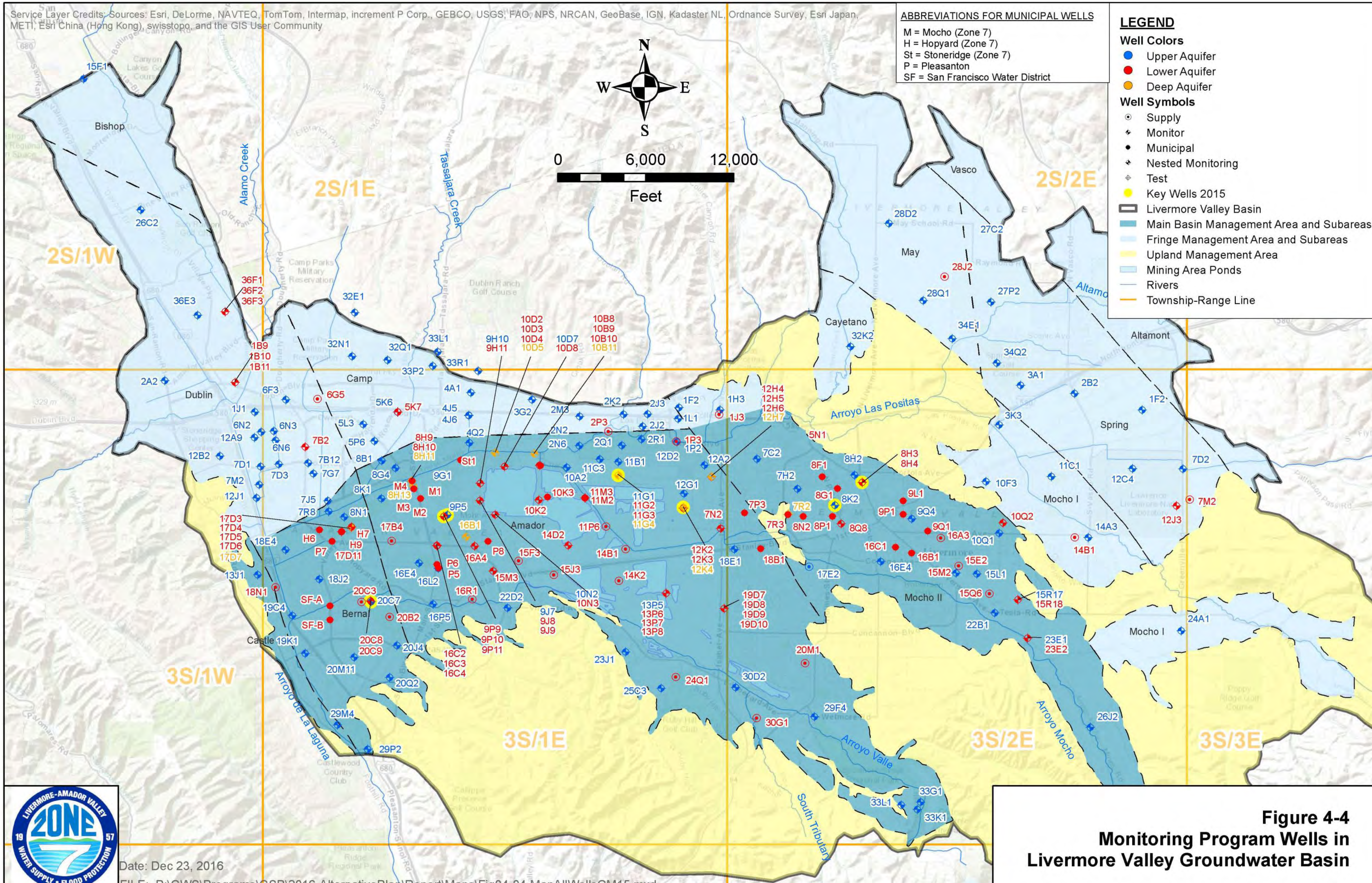
- track groundwater occurrence and flow,
- analyze the water table (and potentiometric surface) of the Upper and Lower aquifers,
- identify short-term and long-term trends and seasonal fluctuations when combined with historical data,
- compare current water levels to historic low water levels as a minimum threshold to track the progress in meeting the sustainability objective for water levels, storage, and inelastic land subsidence,
- estimate subsurface flows between Management Areas, and
- support the water budget with an analysis of current groundwater in storage and the change in storage over time; in this manner, water levels are also used to track the progress in meeting the sustainability objective for groundwater storage.

The program focuses on the Main Basin Management Area where groundwater is pumped for municipal uses; however, groundwater levels are also routinely measured in the Fringe Management Area, and occasionally in the Uplands Management Area. A subset of these data is submitted to the DWR in compliance with the CASGEM program.

There are currently about 240 wells in the Zone 7 Groundwater Elevation Monitoring Program including 18 nested wells providing local information on vertical gradients (well locations shown on **Figure 4-4**).

Well construction details for each of the wells in the program are also provided in **Appendix C-1**. Each well in the program is monitored to fulfill one or more specific objective. A list of all the wells in the program, their objective(s), and the frequency of monitoring for each objective is provided in **Appendix C-2**. The Groundwater Elevation Monitoring Program elements are summarized below:

Routine Water Level Monitoring – groundwater level measurements are made at least twice per year during seasonal extremes (i.e., spring highs and fall lows) to confirm sustainability objectives are being met and to calculate storage. Water level measurements are also made monthly in several wells to track performance of recharge and pumping operations, and to ensure groundwater levels are not falling below "Historic Lows" anytime during the water year. The monthly data is also used to identify when the seasonal peaks are occurring so that semi-annual water level measurements can be scheduled appropriately. A few of the monthly monitored wells have recording pressure transducers installed to record drawdown caused by supply wells cycling on and off in the subarea. This information is used to evaluate aquifer connectivity and distance-drawdown impacts of the pumping wells.



Date: Dec 23, 2016

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Figure 4-4
Monitoring Program Wells in Livermore Valley Groundwater Basin

Del Valle Water Rights (WR) – continuous and monthly monitoring of water levels is required in six specific wells to maintain Zone 7‟s surface water rights on the Arroyo Valle (see **Table 4-6**).

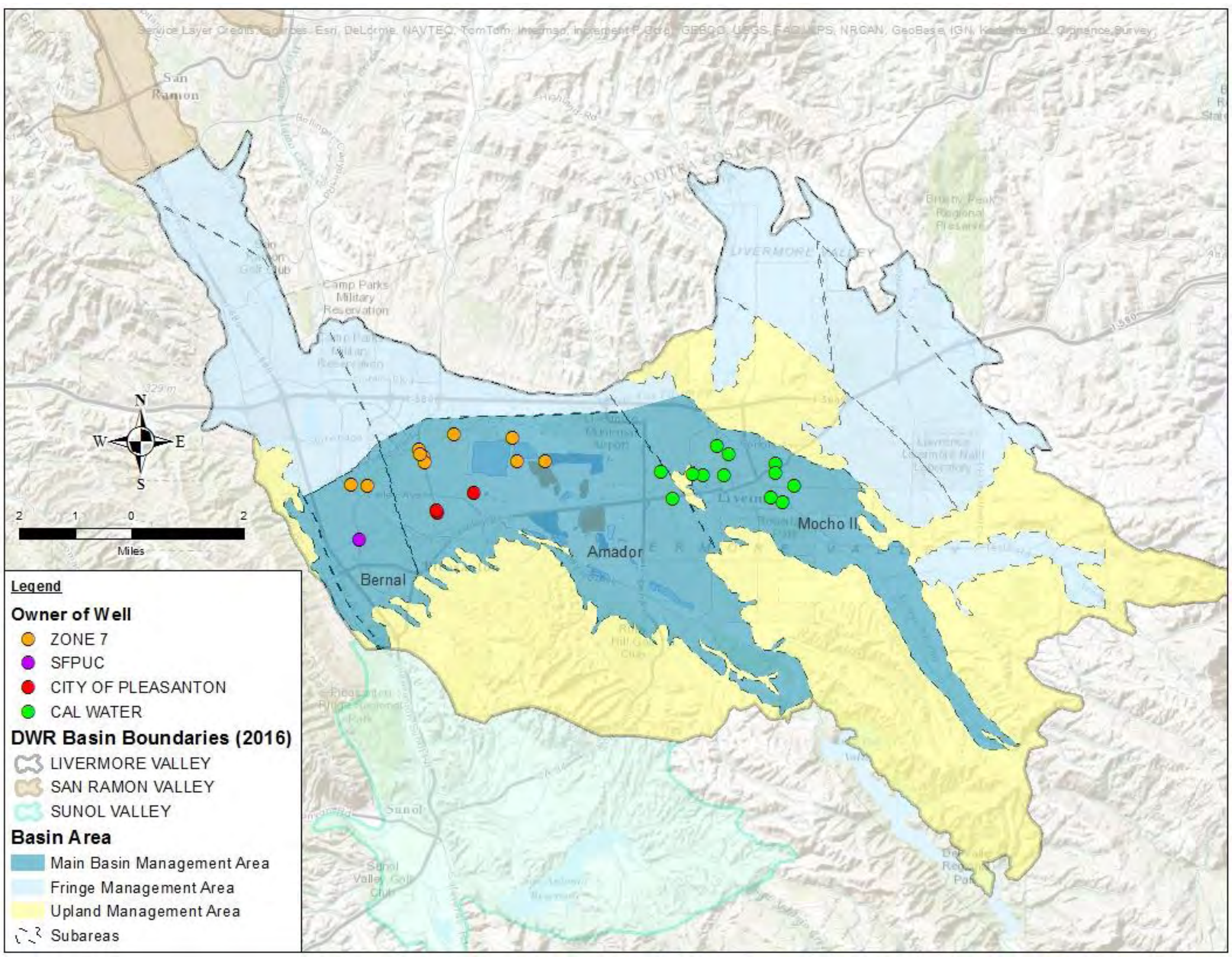
Table 4-6: Del Valle Water Rights Monitoring Wells

Monitoring Well	Monitoring Frequency
3S/1E 16P 5	Continuous*
3S/1E 20C 7	Continuous*
3S/1E 29M 4	Monthly
3S/2E 29F 4	Monthly
3S/2E 30D 2	Continuous*
3S/2E 33G 1	Monthly

* 15-minute water level data being recorded

Municipal Supply Well (Mu) – monitoring of water levels and water quality is conducted continuously, monthly, or quarterly in all the municipal supply wells for production well performance monitoring and State drinking water operations permit compliance. The wells in this program are shown on **Figure 4-5**.

Figure 4-5: Municipal Wells



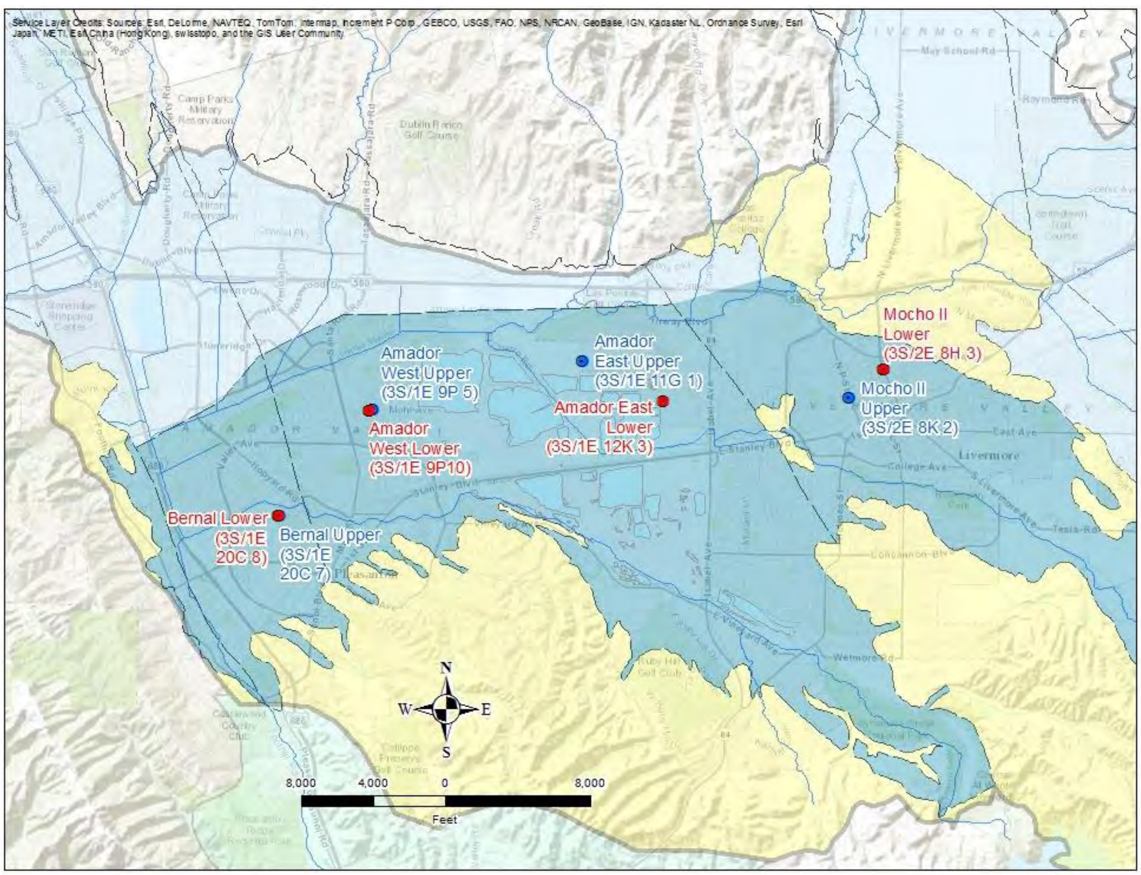
Key Wells (Key) –water levels are monitored at least monthly in eight key index monitoring wells located in the central parts of the three largest subareas of the Main Basin (Bernal, Amador, and Mocho II) where the municipal pumping occurs. Because the Amador Subarea is over twice the size of the other two subareas, it is split into the Amador West and Amador East Subareas. Each subarea is represented by an upper and a lower aquifer well. The wells currently being monitored for the Key Well Program are shown on the **Table 4-7** and **Figure 4-6** below.

Table 4-7: Key Well Program Wells

Subarea	Aquifer	Key Well Name	Current Well
Bernal	Upper	Key_Bern_U	3S/1E 20C 7*
	Lower	Key_Bern_L	3S/1E 20C 8*
Amador-West	Upper	Key_AmW_U	3S/1E 9P 5*
	Lower	Key_AmW_L	3S/1E 9P10*
Amador-East	Upper	Key_AmE_U	3S/1E 11G 1
	Lower	Key_AmE_L	3S/1E 12K 3*
Mocho II	Upper	Key_Mo2_U	3S/2E 8K 2*
	Lower	Key_Mo2_L	3S/2E 8H 3*

* 15-minute water level data being recorded

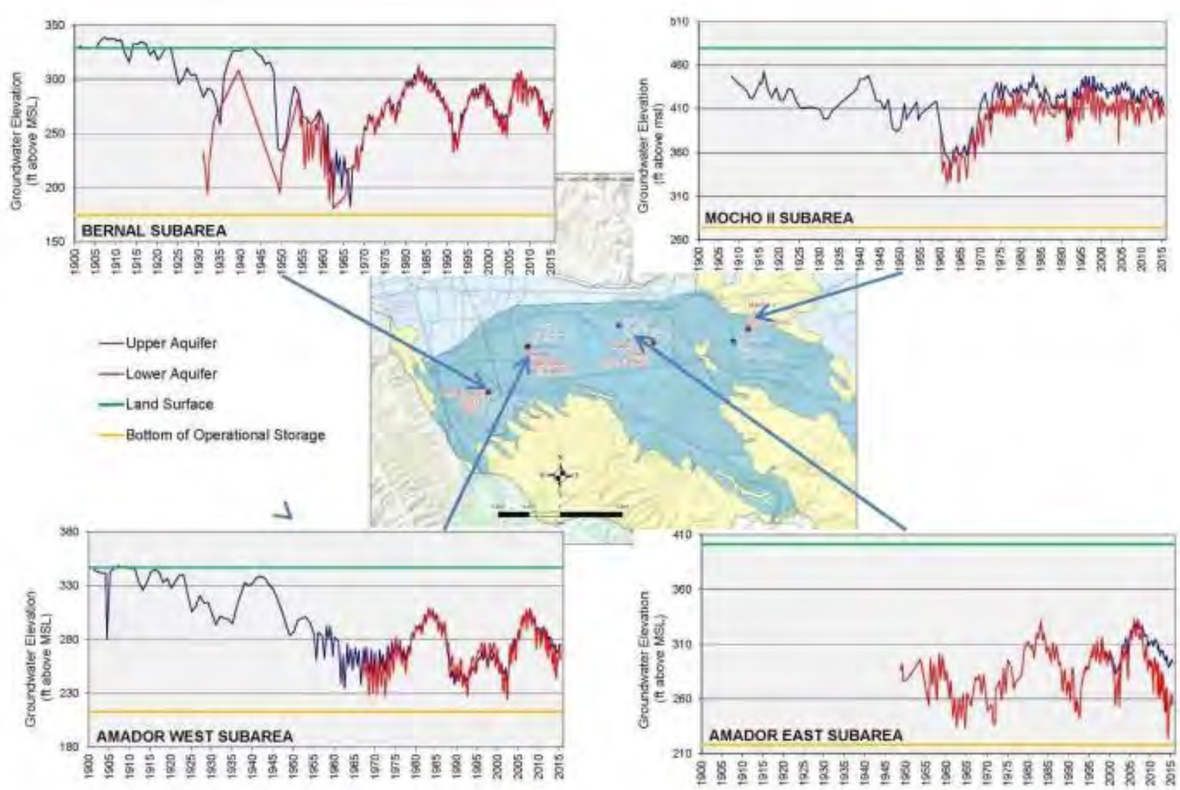
Figure 4-6: 2015 Key Wells



The Key Well datasets are composite records as the actual monitoring wells have been replaced in-kind over time. However, the hydrographs for the Key Wells represent some of the oldest and longest-running continuous record of water levels for the Basin; some dating back to the early 1900s, and are often used in reports when discussing the history of groundwater levels in the Basin (**Figure 4-7**).

Although water levels are measured and plotted in the Key Well hydrographs as monthly data, nearly all of the Key Wells have pressure transducers and data recorders installed that collect water level information at 15-minute intervals. Currently, only the Upper Amador East Key Well (3S/1E 11G 1) does not have a transducer installed. Zone 7 is considering adding telemetry to these wells which would allow for remote access to real-time water level data.

Figure 4-7: Key Wells with Hydrographs



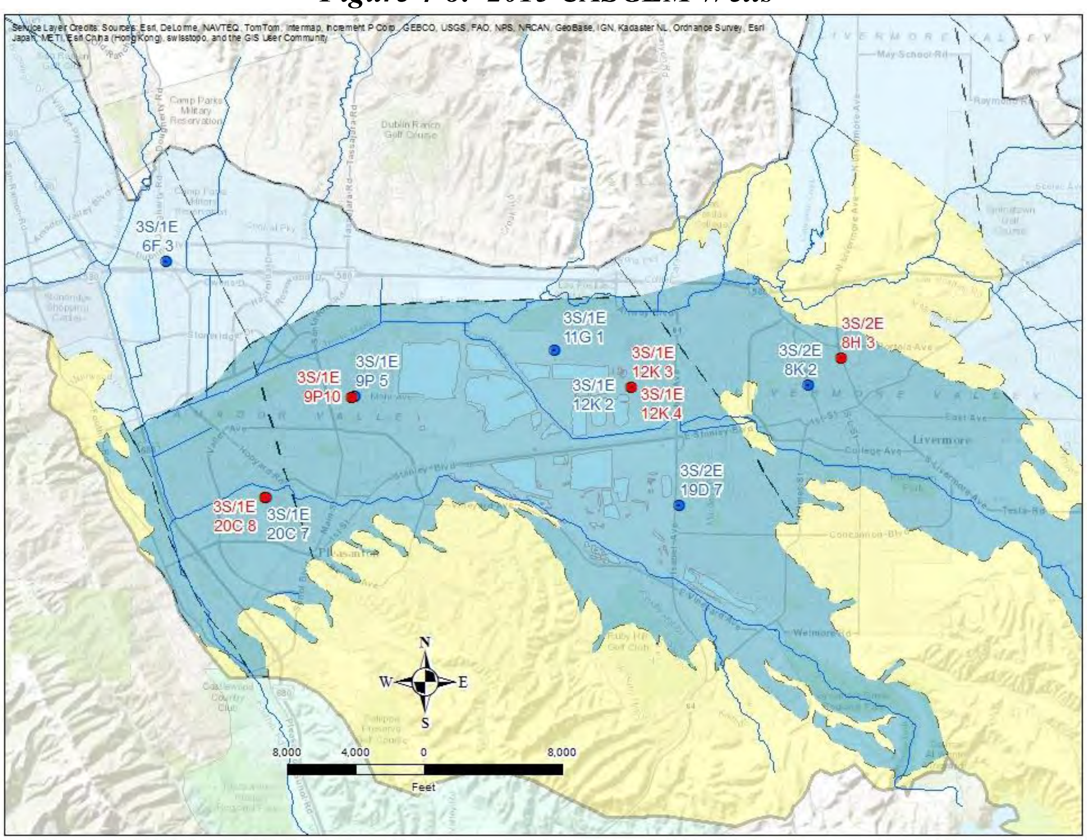
CASGEM – In 2012, DWR developed the CASGEM Program to track groundwater elevations in California groundwater basins to satisfy the requirements under Water Code §10920, *et seq*. The program requires monitoring entities, such as Zone 7, to submit groundwater level data semiannually to DWR. Working collaboratively with DWR staff, Zone 7 selected ten wells (the eight Key Wells plus two others) to represent overall groundwater elevations in the basin. Two more wells were added to the CASGEM Program in 2015, when Zone 7 replaced the Key Well representing Lower Amador East (3S/1E 12K 2) with another one from the same nested group (3S/1E 12K 3) that has a slightly deeper well screen. At that time, it was decided to add the replacement well

(3S/1E 12K 3) and the next deeper screened well in the nested group (3S/1E 12K 4) to the program, and to keep the former key well (3S/1E 12K 2) in the program as well. The CASGEM Program wells are shown on the table and map below (**Table 4-8** and **Figure 4-8**, respectively).

Table 4-8: CASGEM Wells for the 2015 WY

Well Number	Basin/Location Description
3S/1E 6F 3	Northern portion of Fringe Management Area, upper aquifer
3S/1E 9P 5	Amador West Upper Key Well
3S/1E 9P10	Amador West Lower Key Well
3S/1E 11G 1	Amador East Upper Key Well
3S/1E 12K 2	Former Amador East Lower Key Well
3S/1E 12K 3	New Amador East Lower Key Well
3S/1E 12K 4	Deepest well in 12K nested well set
3S/1E 20C 7	Bernal Upper Key Well
3S/1E 20C 8	Bernal Lower Key Well
3S/2E 8H 3	Mocho II Lower Key Well
3S/2E 8K 2	Mocho II Upper Key Well
3S/2E 19D 7	Southern portion of Amador, lower aquifer

Figure 4-8: 2015 CASGEM Wells



4.6 Groundwater Quality Monitoring

This section describes the groundwater quality monitoring conducted for the Livermore Valley Groundwater Basin. The purpose of monitoring groundwater quality is to assure that historical degradation is being successfully mitigated and no additional groundwater degradation is occurring. Zone 7‟s Groundwater Quality Monitoring Program includes the sampling and analysis of groundwater in a sufficient number of monitoring and production wells to meet the following specific monitoring objectives:

- track changes in groundwater quality over time making sure the Basin is meeting the sustainability objectives,
- quantify salt and nutrient loading and monitor the fate of historic TDS and nitrate plumes,
- monitor progress of soil and groundwater contamination investigations and clean-ups, and
- satisfy regulatory requirements for public water supply and wastewater systems, and for surface water rights permits.

The Groundwater Quality Monitoring Program focuses primarily on the Main Basin Management Area, where groundwater is used for municipal supply; however, groundwater quality is also routinely monitored in the Fringe Management Area, and occasionally in the Uplands Management Area where groundwater is used in small quantities for domestic supply, agricultural irrigation, or livestock watering. Most of the groundwater quality results used to meet the objectives above come from sampling and analyses conducted by Zone 7‟s Water Quality Laboratory. The Zone 7 Water Quality Laboratory is an ELAP-accredited laboratory, certified to conduct testing for: Inorganic Chemistry; Toxic Chemical Elements; Volatile and Semi-volatile Organic Chemistry; and Radiochemistry in drinking water. Other groundwater quality data are sourced from other agencies‟ programs, such as: DSRSD‟s monitoring of their wastewater treatment operations; Alameda County‟s oversite of onsite wastewater systems, domestic water supply, and leaking underground storage tank cleanup sites; and the SWRCB‟s GeoTracker database.

Each well in the program is sampled to fulfill one or more specific objective. A list of all the wells in the program, their objective(s), and the sampling frequency of monitoring for each objective is provided in **Appendix C-3**. The Groundwater Quality Program objectives are summarized below:

Routine Water Quality Sampling (GQ) – routine water quality sampling of groundwater is performed annually, with samples collected from each of the wells that are in the Routine Water Elevation Monitoring Program (**Figure 4-4**). Some wells are sampled more frequently if required for an additional program described below. Also, some program wells are sampled and analyzed by outside entities. In those cases, results are supplied to Zone 7 by the outside entity. In general, samples are analyzed for physical water parameters, inorganic minerals, and select metals. **Table 4-9** is a partial list of the analytes common to all of the groundwater and surface water quality programs except the Toxic Site Surveillance Program. No hydrocarbon or other organic chemical parameters are included in the routine analyses of these monitoring well samples. The sampling and sample handling procedures are described in **Appendix B**.

Table 4-9: List of Standard Analytes for Zone 7's Routine Groundwater and Surface Water Quality Programs

Minerals	***Metals***	***Other***
Calcium	Boron	Total Dissolved Solids
Magnesium*	Arsenic	Total Hardness
Sodium	Chromium	Electrical Conductivity
Potassium	Manganese	Alkalinity
Bicarbonate	Selenium	Calcium Hardness
Sulfate	Iron	
Chloride	Lead	
Nitrate	Copper	
Silica	Mercury	
Carbonate	Others	

** Calculated*

Del Valle Water Rights (WR) – semi-annual sampling for water quality is required for the same wells that are in the Del Valle Water Rights Groundwater Elevation Monitoring Program to maintain Zone 7‟s Arroyo Valle water rights application. The laboratory analyses are the same as the analyses conducted for the routine Water Quality Sampling objective (**Table 4-9**).

Municipal Supply Well (Mu) –sampling for water quality and drinking water operating permit compliance is conducted at the municipal supply wells quarterly or annually. The analyses conducted include the routine analyses of Zone 7‟s Water Quality Sampling described above plus the analyses required for compliance with Title 22 Domestic Water Quality and Monitoring Regulations as established by the California Division of Drinking Water (22*CCR Section 64416*).

Salt/Nutrient Management Plan (SNMP) – annual sampling and routine water quality analyses from program wells to identify salt and nutrient quantity and migration in groundwater. Twenty one of these wells were installed in the early 2000s as part of the original SMP (Zone 7, *2004*) to monitor salt concentrations in the upper aquifer across the basin. Information on Zone 7‟s SMP and NMP are provided in **Section 2.3.8.** As part of the NMP, Zone 7 embarked on a study (*Zone 7, 2016b*) in South Livermore to help delineate three Areas of Concern (AOCs) identified in the NMP (Buena Vista, Greenville, and Mines Road) and to better characterize the potential groundwater nitrate contamination. Sampling results from that study are included in **Section 2.3.8.4**.

Dublin San Ramon Services District (DSRSD) – Zone 7 continued its data sharing agreement with DSRSD to obtain water levels and water quality samples from several of DSRSD‟s wells listed in **Table 4-10** below, which were installed to monitor the impacts, if any, from their facultative sludge lagoons and on-site sludge disposal operations in Pleasanton.

Table 4-10: DSRSD Wells Monitored in 2015 WY

Well Number	DSRSD Well	Aquifer
3S/1E 6N 2	MW-3	Upper
3S/1E 6N 3	MW-4	Upper
3S/1E 6N 6	NE-76	Upper
3S/1E 7D 1	SW-75	Upper
3S/1E 7D 3	SE-70	Upper
3S/1W 1J 1	MW-1	Upper
3S/1W 12A 9	NW-75	Upper

Groundwater samples from these wells are collected and analyzed by DSRSD, and the results are supplied to Zone 7. DSRSD also supplied Zone 7 with split samples for analysis by the Zone 7 Water Quality Laboratory.

Toxic Site Surveillance (TSS) – Data are also collected from the TSS Program to obtain data from sites (**Figure 4-9**) that are contaminated with other (organic) contaminants (petroleum hydrocarbons, synthetic organic compounds, solvents, etc.). The TSS Program, described in detail in **Section 2.3.8.9**, is administered by Zone 7 for the purpose of identifying and monitoring sites that pose a potential threat to drinking water. Zone 7 also coordinates closely with lead agencies to ensure protection of beneficial uses. Information is gathered from state, county, and local agencies, as well as from Zone 7's Well Permitting Program and the SWRCB‟s GeoTracker website, and compiled in a GIS database.

Each site in Zone 7‟s TSS Program has been assigned a Zone 7 number, which corresponds to a file number containing reports or other information about the site. In addition, all sites are reviewed and given a priority designation (high, moderate, or low) based on the threat they pose to groundwater. These data are used to support Zone 7‟s management programs and tools to address water supply and water quality, such as the SMP, the NMP, and calibration of the Zone 7 groundwater model.

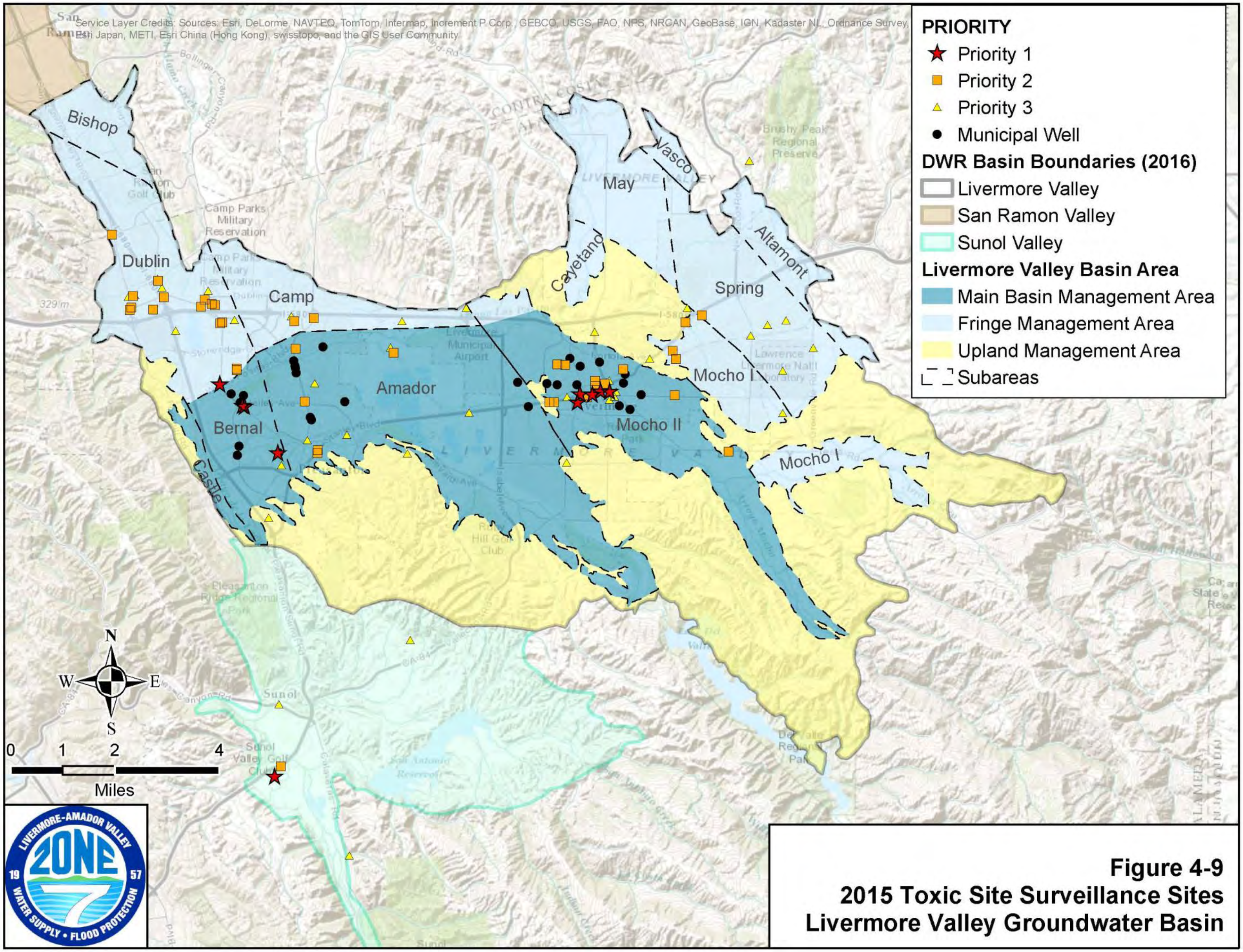


Figure 4-9
2015 Toxic Site Surveillance Sites
Livermore Valley Groundwater Basin

4.7 Land Surface Elevation Monitoring

Zone 7‟s Land Surface Elevation Monitoring Program tracks ground surface elevation changes across the groundwater basin to help identify any significant long-term trends. Land surface may exhibit changes in elevation over time due to several mechanisms such as:

- **Reginal Tectonism** - The Livermore Valley is in a tectonically active part of the greater SF Bay Area, with the Calaveras fault passing through the western part of the Valley, and the active Mt. Diablo piercement bordering it on the north.
- **Localized shrinking and swelling of expansive soils** - Expansive clayey soils are abundant in the upper 15 feet (and variably, as deep as 50 feet) in the north and central parts of Pleasanton where marshlands existed historically. Surface expressions of the shrinking and swelling of expansive soils would tend to be accentuated where surface and shallow conditions that affect soil moisture change abruptly (e.g., soil type; drainage patterns; impervious surfaces, such as pavement; vegetation; irrigation; and leaking pipes).
- **Changes in groundwater levels** - Surface elevations may also rise and fall in response to groundwater level variations in the form of land subsidence. The magnitude of the rise and fall depends on the thickness and arrangement of each aquifer/aquitard, internal pore pressures, compressibility of layers, and other factors. Normally, changes in surface elevations related to groundwater withdrawals are more regional in nature and cover larger areas (e.g., historical subsidence in the Central Valley) as compared to surface elevation changes due to localized shrinking and swelling of expansive soils. Land subsidence due to groundwater withdrawals can be temporary (elastic) or permanent (inelastic). If sediments are capable of compressing and expanding with changes in pore pressure, the land can rebound when pumping ceases. However, this elastic subsidence is typically associated with less compressible sediments and results in much smaller amounts of subsidence. Compressible clay particles are often tabular in form and more subject to permanent realignment (and inelastic subsidence). As explained in **Section 2**, inelastic land subsidence has not been documented in the Livermore Valley Groundwater Basin. **Section 3** identifies a sustainability objective as avoidance of future inelastic subsidence and designates the historic low water levels as a conservative minimum threshold for prevention.

Responsible groundwater basin management precipitated Zone 7‟s current Land Surface Elevation Monitoring Program in 2002. The adoption of the Well Master Plan EIR in 2005 (*Zone 7, 2005b*) required the continuation of the Land Surface Elevation Monitoring Program. Prior to the current land surface elevation monitoring procedures, Zone 7 conducted a study of historical benchmark elevation data throughout the western Subareas and concluded that there was no evidence of significant inelastic subsidence in the basin up to that point in time. This was the technical basis for Zone 7 to use the historic low groundwater levels as a conservative operating guide to avoid inelastic land surface elevation changes.

The Land Surface Elevation Monitoring Program involves conducting high precision spirit level surveys (see **Appendix B** for the Standard Operating Procedures) across the Bernal and Amador Subareas where most of the groundwater pumping occurs in the basin. The survey route begins and ends at stable bedrock elevation stations (A1-1.0 and A1-17.0) and passes through or near Zone 7 and City of Pleasanton wellfields. From this main circuit, several looped or branched circuits are also surveyed in the same manner to assess ground surface elevation changes within other Zone 7 wellfields (Circuits B1, B3 and B4) and across the northern Main Basin boundary (Circuit B5) (see **Table 4-11** and **Figure 4-10**).

Table 4-11: 2015 Survey Points and Descriptions

Site ID	Well ID	Survey Points	Description
A1- 1.0*		G972	Brass disk located in sidewalk
A1- 2.0		Foot-La-Pos	Chisel mark on bridge footing
A1- 3.0		C972	Brass disk mounted on bridge platform
A1- 4.0		Mocho-Chabot	Brass disk located on access road
A1- 5.0		Mocho-Tass-W	Brass disk located on access road
A1- 6.0		Mocho-Tass-E	Brass disk located on access road
A1- 6.05		Mocho TP48	
A1- 6.1		Mocho_CB	Chisel mark on catch basin
A1- 7.0		BM M1257 Reset 1988 Disc	
A1-10.0		Vine-Pipe	Brass disk in concrete
A1-12.0		Mohr-RR	Spike at Mohr Ave and RR
A1-13.1		COP RE 25281	Replaced A1-13.0 on 4/13/09
A1-14.1		Bush-Valley	
A1-15.0		D8	Brass disk on bridge foundation
A1-15.1		BM-P929 Reset	
A1-16.0		V1	Brass disk
A1-17.0*		K2	Brass disk, NGVD Benchmark
B1- 5.1	3S/1E 8H18	STP640 MN/W	Replaced B1-5.0 on 4/13/09
B1-13.0	3S/1E 9M 4	Mocho 3, Shiner	Shiner at entrance door
B1-14.1	3S/1E 9M 2	Mocho 1, Floor	
B1-16.2	3S/1E 9M 3	Mocho 2, Floor	
B3- 1.0		Mocho-Park	Brass disk on concrete vault
B3- 2.0		1H ALA	County Benchmark
B3- 3.0	3S/1E 17D12	Hop 9 BM	Benchmark, rod in access road
B3- 4.0		MP1 (Disc)	
B3- 5.0		MP2 (Disc)	
H7- C	3S/1E 17D10		Hopyard 7 Well (Punch)
B4- 1.0 S		AMP-Ctl S	Brass Disk on Control
B4- 1.0 N		AMP-Ctl N	
B4- 2.0	3S/1E 9B 1	Stoneridge, Floor	Chisel mark at entrance door
B4- 3.0		GUZMAN PKWY	
B4- 4.0		Trevor Pkwy at Stoneridge	
B4- 5.0		El Charro at Arroyo Mocho	
B4- 6.0	3S/1E 11M 3	Chain of Lakes 2	
B4- 7.0	3S/1E 10K 3	Chain of Lakes 1	
B5- 1.0		OSRR-BC	New Monument disk
B5- 2.0		OSRR-Andrew	New Monument disk
B5- 3.0		OSRR-Cafe	New Monument disk
B5- 4.0		Tass-Rose	Disk on bridge foundation (A1-8.0)

* *Probable bedrock sites*

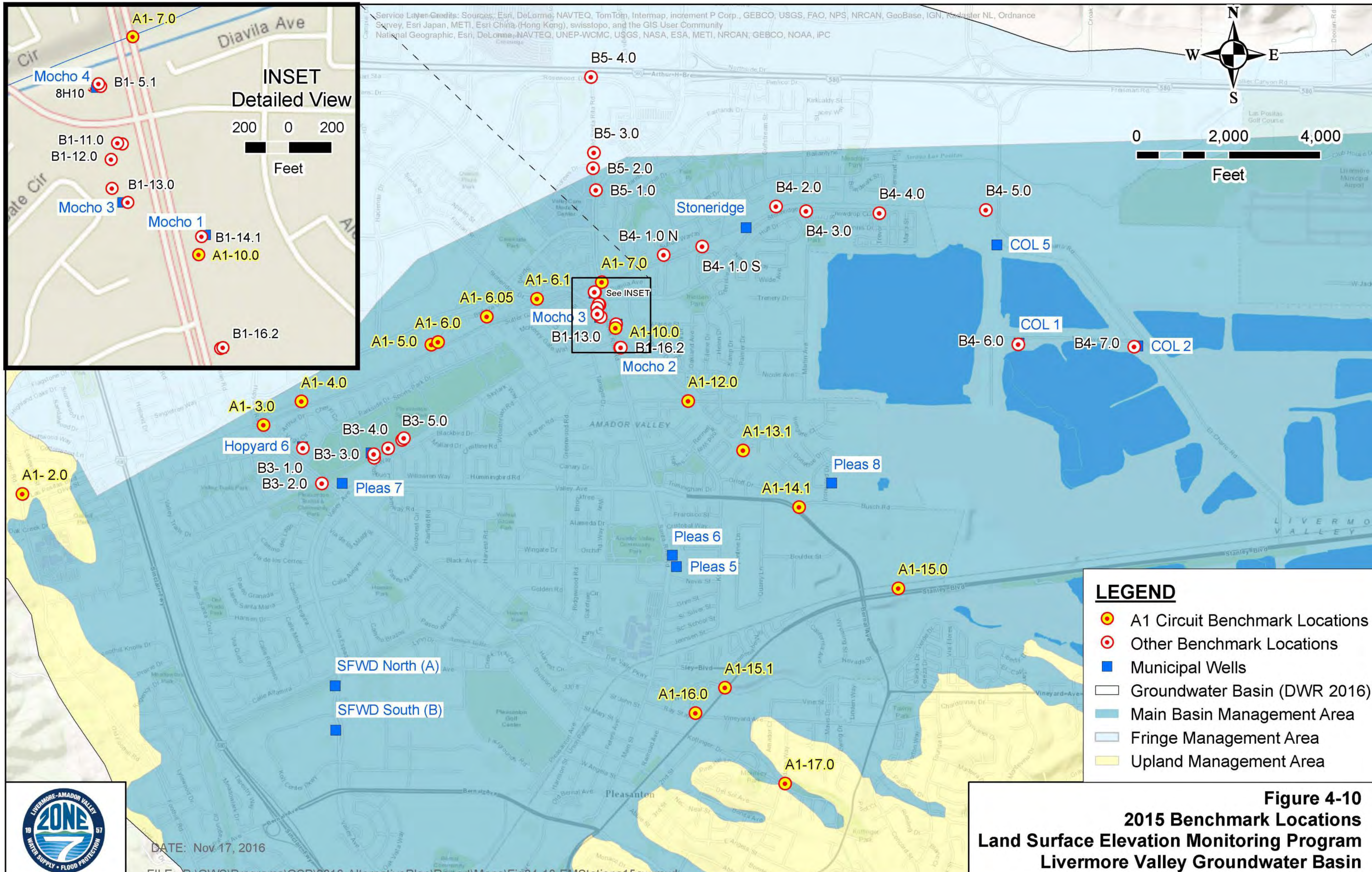


Figure 4-10
2015 Benchmark Locations
Land Surface Elevation Monitoring Program
Livermore Valley Groundwater Basin

Circuit B4, which was originally created to monitor elevation changes near Stoneridge Well No. 1, was extended in 2013 to incorporate the Chain of Lakes wellfield. Elevations and vertical distances between certain wellhead features, such as concrete pads, floors, pedestals, casing flanges, and water level reference points are also monitored for change. The normal monitoring frequency is twice per year for Circuits A1, B1, B3, and B4 and the wellhead features, corresponding with the semi-annual groundwater level monitoring events (spring and fall), and only during the fall event for Circuit B5 (**Table 4-12**).

Table 4-12: 2015 Survey Circuit Frequency

Circuit	Frequency
A1 Circuit*	Semi-annually
B1 Mocho loop	Semi-annually
B3 Hopyard wells loop	Semi-annually
B4 Stoneridge well loop	Semi-annually
B5 Tassajara - Rosewood	Annually
Municipal Wells	As needed

* *Not including the A1 North Segment, which was discontinued in 2007.*

In 2016, Zone 7 asked TRE ALTAMIRA Inc. (TRE) to complete a satellite-based interferometric synthetic aperture radar (InSAR) analysis of historical ground deformation in the Livermore and Pleasanton area. The objective of the study (*TRE, 2016*, included in **Attachment I**) was to evaluate historical ground surface movement across the Basin. The study was based on an analysis of from three different satellites over a 24-year period, from 1992 to 2016. The study involved analysis of 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 (*TRE, 2016*). The study results are discussed in **Section 2.3.9**. Going forward, Zone 7 will be evaluating the results of the InSAR study, comparing them to the level surveys, and identifying the value of continuing with the InSAR analysis on a regular basis.

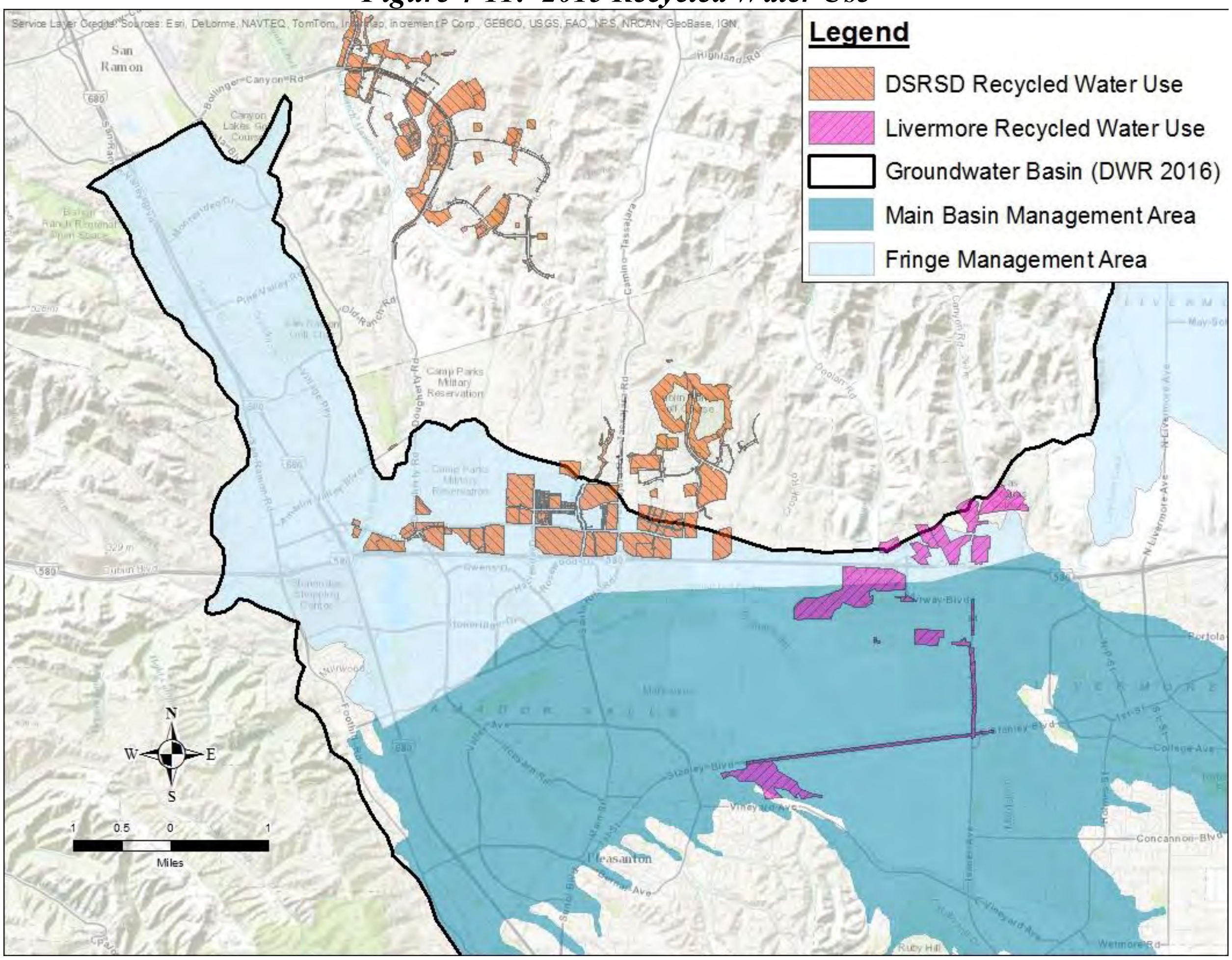
4.8 Wastewater and Recycled Water Monitoring

Zone 7 monitors the quality and quantities of wastewater and recycled water as they apply to the Livermore Valley Groundwater Basin (recharge supply and quality). Assessments of wastewater quality and the contribution to the water budget are discussed in **Section 2.3.8** and **2.4**, respectively, in this Alternative Plan.

The City of Livermore and DSRSD are currently responsible for treating and either discharging or recycling (see **Figure 4-11**) the vast majority of wastewater produced in the Valley. Applications of recycled water are mostly conducted for landscape irrigation projects; however, a minor amount is used for dust suppression, grading projects, and crop irrigation.

The program assumes that there are small, but quantifiable amounts (estimated) of untreated wastewater that percolate in the Main Basin Management Area from onsite wastewater treatment systems (OWTS). The quantity of leachate is based on the estimated number of individual OWTS that overlie the Main Basin. The quality of the leachate is estimated from published technical literature. Zone 7 receives monthly monitoring reports from the Department of Veteran Affairs for the VA Medical Center‟s sewage treatment system located in southern Livermore. Zone 7 also estimates contributions from leaking wastewater and recycled water pipelines that run throughout the Groundwater Basin. The quantity is based on the length and age of buried pipes (**Section 2.4.2.2**). The quality is based on sample data received from DSRSD and the City of Livermore.

Figure 4-11: 2015 Recycled Water Use



4.9 Data Management System

Zone 7 stores its environmental data (e.g., groundwater levels, water quality, geology, well construction) in GIS/Key, a proprietary environmental database management system designed for storing chemistry, hydrology, and geologic information. The program includes a detailed QA/QC checking module that confirms data integrity during import. Once imported into the database, Zone 7 uses the reporting and mapping tools within GIS/Key to view and report the datasets. Zone 7 also exports datasets from GIS/Key for use in other programs such as Microsoft Excel, Microsoft Access, and ArcGIS to generate tables and figures in reports and other work products.

Zone 7 uses a proprietary program called AQUARIUS Time-Series® (AQUARIUS) for managing time series datasets for:

- surface water stage and flow,
- groundwater elevation,
- diversion flow,
- precipitation, and
- evaporation.

The program also allows Zone 7 to build rating curves, apply corrections, create comparison graphs, derive statistics, and report datasets.

Other datasets that are not appropriate for GIS/Key or AQUARIUS (e.g., land surface elevations, waste water volumes, land use) are entered into Microsoft Access databases and/or ArcGIS feature classes.

4.10 Evaluation of the Monitoring Networks and Data Gaps

Zone 7 has incorporated an adaptive management approach to its vast and comprehensive monitoring network. In each annual report, changes and improvements to the monitoring program are documented. To the extent possible, monitoring wells, including key wells as representative monitoring, are maintained for consistency and evaluation of long-term trends. With water levels routinely monitored in 240 wells (including 18 nested wells), annual (or quarterly) water quality sampling in more than 222 wells, surface water flows and quality monitoring in all major streams and gravel pits, and extensive tracking of land use, climate data, and ground surface elevations (for subsidence monitoring). Importantly, all monitoring networks meet the objectives of tracking the key parameters needed for minimum thresholds and sustainable yield.

As documented in this section, monitoring is focused on the Main Basin Management Area, where most of the groundwater pumping occurs and most of the management actions are needed. Extensive monitoring networks also extend into the Fringe Management Area, especially to evaluate changes in groundwater levels or quality. At this time, only limited wells are included in the monitoring programs for the Upland Management Area and are identified on an issue- or as-needed basis. This is justified by the relatively low number of active wells, the relatively low well yields, and historically low groundwater use in the area. Even in areas of relatively high density of wells, groundwater use is small. Inflows from these areas are also a minor portion of the water budget. Due to the closed nature of the groundwater basin, these areas are all passively monitored through the Fringe and Main Basin monitoring programs.

In addition, climate monitoring covers the entire groundwater basin, including all three management areas, and the contributing watershed. Land use is also monitored on a regional basis. As the primary groundwater manager in the basin and now as the exclusive GSA (official notification underway), Zone 7 has significant knowledge and authority to evaluate changes to groundwater use, storage and components of the water budget, and make course corrections for the groundwater basin as needed. Examples of this include the well permitting process that allows Zone 7 to monitor all new wells in the basin, and the OWTS permit review process, which allows Zone 7 to manage nutrient loading.

At this time, no major data gaps are identified. Numerous ongoing programs and evaluations are expected to address some knowledge gaps with regard to the vertical movement of salts in the basin, subsurface flows between management areas, recharge of the Lower Aquifer in the vicinity of the Chain of Lakes, and better quantification of water budget components for the Fringe and the Uplands Management Areas (among other items). Additional monitoring points may be recommended in the future based on these evaluations. Again, due to the closed nature of the basin, none of these knowledge gaps affect other groundwater basins of the state.

Numerous ongoing programs are addressing a variety of groundwater quality issues as documented in **Section 2.3**, including removal of salts through demineralization of groundwater at the Mocho wellfield, and planned advanced treatment of recycled water for recharge into the basin. These and other programs and ongoing management actions are summarized in both **Sections 1** and **5** and are incorporated into this Alternative Plan for maintaining sustainable management into the future.

5 Projects and Management Actions

5.1 Introduction

Zone 7 has been sustainably managing the Livermore Valley's groundwater storage and use for over 40 years. This management—involving ongoing plans and programs, plus specific projects—is responsive to Zone 7 goals and basin measurable objectives and is adaptive to ensure sustainability out to the planning horizon. In this section, those groundwater management activities and their results are reviewed with regard to long-term sustainability of the basin's groundwater supply and groundwater quality.

Implementation of Zone 7's groundwater management projects and actions is primarily the responsibility of the Groundwater Section of the Integrated Water Resources Division of Zone 7. The Groundwater Section currently employs a staff of seven including four hydrogeologists and three Water Resource Technicians. Section budgets are set every two years. The annual Groundwater Section budgets for the 2016-17 and 2017-18 fiscal years are approximately $1.5M and $1.6M respectively. About 98% of the funding for these budgets will come from water sales and well permit revenues. The balance of the Section's funding will be from new water connection fees and property taxes.

5.2 Groundwater Supply

The availability of SWP supplies, plus local sources, 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 surface water beneficial uses. Consistent with planning documents (such as the GWMP, UWMP, and WSE Update) that were developed with agency collaboration and public outreach, Zone 7 manages all of its available water supplies—imported surface water, local surface water, groundwater, and recycled water—with conjunctive use principles and ongoing adaptive management.

5.2.1 Import of Surface Water

Zone 7 ensures that local water supplies (e.g., groundwater) are not depleted by importing approximately 80% of the Valley's water supply (delivered to Zone 7's retailers and agricultural customers) and by recharging the Main Basin with surplus surface water when available (artificial recharge). These available surface water supplies, which are accounted for by calendar year, come from the following sources:

- **State Water Project (SWP deliveries via the South Bay Aqueduct [SBA])** - As a SWP contractor, Zone 7 imports supplies from the SWP through the SBA. As of 1998, Zone 7 has had an annual maximum SWP contract amount of 80,619 AFY referred to as the ―Table A Contract Amount." However, actual SWP deliveries are usually allocated in any given year by DWR at a lower level based on numerous factors, including hydrologic conditions. Currently, the long-term reliable yield of the SWP is approximately 60% of the Table A amount (48,370 AFY). This should increase if the California Water Fix is implemented by the State.

- **Arroyo Valle Water Rights (Lake Del Valle)** – Zone 7 has temporary water rights for a portion of the natural flows into Lake Del Valle. Accordingly, Zone 7 coordinates releases from the reservoir into the Arroyo Valle to maintain downstream flows and streambed recharge at the levels that would have occurred had the reservoir not been constructed. Additional releases of Arroyo Valle water can be made from the lake when such water is available for Zone 7. Maintaining minimum flows is a condition of Zone 7's water rights permit for the Arroyo Valle water. Zone 7 can also use other portions of Arroyo Valle water for supply to its treatment plants and for supplemental aquifer recharge. Zone 7 is currently pursuing the permanent rights to this surface water source.

- **Byron-Bethany Irrigation District (BBID)** - Zone 7 has a contract with Byron-Bethany Irrigation District (BBID) for up to an additional 5,000 AFY of supplemental water made available to Zone 7 as a transfer of BBID's pre-1914 water rights water when surplus supplies are declared by BBID. When available, it is delivered upon request to Zone 7 through the SBA and can be used to supply Zone 7's artificial recharge program as well as Zone 7's water treatment plants. This water is only available in years when BBID declares that a surplus is available for transfer and when approvals from DWR and the U.S. Bureau of Reclamation are received.

- **Kern Groundwater Basin (storage rights only)** - Zone 7 has purchased water storage rights in the Semitropic Water Storage District (78,000 AF) and in the Cawelo Water District (120,000 AF) groundwater basins in Kern County. These rights give Zone 7 the ability to remotely store surplus SWP water when available. When Zone 7 is ready to use the water locally; it can import that quantity of SWP water through an exchange procedure within the SWP system.

- **Yuba Accord –** In 2008, Zone 7 entered into a contract with DWR to purchase additional water under the Lower Yuba River Accord (Yuba Accord). The contract was amended in November 2014 to cover the period from October 2015 through 2020. There are four different Components (types) of water available; Zone 7 has the option to purchase Component 2 and Component 3 water during drought conditions, and Component 4 water when Yuba County Water Agency has determined that it has water supply available to sell. Zone 7 estimates the average yield from the Yuba Accord to be 850 AFY.

- **Multi-Year Pool –** In 2013 and 2015, DWR implemented the Multi-Year Water Pool Demonstration Program, intended to facilitate the transfer of water between SWP contractors and to serve as an alternative to the under-used Turnback Pool Program. This program remains a pilot program. Zone 7 participated in the Multi-Year Pool in 2013 and 2015, and expects to participate in 2016.

- **Dry Year Transfer Program –** The State Water Contractors, an organization composed of contractors of the SWP, facilitates the purchase of water from the Feather River

Watershed for transfer to SWP contractors during dry years. This is an optional program that Zone 7 will utilize on an as-needed basis.

As described in the 2015 UWMP, Zone 7 recognizes the uncertainty associated with water supply planning into the future. As part of its WSE Update, Zone 7 developed a new risk model with probability curves for hydrologic conditions, incorporating potential variations from the historical hydrologic sequence. This dynamic model allows for a more rigorous year-by-year analysis of water system operations in response to changing hydrologic conditions. Data from DWR's 2009 SWP Water Project Reliability Report were incorporated into the model, accounting for potential climate change impacts and SWP impacts on fish.

As part of its existing Capital Improvement Program (CIP), Zone 7 is planning to construct a reliability intertie with another major water agency (e.g., EBMUD or SFPUC) to help mitigate some of the risk during a major water supply interruption from the Delta and to create opportunities for transfers/exchanges. This intertie could allow Zone 7 to acquire emergency water supplies to help meet minimum health and safety water supply needs during a major Delta outage, assuming the partnering agency has available supply and the transmission capacity available during the emergency period. The intertie could be completed as early as 2022.

5.2.2 Conjunctive Use

Since the 1960s, Zone 7 has actively embraced a conjunctive use approach to Basin Management by integrating management of local and imported surface water supplies with the management of 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). Most of the local streams do not naturally carry year-round flow and therefore, greatly enhance recharge from artificial releases.

A key component of Zone 7's conjunctive use program has been its artificial recharge program, which consists of releases of surface water to dry arroyos to recharge the groundwater basin. The timing and quantity of artificial recharge are typically dependent upon available supply, available recharge capacities, source water quality, and regulatory requirements.

The location and timing of artificial recharge operations can be used as a water quality management tool as well as a temporal water storage activity. When practical to do so, Zone 7 prioritizes its SWP releases for recharge to occur in the spring and summer when TDS of the source water is low. Because each acre-foot that is subsequently pumped from the Basin removes water with higher TDS, this can eventually improve the salinity of the groundwater basin, helping achieve salt management objectives. The salt removal effectiveness of the conjunctive use is related to the difference in the TDS of recharge and pumped water and the annual volumes involved (see **Section 2.3.8**).

5.2.3 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, estimated that Zone 7 would need to install seven to nine new municipal water supply wells over the next 30 years to maintain Zone 7's potable water reliability goal. This estimate was based on Zone 7's then-current goal of maintaining 100% reliability even during worse-case drought conditions. Additional benefits of these new wells would include providing Zone 7 with improved operational flexibility to pump its stored water resources, optimizing groundwater production while maintaining groundwater levels above localized historic lows, and removing dissolved salts from more of the groundwater basin.

This WMP provides a road map to guide construction of new Zone 7 wells in the basin. Preparation of the WMP included development of hydrogeologic cross sections, compilation of aquifer test data, groundwater modeling, review of water quality data, field inspection of existing wells, and discussions with operations staff. Several levels of impact analysis were performed for potential well sites. Potential basin-wide water level impacts were assessed by comparing simulated drought water levels with historical lows. Potential impacts of Zone 7's planned drought operations on individual municipal wells were evaluated by comparing simulated water level lows to well construction information. Instances where simulated water levels fall below either the pump setting or top of well screen were noted and potential impacts to the well assessed.

The WMP recommended that Zone 7 install several municipal water supply wells in the Chain of Lakes and Gravel Pit Wellfields. The first two wells (COL 1 and 2) were completed in 2008, and the next well (COL 5) was completed in 2014. Another well (BV 1) is being planned for a site near Boulder Street and Valley Avenue in Pleasanton.

In November 2012, Zone 7's Board adopted new reliability goals which may change the quantity and urgency of new supply wells needed by Zone 7 as development occurs in the Valley (see **Section 3.2**). With the adoption of the new reliability goals, implementation of additional water conservation measures, and expansion of recycled water use by Retailers the need for new wells has changed. Accordingly, the need for new supply wells and the timing of their construction will be further explored during future water supply planning efforts.

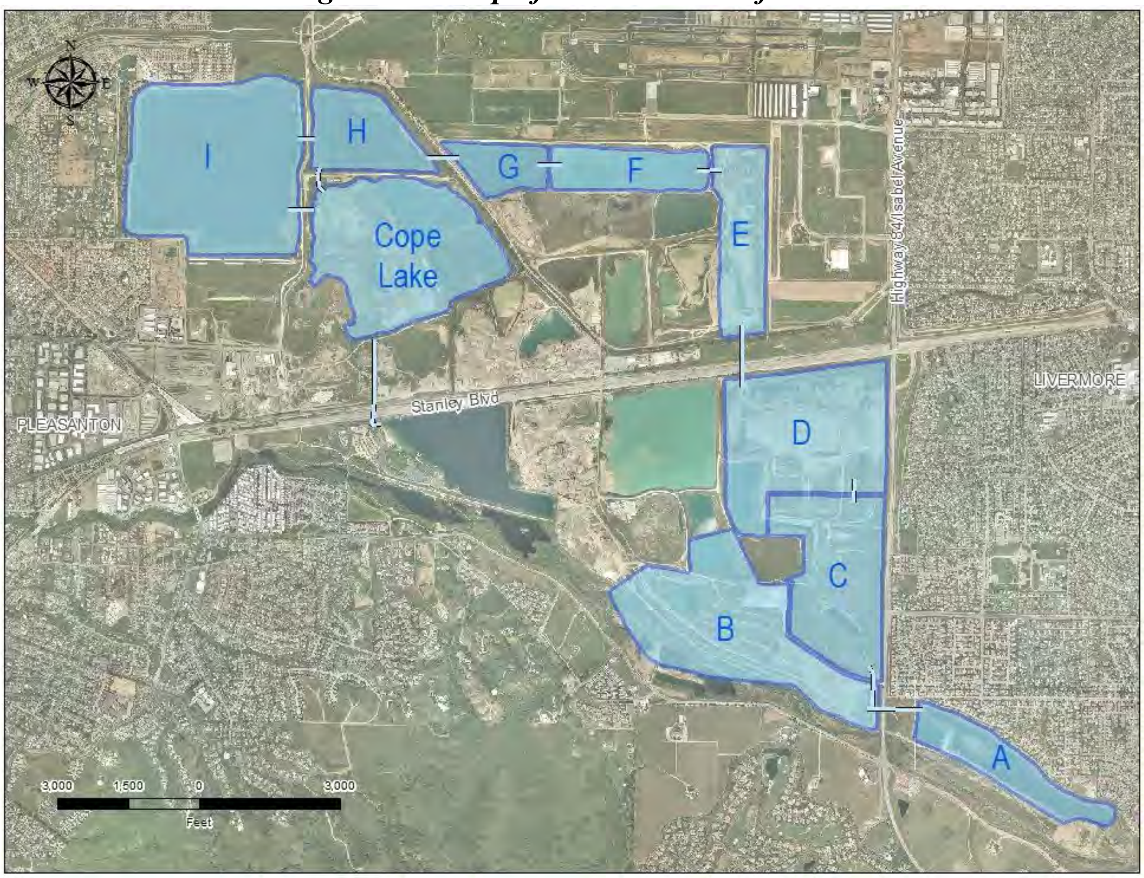
5.2.4 Chain of Lakes Recharge Projects

The coarse-grained alluvium in the center of the Main Basin has been mined for aggregate since the 19th century. Continued mining has impacts on the local groundwater budget, levels and flow. Most notably, many of the quarry pits have been dug deep into the Upper Aquifer and some are proposed to mine into the Lower Aquifer. This mining activity has removed aquifer material, created ―windows" into the groundwater basin, and exposed groundwater to large evaporative losses. Groundwater is also pumped from some of the pits and transferred to others or discharged to the arroyos to facilitate gravel extraction; the latter can result in loss of water from the basin.

In addition, interruption of groundwater movement can result from the mining of aggregate resources and occasional placement of less permeable material in former pits.

Accordingly, Zone 7 is continuing to work closely with the mining companies and Alameda County Community Development Agency (the administrative representative of the State for mining operations and reclamation) to develop a reclamation plan whereby ownership of ten quarry lakes (–Chain of Lakes" A through I and Cope Lake) is to be transferred to Zone 7 for water resources management purposes (**Section 2.3.10.3**, **Figure 5-1**). Two of the lakes have already been transferred to Zone 7 (Lake I and Cope Lake) and are currently operated and maintained by Zone 7 for water storage and groundwater replenishment.

Figure 5-*1*: Map of Future Chain of Lakes



Full implementation of the Chain of Lakes use by Zone 7 is not expected before 2050 according to mining estimates and completion projections. However, Zone 7 is working on several interim projects that are designed to convey, capture, and recharge imported SWP water and captured mining releases, and/or detain peak stormwater flows.

In 2013 and 2014, a water discharge pipeline was extended from the existing Arroyo Mocho discharge point to Cope Lake so that groundwater pumped during quarry operations could be captured in Cope Lake. Later in 2014, Zone 7 installed a pipeline between Cope Lake and Lake I to convey the discharge water to Lake I, where there is a much higher capacity for storage and ability for aquifer recharge.

Another future, but near-term, project involving some of the completed Chain of Lakes and aquifer recharge is the Arroyo Mocho Diversion, which is anticipated to be in service within the next few years. This project consists of a fish-friendly stream diversion facility on the Arroyo Mocho that will divert water (e.g., imported SWP water released to the Arroyo from the SBA) into Lake H and then, in turn, convey the water into Lake I to further enhance Zone 7's artificial aquifer recharge capacity. Zone 7 has worked with Hanson Aggregates on the design; the permitting process is underway. Zone 7 will eventually own and operate the structure.

In 2012, CEMEX, the current mining company primarily operating in the southern part of the Chain of Lakes area (Lakes A and B), started the amendment process for their surface mining permit due to anticipated changes in their planned mining. These proposed changes include realigning the Arroyo Mocho and changing the shape and size of Lakes A and B. Zone 7 staff have reviewed and accepted the CEMEX conceptual design and are collaborating currently with the Alameda County Community Development Agency and CEMEX on environmental review.

5.2.5 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, see **Section 5.3.3**). Recycled water can reduce the demand for surface water imports and pumped groundwater, and contribute to groundwater storage when incidental percolation occurs during irrigation of landscapes and crops.

Currently, the City of Livermore and DSRSD treat over 99% of the wastewater in the Valley and produce about 5,600 AFY of tertiary-treated recycled water. Initially, the recycled water use was permitted under a Master Water Recycling Permit authorized by the RWQCB-San Francisco Bay Region (*RWQCB Order No. 93-159*) and jointly held by Zone 7, DSRSD and the City of Livermore. Livermore and DSRSD's recycled water production and distribution are now operating independently under *RWQCB's Order 96-011*, General Water Reuse Requirements for: Municipal Wastewater and Water Agencies. The General Order includes requirements for self-monitoring and reporting to the RWQCB on at least an annual basis.

Most of this recycled water is used for landscape irrigation, with a minor amount used for dust suppression, grading projects, and crop irrigation. Only a small portion of the recycled water applied as irrigation 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. In general, less than about three percent of the groundwater inflow comes from incidental recharge of recycled water. Currently, none of the recycled water is used for groundwater replenishment projects; however the use of purified recycled water as a future potable water supply is currently under consideration as a joint effort by Zone 7 and the four Retailers. Options being evaluated include groundwater recharge/injection, surface water augmentation, and connection upstream of the Zone 7 water treatment plants.

Both City of Livermore and DSRSD plan to expand the use of recycled water for turf and landscape irrigation projects over the next few years. Similarly, Pleasanton is planning to use recycled water from DSRSD and/or Livermore for irrigation of city parks and landscapes located over the Main Basin. The City of Pleasanton Recycled Water Feasibility Study envisions use of 447 AFY of recycled water by 2020.

While recycled water is currently only a minor contributor to salt accumulation in the Main Basin, the average TDS concentration of the applied recycled water tends to be over twice the average TDS concentration of the potable water served by Zone 7. Mitigation of the water quality concerns related to salt and nutrient loading from recycled water use is addressed in Zone 7's SMP and Zone 7's NMP. Together, these reports are comparable to the SNMP required under the State Water Board's Recycled Water Policy (*State Water Board, Resolution No. 2009-0011, adopted February 2009*). Zone 7 is collaborating with Livermore, DSRSD, and Pleasanton to mitigate for additional potential impact to groundwater quality from the future planned recycled water use.

5.2.6 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 environmental benefits associated with surface water that is connected to groundwater.

Water conservation by Zone 7 and the Retailers is ongoing and will be maintained over the implementation horizon. Responsive to the Urban Water Management Planning Act, all of the urban retailers in the basin (Cal Water, DSRSD, EBMUD, Livermore, and Pleasanton) have prepared at least 2010 and 2015 Urban Water Management Plans. Zone 7 adopted its first UWMP in 1985, and then prepared an updated UWMP in 1991 in cooperation with Livermore, Pleasanton, and DSRSD. Zone 7 has prepared and adopted UWMPs for 1995, 2000, 2005, 2010, and 2015. Agency outreach and public noticing is included in the UWMP process, and public information is part of the ongoing implementation of water demand management measures.

Zone 7 is a member of the California Urban Water Conservation Council (CUWCC) and is in full compliance with the CUWCC MOU. As documented in its 2015 UWMP, Zone 7 is –on track" with all applicable Best Management Practices for water demand management. As a wholesaler, Zone 7 provides regional coordination of conservation programs, including community workshops and other events, school education programs, and rebates and giveaway programs. Zone 7 retains a Conservation Coordinator who is also actively engaged in conservation-oriented regional and state-wide organizations and tracks state legislation and local ordinances for integration in the Zone 7 water conservation program.

The Zone 7 2015 UWMP also documents the Water Shortage Contingency Plan, which provides a response to drought and other shortages. The Water Shortage Contingency Plan presents four stages of action that Zone 7 established with the Retailers. The stages of action (from minimal to critical shortage) are linked to demand reduction targets, specified voluntary and/or mandatory actions, and triggers for implementation. Zone 7 works with the Retailers to monitor daily water production rates and water deliveries, and thereby allow the Retailers to evaluate the effectiveness of reduction efforts.

The 2015 UWMP explicitly acknowledges uncertainty in the discussions of water supply reliability and water demand projections. With regard to the latter, uncertainty is inherent and the rate of increase of total demands and the ultimate demands will be affected by economic conditions, regulations (e.g., land use ordinances), technology (e.g., water efficiency of future appliances), behavior, and other factors. In response, Zone 7 continues to re-evaluate demand trends annually.

5.3 Groundwater Quality

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 to basin measurable objectives to maintain groundwater quality and are indirectly supportive of groundwater supply objectives as well.

5.3.1 Well Ordinance Program

The construction, repair, reconstruction, destruction or abandonment of wells within Zone 7's service area is currently regulated by *Alameda County General Ordinance Code, Chapter 6.88*. As described in **Section 1**, Zone 7 administers the associated well permit program within its service area and the three incorporated cities (Dublin, Livermore, and Pleasanton) pursuant to an MOU with Alameda County. 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. The program is transparent to the public; a copy of the current Zone 7 drilling permit application is available for download from the Zone 7 website. Well construction and destruction permit requirements are determined on a case-by-case basis, but generally follow DWR's *California Well Standards* (*Bulletins 74-81 and 74-90, DWR, 1990*).

As provided in the Alameda County Water Wells Ordinance, Special Requirement Areas have been defined within Zone 7's jurisdiction where soil boring permits are required for boreholes at 10 feet or greater depth, regardless of groundwater depth; supply wells are prohibited; and special well construction techniques are required for boreholes and monitoring wells to prevent vertical spreading of contamination. In addition, five Special Requirement Areas are clearly identified on the Zone 7 website; these are contamination sites where additional protection measures are required.

This program is active and ongoing and will be continued to the planning horizon. It provides benefits to several basin measurable objectives, most notably protection of the groundwater basin from any negative impacts that would be threatened by poorly-constructed wells. Implementation of the Well Ordinance Program allows identification and compilation of data on all pumping wells in the basin; this indirectly supports the monitoring program (whereby wells may be identified for potential monitoring) and potential management of groundwater pumping, with potential future benefits to management of groundwater levels, storage, and subsidence.

5.3.2 Toxic Site Surveillance Program

Through the Toxic Sites Surveillance (TSS) Program, Zone 7 documents and tracks polluted sites that pose a potential threat to drinking water. Information is gathered from state, county, and local agencies, as well as from Zone 7's well permitting program and the SWRCB's GeoTracker website, and compiled in a GIS database.

Each site in the TSS Program has been assigned a Zone 7 number, which corresponds to a file number containing reports or other information about the site. In addition, all sites are reviewed and given a priority designation (high, moderate, or low) based on the threat they pose to groundwater. For example, a site is designated as high priority if contamination at the site is present in groundwater at concentrations greater than the MCL and a water supply well is within 2,000 ft down-gradient of the site, or it is shown that drinking water or surface water will likely be impacted by the contamination at the site. In general, the TSS Program has found two types of contamination threatening groundwater: petroleum-based fuel products and industrial chemical contamination (e.g., chlorinated solvents).

The TSS program is ongoing and its implementation is anticipated out to the planning horizon. The program is described in the Zone 7 Annual Reports, including lists, maps, and updates on case closures, sites pending closure review, new cases and specific updates on high priority sites.

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 protects municipal wells that have an integral role in conjunctive use.

5.3.3 Salt Management

5.3.3.1 Salt Management Plan

In 2004, Zone 7 prepared a SMP (see **Attachment D**) to protect the long-term water quality of the Main Basin while expanding the area's use of recycled water. Recycled water is a critical part of the diverse water supply portfolio for the Livermore-Amador Valley. The SMP was a permit condition of the Master Water Recycling Permit, *RWQCB Order No. 93-159*, issued jointly to Zone 7, the City of Livermore, and DSRSD. The SMP was approved by the RWQCB in October 2004 and then incorporated into Zone 7's GWMP in 2005.

The SMP is an active, ongoing program. In February 2009, the State Water Resources Control Board adopted a Recycled Water Policy (*State Water Board, Resolution No. 2009-0011*) which requires that Salt-Nutrient Management Plans (SNMPs) be completed for all groundwater basins not already having RWQCB-approved SMPs in California by May 2014. Although not required, Zone 7 updated its SMP analysis in 2013 and confirmed the validity of the adopted SMP strategies to reduce salt loading to the groundwater basin and mitigate future salt impacts from the planned recycled water use increases over the Main Basin. In 2015, Zone 7 completed a NMP as an addendum to its SMP to address nutrients in the groundwater basin (see **Attachment E**).

Development of the SMP was achieved through agency collaboration and substantial public outreach, including a Management Advisory Committee and Technical Advisory Group (see **Section 1.3.5**) The SMP included identification and screening of multiple strategies (including application of numerical modeling), cost allocation, and an implementation plan. The status of salt management implementation has been regularly updated in Zone 7's Annual GWMP Reports, copies of which are provided on the Zone 7 website and also submitted to the RWQCB (to satisfy associated permit reporting requirements) and to DWR.

As documented in this section, the SMP program is directly beneficial to the basin measurable objective of maintaining and protecting groundwater quality. The SMP program also supports basin measurable objectives of maintaining groundwater levels and storage by protecting the groundwater quality in municipal wells that have an integral role in conjunctive use.

5.3.3.2 Salt Management Strategy

The RWQCB has set the Basin Objective for TDS in the Main Basin at 500 mg/L, and 1,000 mg/L for the Fringe Management Area (*RWQCB, 2011*). Zone 7’s water supply operations use an adaptive management approach to select the combination of salt management strategies to be implemented in a given year. Multiple variables are balanced when making decisions and priorities change from year to year; hence the need for an ―adaptive management” approach. Zone 7’s SMP identified several potential salt management strategies that generally fall into three categories:

- Artificially recharging the Basin with low TDS imported water when available;
- Pumping and delivering additional groundwater to customers so more salts are exported as wastewater; and
- Operating groundwater demineralization facilities that export salts as part of the waste by-products (concentrate/brine).

This plan led to the construction of Zone 7’s Mocho Groundwater Demineralization Plant (MGDP), which was completed in July 2009. The MGDP is operated to remove salts from the groundwater basin while improving delivered drinking water quality. Zone 7 has used its groundwater model (**Section 2.6**) to evaluate salt loading impacts from the MGDP and the effects of a second Zone 7 groundwater demineralization plant planned for construction in the future.

5.3.3.3 Groundwater Demineralization Program

Zone 7's MGDP began operations in July 2009 to reduce salt build-up 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 producing 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 DSRSD through the regional wastewater export pipeline operated by LAVWMA. Additional salt removal facilities may be required to keep pace with the additional salt loading projected for the basin as the overlying communities approach build-out and the use of recycled water increases. Since its construction, the MGDP has exported 13,153 tons of salt from the Valley (see **Table 5-1** below).

Table 5-1: Salts Removed by Zone 7's MGDP 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
TOTAL	**2,979**	**3,269**	**13,153**	**4.42**

The RO process generally takes groundwater and separates it into 85% low-mineral product water and 15% high-mineral concentrate or brine. During droughts, use of the RO process is minimized so that the water normally lost during the RO process is conserved and available to the system. To minimize groundwater loss from MGDP operations in the 2015 WY, only 35 AF of the produced groundwater were routed through the demineralization plant's RO membranes. As a result, the RO process generated approximately 16 AF of wastewater (rejected brine), containing about 76 tons of salt, which was exported from the Main Basin through the LAVWMA pipeline. The discharge volumes and salt concentrations of the exported brine were monitored by DSRSD and reported to Zone 7 staff periodically throughout the year.

5.3.4 Nutrient Management

Zone 7 tracks nutrient concentrations in groundwater annually as part of its routine groundwater quality monitoring program. The primary nutrient of concern in the Main Basin is nitrate (**Section 2.3.8**), which has a Basin Management Objective (BMO) of 10 mg/L (measured as nitrogen) for both the Main Basin and Fringe Management Areas (*RWQCB, 2011*). The MCL for nitrate in drinking water is also 10 mg/L.

Historically, nutrient loading became less of an issue for the Livermore Valley Groundwater Basin when the LAVWMA pipeline was constructed and put into operation in 1979, exporting treated municipal sewer effluent from the valley. Prior to that, the nutrient-rich municipal effluent was applied to the ground at several different locations over the Main Basin. Also, over time, much of the historical concentrated animal and fertilized agriculture operations that contributed to the historic nutrient loading have given way to the lower nutrient loading vineyard operations.

There is a small, but quantifiable amount (estimated) of untreated wastewater that percolates to the Main Basin from OWTS and leaky sewer pipes discharges. The quantity of leachate from these assumed sources is estimated based on the length and age of buried pipes and the estimated number of individual OWTS over the Main Basin. The quality of the leachate is estimated from published literature on the subject. Contributions also are assessed from the Veteran's Administration (VA) Hospital wastewater treatment ponds located in southern Livermore, from onsite domestic wastewater systems (septic systems), and from leaking wastewater and recycled water pipelines that run throughout the Groundwater Basin. Zone 7 receives monthly monitoring reports from the Department of Veteran Affairs for the Livermore VA Medical Center's sewage treatment system.

5.3.4.1 Nutrient Management Plan

In June 2015, Zone 7 adopted its NMP, 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 most predominant nutrient of concern in the Livermore Valley is nitrate. The RWQCB's Basin Plan includes a groundwater Basin Objective for nitrate as nitrogen of 10 mg/L or 45 mg/L for nitrate as NO3.

The NMP concludes that although overall basin groundwater quality is not expected to degrade, there is still a need to further monitor, assess, reduce, and/or manage future nutrient loading. The NMP outlines plans to simultaneously refine the extent of nitrate AOCs and 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 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 5.3.5** below). The NMP includes an implementation schedule that recognizes the ongoing monitoring and BMPs, and presents a specific schedule for AOC investigations. To refine the extent of the AOCs, Zone 7 initiated a study in late 2015 of nitrate occurrences in South Livermore and may seek future opportunities to obtain grant funding for new monitoring wells and/or soils borings.

5.3.5 OWTS Management

In 1982, the Zone 7 Board of Directors adopted the “*Wastewater Management Plan for the Unsewered, Unincorporated Area of Alameda Creek Watershed above Niles* (WWMP, *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 No. 1165*).

As a result of these policies, currently ACEH issues permits for the operation, installation, alteration, and repair of OWTS in Alameda County, while Zone 7 approval is required for the following types of OWTS projects located within the Upper Alameda Creek Watershed.

- New septic systems constructed partially or fully for a commercial or industrial use;
- Conversion or expansion of existing septic systems to a commercial or industrial use; or
- New residential septic systems that discharge greater than one Rural Residential Equivalence (RRE) of wastewater per five acres (one RRE per 10 acres inside the NMP nitrate AOCs).

The Zone 7 NMP recommends that ACEH implement additional performance measures for new and replacement OWTS in the AOCs. No new performance measures were recommended for properly-working existing OWTS. These measures were designed to prevent nitrogen loading from increasing, and in the long term, to help decrease the loading in these nitrate “hot spots”. Currently, Zone 7 is cooperating with ACEH in its development of a Local Agency Management Program (LAMP) for OWTS.

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APPENDIX A

MEMORANDUMS OF UNDERSTANDING WITH OTHER AGENCIES

MEMORANDUM OF UNDERSTANDING
AMONG
ZONE 7 OF THE ALAMEDA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT,
CONTRA COSTA COUNTY,
CONTRA COSTA COUNTY WATER AGENCY,
CITY OF SAN RAMON,
EAST BAY MUNICIPAL UTILITY DISTRICT
AND
DUBLIN SAN RAMON SERVICES DISTRICT

This memorandum of understanding (MOU) is made and entered among Contra Costa County (CCC), Contra Costa County Water Agency (CCCWA), the City of San Ramon (San Ramon), the East Bay Municipal Utility District (EBMUD) and the Dublin San Ramon Services District (DSRSD) (together, the Five Parties) and Zone 7 of the Alameda County Flood Control and Water Conservation District (Zone 7) in consideration of the factual recitals and mutual obligations contained herein.

WITNESSTH

WHEREAS, the Sustainable Groundwater Management Act of 2014 (SGMA) requires the formation of Local Groundwater Sustainability Agencies (GSAs) and the adoption of Groundwater Sustainability Plans for high- and medium-priority basins within five to seven years; and

WHEREAS, while the majority of the Livermore-Amador Valley Groundwater Basin (DWR Groundwater Basin No. 2-10, hereinafter referred to as "Basin No. 2-10"), a medium priority basin, lies within the boundaries of Alameda County and the jurisdiction of Zone 7, portions lie within the boundaries of Contra Costa County and the jurisdictions of CCC, CCCWA, San Ramon, DSRSD, and EBMUD; and

WHEREAS, SGMA identified Zone 7 as the exclusive local agency to be the GSA for managing groundwater within its statutory boundaries (Water Code, § 10723, subd. (c)(1)(A)), and those statutory boundaries include the portion of Basin No. 2-10 lying within Alameda County, which comprises the majority of the basin; and

WHEREAS, the Five Parties agree it would be prudent for Zone 7 to also manage the small remaining portion of Basin No. 2-10 that lies within the jurisdictions of CCC, CCCWA, San Ramon, DSRSD, and EBMUD to achieve effective groundwater management; and

WHEREAS, it is in the interests of the Five Parties and Zone 7 to maintain current levels of jurisdictional authority while striving for holistic, sustainable groundwater basin management; and

WHEREAS, it is mutually beneficial to create this agreement to establish a delegation of authority to allow Zone 7 to be the GSA for the remaining portion of Basin No. 2-10 within the jurisdictions of CCC, CCCWA, San Ramon, DSRSD, and EBMUD to assure sustainable groundwater management;

NOW, THEREFORE, the Five Parties and Zone 7 do hereby agree as follows:

1. Purposes of MOU. The purposes of this MOU are (1) for each of the Five Parties to agree to confer to Zone 7 certain Delegated Authority (as that term is defined in Paragraph 2.A below) within the Delegated Area (as that term is defined in Paragraph 3 below), and (2) for Zone 7 to agree to exercise the Delegated Authority within the Delegated Area.

2. Authority and Responsibility.

   A. Upon execution of this MOU, and upon final approval by California Department of Water Resources recognizing Zone 7 as the GSA responsible for the portion of Basin No. 2-10 lying within the area described in Paragraph 3 of this MOU, the Five Parties agree to delegate to Zone 7 all functions, powers, duties, and authority of a GSA conferred by SGMA. Notwithstanding any other provision of this MOU, the following authority shall not be delegated to Zone 7: (1) CCC shall continue to be the well permitting agency for all areas within its jurisdiction, (2) San Ramon and CCC shall continue to be the land use agencies for all areas within their respective jurisdictions, and (3) EBMUD and DSRSD shall continue to be the water supply agencies for all areas within their respective jurisdictions. The authority delegated by this Paragraph 2.A is referred to herein as the "Delegated Authority".

   B. Zone 7 agrees to assume and exercise all responsibilities required of a GSA, and to enforce all provisions and requirements contained in the Groundwater Sustainability Plan to be adopted for Basin No. 2-10 in accordance with SGMA. Zone 7 shall continue to monitor groundwater elevations within the Designated Area and to enter data into CASGEM as required in order to maintain grant eligibility.

3. Geographic Extent of Delegated Authority. The Delegated Authority shall have effect in that portion of Basin No. 2-10 which lies within the jurisdictional boundaries of each of the Five Parties, which portion is depicted in Exhibit A and is referred to herein as the "Delegated Area".

4. Records. Zone 7 shall provide each of the Five Parties copies of all documents, reports, studies and other records created in the course of its exercise of the Delegated Authority which affects or relates to groundwater management within the Delegated Area. CCC shall provide Zone 7 with copies of all well permits issued or environmental reports received (including well completion reports) and any water level measurements taken within the Delegated Area. Zone 7 and the Five Parties shall cooperate and coordinate in responding to requests made under the California Public Records Act regarding records related to groundwater management within the Delegated Area.

5. Term. This MOU becomes valid and effective immediately upon execution by each of the Five Parties and Zone 7 and shall remain in effect unless terminated pursuant to Paragraph 9, below.

6. Entire Agreement. This MOU shall constitute the entire agreement among the Five Parties and Zone 7 relating to the delegation of authority provided by SGMA as relates to Basin No. 2-10. This MOU supersedes and merges all previous understandings, and all other agreements, written or oral, between the parties and sets forth the entire

understanding of the parties regarding the subject matter thereof.

7. Counterparts and Copies. This MOU may be executed in any number of counterparts, each of which may be deemed an original and all of which collectively shall constitute a single instrument. Photocopies, facsimile copies. and PDF copies of this MOU shall have the same force and effect as a wet ink original signature on this MOU.

8. Amendment. This MOU may be amended at any time by a written agreement duly executed by each of the Five Parties and Zone 7.

9. Termination.

A. This MOU may be voluntarily terminated in full at any time by a writing signed by each of the Five Parties and Zone 7.

B. Any of the Five Parties may elect to terminate its participation in this MOU at any time. Termination of such party's participation in this MOU shall not become effective until after both of the following have occurred: (1) the terminating party provides written notice to all other signatories to this MOU of its intent to terminate its participation, and (2) one year has elapsed following the date of such written notice, during which time the terminating party may make efforts to assume the GSA role for the portion of the Delegated Area within the terminating party's jurisdiction. The termination of any of the Five Parties' participation in this MOU shall not affect the continuing validity of the MOU with respect to the remaining signatories.

C. Zone 7 may provide written notice to each of the Five Parties of its intent to terminate the Agreement, and the MOU shall cease to be of further effect one year following delivery of Zone 7's notice, during which time Zone 7 shall continue to exercise the Delegated Authority within the Delegated Area to allow adequate time for the Five Parties to address GSA related requirements for their respective portions of the Delegated Area.

10. Signatures. The individuals executing this MOU represent and warrant that they have the legal capacity and authority to do so on behalf of their respective legal entities.

IN WITNESS WHEREOF, the parties hereto have executed this MOU as follows:

CONTRA COSTA COUNTY	ZONE 7 OF THE ALAMEDA COUNTY FLOOD CONTROL & WATER CONSERVATION DISTRICT
By:______________________	By: [signature] 21 Apr 2016
President, BOS Dated:	G.F. Duerig Dated:

understanding of the parties regarding the subject matter thereof.

7. Counterparts and Copies. This MOU may be executed in any number of counterparts, each of which may be deemed an original and all of which collectively shall constitute a single instrument. Photocopies, facsimile copies, and PDF copies of this MOU shall have the same force and effect as a wet ink original signature on this MOU.

8. Amendment. This MOU may be amended at any time by a written agreement duly executed by each of the Five Parties and Zone 7.

9. Termination.

   A. This MOU may be voluntarily terminated in full at any time by a writing signed by each of the Five Parties and Zone 7.

   B. Any of the Five Parties may elect to terminate its participation in this MOU at any time. Termination of such party's participation in this MOU shall not become effective until after both of the following have occurred: (1) the terminating party provides written notice to all other signatories to this MOU of its intent to terminate its participation, and (2) one year has elapsed following the date of such written notice, during which time the terminating party may make efforts to assume the GSA role for the portion of the Delegated Area within the terminating party's jurisdiction. The termination of any of the Five Parties' participation in this MOU shall not affect the continuing validity of the MOU with respect to the remaining signatories.

   C. Zone 7 may provide written notice to each of the Five Parties of its intent to terminate the Agreement, and the MOU shall cease to be of further effect one year following delivery of Zone 7's notice, during which time Zone 7 shall continue to exercise the Delegated Authority within the Delegated Area to allow adequate time for the Five Parties to address GSA related requirements for their respective portions of the Delegated Area.

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IN WITNESS WHEREOF, the parties hereto have executed this MOU as follows:

CONTRA COSTA COUNTY	ZONE 7 OF THE ALAMEDA COUNTY FLOOD CONTROL & WATER CONSERVATION DISTRICT
By: [signature]	By:________________________
President, BOS Dated:12/22/16	G.F. Duerig Dated:

CONTRA COSTA WATER AGENCY

By:______________________________

CITY OF SAN RAMON

By:______________________________

DUBLIN SAN RAMON SERVICES DISTRICT

By:______________________________

EAST BAY MUNICIPAL UTILITY DISTRICT

By:______________________________ 8/19/16
Richard Sykes Dated:
Director of Water
and Natural Resources

CONTRA COSTA WATER AGENCY

By:______________________________

CITY OF SAN RAMON

By:______________________________

DUBLIN SAN RAMON SERVICES DISTRICT

By: [signature] 10/20/16

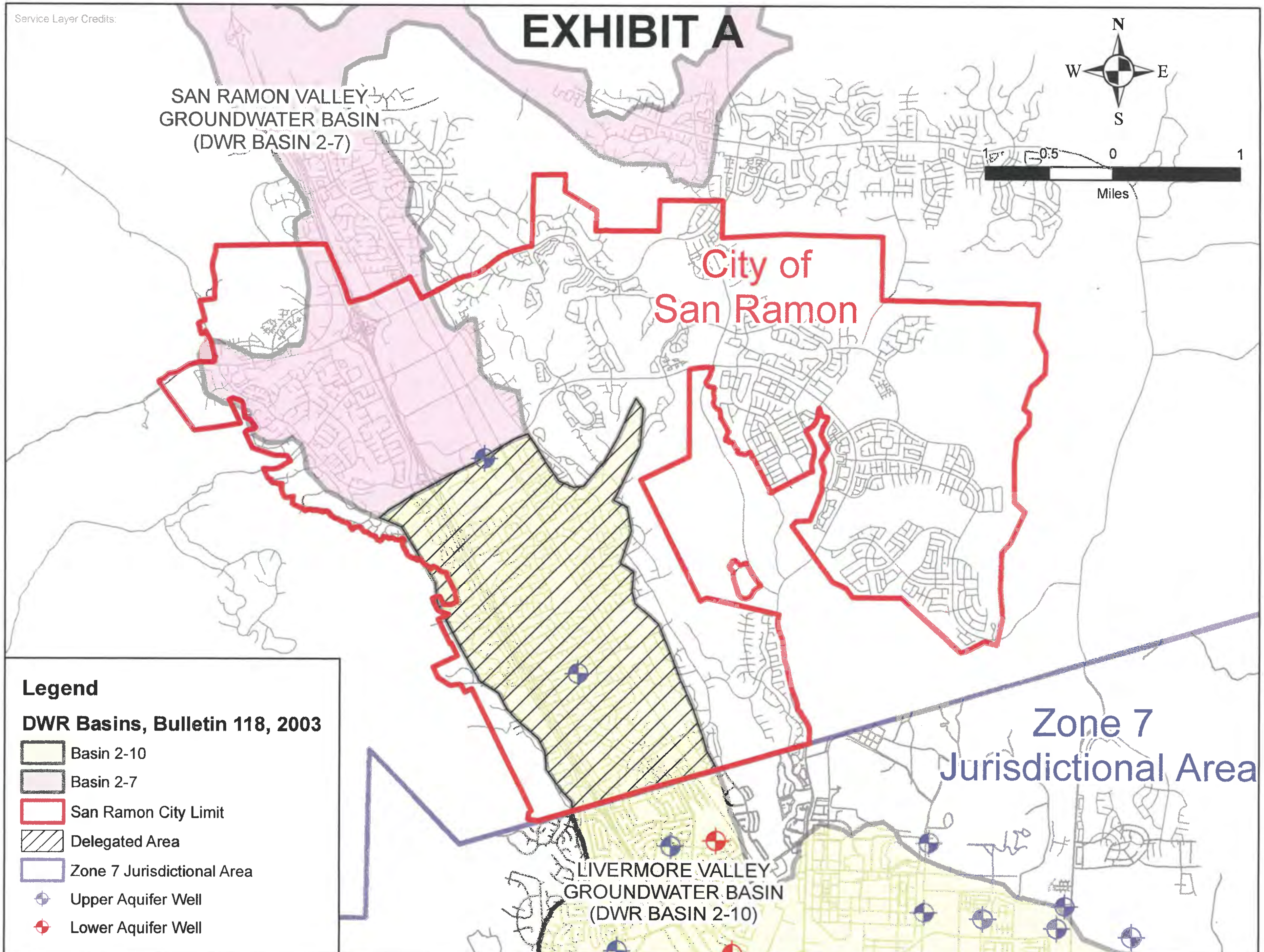
Dan McIntyre Dated:
General Manager

EAST BAY MUNICIPAL UTILITY DISTRICT

By:______________________________

Richard Sykes Dated:
Director of Water
and Natural Resources

EXHIBIT A


Service Layer Credits:
SAN RAMON VALLEY
GROUNDWATER BASIN
(DWR BASIN 2-7)
City of
San Ramon
N
W
E
S
0.5
0
1
Miles
Zone 7
Jurisdictional Area
LIVERMORE VALLEY
GROUNDWATER BASIN
(DWR BASIN 2-10)
Legend
DWR Basins, Bulletin 118, 2003
Basin 2-10
Basin 2-7
San Ramon City Limit
Delegated Area
Zone 7 Jurisdictional Area
Upper Aquifer Well
Lower Aquifer Well

APPENDIX B

STANDARD OPERATING PROCEDURES

APPENDIX B: STANDARD OPERATING PROCEDURES

1 Groundwater Elevation Measurement Procedures

1.1 GENERAL

The common datum for all water and land surface elevations is in Mean Sea Level (MSL) in feet (ft), using the North American Vertical Datum of 1988 (NAVD88). To calculate the water elevation, Zone 7 measures the depth-to-water relative to a known reference point, or measures it directly using Zone 7's Real Time Kinematic (RTK) Global Positioning System (GPS) Unit (Sokkia GRX1).

For each field measurement event, Zone 7 completes a field sheet that includes the following columns:

- Site
- Sample Date
- Sample Time
- Reference Point
- Previous Measurement
- Depth To Water
- Groundwater Elevation
- Equipment Used
- Notes

All water elevation field measurements are compared to the previous measurement shown on the field sheet. Wells with suspicious levels are re-measured to check the elevation. Back in the office, groundwater elevation data are graphed and/or contoured to check the general accuracy of the data. Suspicious water levels are investigated and, if deemed invalid or questionable, are then (1) re-measured, if possible, or (2) noted as suspect in the database and are deleted from graphs and reports.

1.2 GROUNDWATER ELEVATIONS IN WELLS

1.2.1 Reference Points

For groundwater elevations in wells, Zone 7 measures depth-to-water from a surveyed reference point in each well, usually on the north side of the top of the well casing. These reference points are typically marked with a sharpie and/or a notch on the well casing. Whenever possible, reference point elevations are surveyed to 0.01' NAVD88 (or better) by a licensed surveyor or measured using Zone 7's GPS Unit (accurate to about 0.05 ft). When not possible, Zone 7 estimates the reference point elevation from the following (in order of preference):

1. Pictometry
2. Lidar
3. Topographic Maps

1.2.2 Depth to Water Measurements

Zone 7 uses Solinst Water Level Meters to measure the depth to water. The elevation of the water surface in the well is computed by subtracting the depth-to-water from the reference point elevation. The field data is then entered into a database (**Section 1.5**) and made available to staff for further analysis.

Water levels are measured under static (or semi-static) conditions. Productions wells are typically turned off and allowed to equalize (same reading for one minute) prior to recording water levels. For those wells not controlled by Zone 7, or when a Zone 7 well cannot be switched off, no water levels measurements are taken for that measurement event. On the field sheet, a note (including the date and time) is made indicating that the well was pumping during the field visit. Pumping water levels are sometimes submitted by other agencies and are so noted in the database, but are not used to create groundwater elevation maps and contours.

1.3 GROUNDWATER ELEVATIONS IN SURFACE WATER BODIES

Zone 7 uses a GPS Unit to measure groundwater elevation in static surface water bodies, (e.g., mining area ponds). The GPS Unit is localized at the beginning of each field event using a known benchmark. In the field the GPS Unit is operated as per the manufacturers specifications and set so that the base of the unit represents the average water surface (i.e., on a rock or on the bank). The GPS reading is noted on a field sheet along with the date/time of the measurement and the equipment used. The accuracy of Zone 7’s current GPS unit (Sokkia GRX1) is approximately 0.05 ft.

1.4 GROUNDWATER ELEVATION DATA FROM OTHERS

In some cases, other agencies or individuals (e.g., CWS and the City of Pleasanton) provide monthly water level data to Zone 7. Water levels measured by others are received a month or more after the actual measurement so a field-check measurement is usually not possible. However, the data is compared to previous measurements for accuracy, and if inconsistent, Zone 7 will contact the measurer for clarification or will flag the dataset as questionable.

1.5 GROUNDWATER ELEVATION DATA MANAGEMENT

Groundwater elevation data is transferred from the field sheets and imported into GIS/Key, a proprietary environmental database designed for storing and reporting chemistry, hydrology, and geologic data. The program includes a detailed QA/QC module that checks data integrity during import. Once imported into the database, Zone 7 uses the reporting and mapping tools within GIS/Key to view and report the datasets. Zone 7 also exports datasets from GIS/Key for use in other programs such as Microsoft Excel, Microsoft Access, and ArcGIS.

2 Groundwater Quality Sampling Procedures

2.1 General

Groundwater samples are collected from all wells, mining area ponds, and surface water stations in Zone 7's programs provided a suitable sample can be obtained. Zone 7 staff typically samples water from municipal wells, various mining area ponds, and arroyos that communicate with groundwater. Zone 7 employs a contractor (Contractor, currently Blaine Tech Services) to perform groundwater sampling from the majority of the non-municipal wells in the program. Both Zone 7 staff and Contractor must follow the procedures below.

2.2 Field Preparation

Prior to sampling, field personnel perform the following:

1. Zone 7 prepares well data sheets of all wells to be sampled for the year. Well data sheets include a map, coordinates, photographs, well depth, well diameter, screen interval, and any sampling notes or instructions specific to that well.
2. For contracted sampling events, the contractor contacts Zone 7s' Laboratory at least a week prior to desired sampling dates to schedule sample delivery and to confirm that the laboratory can analyze the anticipated number of samples in a timely manner. The contractor delivers all samples on Monday through Thursday in consideration of holding times for certain analyses.
3. Zone 7 obtains and/or provides sample containers, sample labels, chain of custody sheet, and parameter stability sheets for purging.
4. If indicated on the well data sheets, field personnel contact the owner to pre-arrange schedule and to access the property and well.

2.3 Field Instrument Calibration

Upon arrival to the first well of each sampling day, the sampler performs a field instrument calibration for pH and specific conductance.

1. Accuracy of pH meters should be +/- 0.1 pH unit of the standard.
2. Accuracy of specific conductance (SC) should be within 5% of the standard.
3. Calibrations are recorded in instrument log books as well as on the chain of custody for that sample day.

2.4 Water Sampling

2.4.1 General

Static depth to water level (for wells) or water elevation (for surface water bodies) are measured and recorded prior to pumping/sampling. In the case of nested wells, static water levels for all associated nested wells are measured before any of them are pumped.

All sampling and purge water stability records are logged and stored in a binder specifically for that purpose. Samples are typically filtered through a single use 0.45-micron filter in the field, except when not appropriate for the analytes being tested (e.g., for VOC sampling, see **Section**

2.5.3). If field-filtering is not possible, the field personnel indicate on the Chain of Custody that the sample is to be filtered by the lab prior to sampling.

Sample labels are filled out completely and placed on all sample bottles.

2.4.2 Wells with No Dedicated Pump

For wells without dedicated pumps, the most appropriate/efficient sampling method for each well, either *Well-Volume Purge and Sample* or *Low Flow Sampling*, is indicated on Zone 7's stability sheets. Detailed instructions for each sampling method are provided below.

2.4.2.1 Well-Volume Purge and Sample

This method involves purging static groundwater from the well so that the water in the well is representative of groundwater. During the purging period, the purged groundwater is monitored for specific conductance, pH, and temperature to determine stability. The stabilization criteria are listed below in **Section 2.4.4**. Samples are collected after the parameters have stabilized.

No purge water is discharged to storm drains; however since groundwater from all wells are believed to be uncontaminated, purge water can be discharged to a permeable ground surface at the well site as long as the discharge does not cause excessive erosion and does not enter a storm drain. If there are no permeable surfaces at the well site, the purge water is containerized and transported to a Zone 7-approved location for surface discharge.

1. Samples are collected after the parameter stabilization criteria specified below have been met.
2. A minimum of three casing volumes are purged. If stability is not reached prior to five casing volumes purged, then a sample is collected when five casings have been purged.
3. The sample SC, pH, and temperature readings are measured in the field and recorded on a field data sheet provided by Zone 7.
4. Readings are taken at every ½ well volume purged or every three to five minutes.
5. If a well purges dry, it must recover to 80% of original water column before the sample is collected. If recovery time takes more than one hour, the sample is collected at end of the day or the following morning (within 24 hours from drying of well).

2.4.2.2 Low Flow Sampling

1. A bladder pump is lowered to specified depth, which is typically halfway down the well screen interval. If there are multiple screen intervals, then the shallowest screen interval is used.
2. The pumping rate is adjusted so that it is less than natural recovery rate of the well (usually between 0.1L and 0.5L/minute), and so that drawdown is no more than 0.33 feet (ft).
3. Water quality readings and water level readings (to monitor drawdown) are taken every three to five minutes. The sample is collected when the parameter stabilization criteria (**Section 2.4.4**) are met.

2.4.3 Wells with Dedicated Pumps

Several wells in Zone 7's program have dedicated submersible pumps, most of which are active pumping wells. The sample is collected when the parameter stabilization criteria (**Section 2.4.4**) are met.

1. For active wells, the sampler opens the sample tap and purge water for five minutes and then collects the sample.

2. Inactive wells are purged for five minutes. After five minutes have passed, the sampler then begins recording water quality parameters every three to five minutes until parameter stabilization occurs.

2.4.4 Parameter Stabilization Criteria

Samples are collected after the specific conductance (SC) and pH have stabilized as follows:

1. **SC** - the difference between the maximum and minimum values of the last three readings must be no more than 5%.
2. **pH** - the difference between the maximum and minimum values of the last three readings must be less than or equal to 0.1 units.

2.4.5 Grab Sampling from Surface Water Bodies

When collecting water samples from surface water bodies, the field personnel avoid sampling water that has been stirred up. Field personnel collect samples choosing Option 1 or 2, below, as appropriate while standing on the edge of the water body or on a rock. The field personnel :

OPTION 1
1. Hold the uncapped bottle upside down and submerse it,
2. Tip bottle upright and allow water to fill bottle, and
3. Remove bottle from water and screw on cap.

OPTION 2 (recommended for soft-sediment water bodies)
1. Use a large, clean dip sampler to collect water,
2. Rinse sampler in stream water three times,
3. Collect stream water, and
4. Fill sample bottles with water from the dip sampler.

2.5 SAMPLING CONTAINERS

2.5.1 General

The field personnel avoid touching the inside or lip of all sample bottles or caps. Each sample container is labeled with the site name/number, sample date, and sample time.

2.5.2 Metals and Minerals

The majority of the water samples taken as part of Zone 7's water quality program are analyzed for metals and minerals. For these analyses, field personnel fill both a 1L bottle (no preservatives) and a 0.5L bottle (no preservatives).

2.5.3 VOC Sampling

Occasionally, Zone 7 samples water for volatile organic compound (VOC) analyses. VOC samples are collected with as little agitation or disturbance as possible.

1. Stainless steel or Teflon bailers are used to collect VOC samples after purging and sampling.
2. Unfiltered groundwater samples for VOC analysis are collected in three 40 ml glass VOA vials supplied by Zone 7. The vials are preserved with hydrochloric acid to allow for a two-week holding time.
3. The vial is filled so that there is a meniscus above the top of the vial and absolutely no bubbles or headspace are present in the vial after it is capped. After the cap is tightened, the vial is inverted and tapped to dislodge any hidden air bubbles. If bubbles are present, the vial is topped off using a minimal amount of sample to re-establish the meniscus. Care is taken not to flush any preservative out of the vial during topping off. If, after topping off and capping the vial, bubbles are still present, a new vial is obtained and the sample re-collected.

2.6 Sample Storage and Delivery

Samples are stored in a cooler with ice or icepacks so that the cooler temperature is approximately four degrees Celsius. Field personnel complete a Chain of Custody for each sample day. Samples are then delivered within the analyte holding times, along with the Chain of Custody and water quality instrument calibration logs, to Zone 7's laboratory.

2.7 Water Quality Data Management

Zone 7's laboratory generates an electronic data deliverable (EDD) file that contains the sample results. This data is imported into GIS/Key, a proprietary environmental database designed for storing chemistry, hydrology, and geologic information. The program includes a detailed QA/QC module that checks data integrity during import. Once imported into the database, Zone 7 uses the reporting and mapping tools within GIS/Key to view and report the datasets. Zone 7 also exports datasets from GIS/Key for use in other programs such as Microsoft Excel, Microsoft Access, and ArcGIS.

3 Surface Water Flow

3.1 General

All relevant information is recorded in a gauge house log sheet and on field note sheets.

3.2 Field Visit

Upon arrival at the site, field personnel :

1. Look for evidence of vandalism/theft/high water destruction to gauge house, solar panels, cellular antennas, outside staff gauges, crest stage gauges, gauge height sensor conduit, and electronics within gauge house.
2. Verify recorder powers on and is recording data, wires are connected and in good order,

and battery is not leaking acid.

3. Check battery voltage and replace battery if below 12.1 volts.
4. Check solar panel and clean if dirty.
5. Check channel banks and path to outside staff gauge to make sure they are clean, clear, stabile, and safe to approach. If not, field personnel use appropriate tools to clear (rake, shovel, broom, pruners, etc.).

Upon completion of the field visit, the gauge house is locked up.

3.3 GAUGE MEASUREMENT

During field visits, the field personnel often read the outside staff gauge and compare it to the recorder stage. During low flow, the field personnel reset the recorder stage if it differs from outside staff gauge by 0.02 ft or more. If there is a difference during high flow, field personnel try to observe what may be causing the difference and reset the recorder stage if appropriate.

Field personnel clean excess debris or algae from the control, and then allow time for stage to stabilize before taking another outside staff gauge reading for comparison to the recorder stage.

3.4 DISCHARGE MEASUREMENTS

For discharge measurements, field personnel look at the flow and mentally determine if it is safe to perform a wading discharge measurement. A general rule of thumb is that if the following condition is true:

Stream Depth (ft) x Stream Velocity (ft/s) > 10

Then the field personnel do not wade into the stream and perform the discharge measurement from the nearest bridge.

Discharge measurements and computations are performed in accordance with guidelines set forth in *United States Geological Survey Water-Supply Paper 2175, Measurement and Computation of Streamflow: Volume 1 and 2*. After the discharge measurement, field personnel recheck the outside staff gauge and recorder readings.

3.5 SURFACE WATER FLOW DATA MANAGEMENT

Zone 7 uses a proprietary program called Aquarius Time-Series (Aquarius) for managing surface water time-series datasets. The program allows Zone 7 to build rating curves, apply corrections, create comparison graphs, derive statistics, and report datasets.

4 Surface Water Quality

4.1 GENERAL

Water quality samples are collected at most of Zone 7’s surface water stations. Stream water sampling procedures are the same as those presented in **Section 2** except for the procedures described below.

4.2 Surface Water Sample Collection

When collecting water samples from streams, the field personnel avoid sampling water that has been stirred up. The field personnel collect samples (choosing Option 1 or 2, below, as appropriate) while standing on the edge of the water body or on a rock. If this is not possible, the field personnel reach upstream as far as possible to avoid collecting stirred up water. The field personnel:

OPTION 1
1. Hold the uncapped bottle upside down and submerse it,
2. Tip bottle upright and allow water to fill bottle near top, and
3. Remove bottle from water and screw on cap.

OPTION 2 (recommended for soft-sediment water bodies and low-flow streams)
1. Use a large, clean dip sampler to collect water,
2. Rinse sampler in stream water three times,
3. Collect stream water, and
4. Fill sample bottles with water from the dip sampler.

5 Municipal Groundwater Production Data

Zone 7 records its groundwater production using its own SCADA system. As part of Zone 7’s agreements with its retailers, Zone 7’s retailer agencies provide their own groundwater production data to Zone 7. Zone 7 and Pleasanton production data are available in a daily format. CWS provides monthly totals.

Zone 7 staff does not collect groundwater production data from domestic, industrial, or agricultural wells in the valley. These volumes are estimated using Zone 7’s Areal Recharge Model or typical pumping rates.

6 Climatological

6.1 Tipping Bucket

Once a month Zone 7 staff visits the rain tipping buckets to download 15-minute rainfall data. The rain gauges are visually inspected to ensure there is no debris clogging the rain gage. Field personnel inspect the associated rainfall data logger and using a field sheet, then record date, time, total rainfall accumulation and battery voltage. The 15-minute rainfall data is then downloaded from the logger to a Zone 7 laptop.

At the end of the water year, field personnel perform a standard monthly check and download the 15-minute rainfall data. Then for annual maintenance, field personnel
1. open up the tipping bucket,

2. check the bubble level to ensure a level surface,
3. manually tip the rain gage,
4. confirm that the associated data logger is correctly recording the tips,
5. reassemble the tipping bucket, and
6. reset the data logger rainfall total is reset to 0.00” for the start of the new water year.

6.2 CIMIS

Zone 7 staff performs maintenance for the California Irrigation Management Information System (CIMIS) station in the City of Pleasanton. Maintenance standards for the station call for a maintenance visit every 3-4 weeks during the warmer months of the year and every 5-6 weeks in the cooler months. The maintenance visit includes checking the sensors for accuracy and/or operation and cleaning or replacing sensors as required.

7 Land Surface Elevation Monitoring

Zone 7’s Land Surface Elevation Monitoring Program involves conducting high precision spirit level surveys of benchmarks across the Bernal and Amador Sub-basins. These benchmark stations have been selected to represent generally stable features (e.g. bridge buttresses) founded in deeper soils so as not to be affected by shallow soils movement (e.g., expansive soils).

The main circuit (A1-1.0 and A1-17.0) starts and ends at stable bedrock elevation stations and passing through or near Zone 7 and City of Pleasanton wellfields. From this main circuit, several looped or branched circuits are also surveyed in the same manner to assess ground surface elevation changes within other Zone 7 wellfields. Elevations and vertical distances between certain wellhead features, such as concrete pads, floors, pedestals, casing flanges and water level reference points are also monitored for change.

The normal monitoring frequency is twice per year for Circuits A1, B1, B3 and B4 and the wellhead features, corresponding with the semi-annual groundwater level monitoring events (spring and fall), and only during the fall event for Circuit B5.

Zone 7 contracts out the level survey measurements to a California-licensed surveyor (currently Kier & Wright Civil Engineers and Surveyors). The contractor typically utilizes a three-man survey crew that conducts a differential level loop to collect elevations using an Electronic digital/bar-code leveling system based on Federal Geodetic Control Subcommittee (FGCS) standards and Specifications for Third-Order Differential Leveling Surveys. The contractor supplies Zone 7 with a copy of all field notes, benchmark data sheets, and a map showing the approximate route for the level runs and points

APPENDIX C

WELLS IN THE ZONE 7 MONITORING NETWORK

APPENDIX C-1
GROUNDWATER PROGRAM
WELL CONSTRUCTION DETAILS
2015 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	Camp	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	ZONE 7	Camp	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	Camp	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	DSRSD	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	supply	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	supply	FCC Well	FCC	May	Lower	518.84	230	6	50 - 230
2S/2E 28Q 1	monitor	hartford ave	ZONE 7	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	Mocho II	Upper	428.44	40	2	25 - 40
3S/1E 1H 3	monitor	Collier Canyon g1	ZONE 7	Mocho II	Upper	422.8	80	2.5	70 - 75
3S/1E 1J 3	irrigation	Triad Vineyard	TKG INTERNATIONAL	Mocho II	Lower	417.88	300	9	270 - 290
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	potable	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

RP = Reference Point Elevation (in feet above MSL)
TD = Total Depth of well (in feet below ground surface)
Dia = Diameter of well casing (in inches)
Perf = Preferated interval (in feet below ground surface), uppermost - lowermost

Site	Type	Other Name	Owner	Basin	Aquifer	RP	TD	Dia	Perf
3S/1E 5P 6	monitor	Owens Park	ZONE 7	Camp	Upper	336.65	35	2	25 - 35
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 6N 3	monitor	DSRSD MW-4	DSRSD	Dublin	Upper	340.74	72		52 - 72
3S/1E 6N 6	monitor	DSRSD NE-76	DSRSD	Dublin	Upper	333.58	75	2	50 - 70
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 7D 1	monitor	DSRSD SW-75	DSRSD	Dublin	Upper	330.09	75	2	54 - 74
3S/1E 7D 3	monitor	DSRSD SE-70	DSRSD	Dublin	Upper	332.28	70	2	45 - 65
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 7M 2	monitor	DSRSD Sub	ZONE 7	Dublin	Upper	328.4	88	4	70 - 85
3S/1E 7R 8	monitor	Mocho Canal North at Willow	ZONE 7	Bernal	Upper	326.63	52	2	42 - 52
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	sutter gate	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 9B 1	muni	Stoneridge	ZONE 7	Amador	Lower	349.23	810	20	250 - 800
3S/1E 9G 1	supply	3775 trenery - Kamp	MRS. KAMP	Amador	Upper	352.36	160	9	77 - 149
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	DSRSD	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 10B15	muni	COL 5	ZONE 7	Amador	Lower	357.584	690	18	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	NorthWest Cope Lake	ZONE 7	Amador	Lower	358.68	590.6	4	195.5 - 585.6

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3S/1E 10K 3	muni	COL 1	ZONE 7	Amador	Lower	363.79	530	18	205 - 530
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 11M 3	muni	COL 2	ZONE 7	Amador	Lower	369.24	684	18	345 - 684
3S/1E 11P 6	potable	New Jamieson Residence	DOUG JAMIESON	Amador	Lower	376.67	400	5	240 - 380
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	380.78	135	2	110 - 130
3S/1E 13P 6	nested	LGA Grant Nested 2	ZONE 7	Amador	Lower	380.76	255	2	230 - 250
3S/1E 13P 7	nested	LGA Grant Nested 3	ZONE 7	Amador	Lower	380.76	375	2	350 - 370
3S/1E 13P 8	nested	LGA Grant Nested 4	ZONE 7	Amador	Lower	380.76	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 14K 2	supply	lone star ind	LONESTAR	Amador	Lower	391.73	508	16	120 - 480
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 2	muni	Pleas 8	CITY OF PLEASANTON	AmWest	Lower	358.2	510	20	200 - 495
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	Upper	355.86	151	12	56 - 136
3S/1E 16L 5	muni	Pleas 5	CITY OF PLEASANTON	Amador	Lower	358.05	685	18	149 - 650
3S/1E 16L 7	muni	Pleas 6	CITY OF PLEASANTON	Amador	Lower	354.47	647	18	165 - 647
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

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3S/1E 17D11	monitor	Hopyard 9 Monitoring Well	ZONE 7	Bernal	Lower	324.84	603	2	340 - 505
3S/1E 17D12	muni	Hopyard 9	ZONE 7	Bernal	Lower	327.9	315	18	235 - 310
3S/1E 18A 5	muni	Pleas 7	CITY OF PLEASANTON	Bernal	Lower	329.05	454	18	120 - 440
3S/1E 18A 6	muni	Hopyard 6	ZONE 7	Bernal	Lower	326.74	500	18	158 - 490
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)	SFWD	Bernal	Lower	337.02	331		189 - 327
3S/1E 19A11	muni	SFWD North (A)	SFWD	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	342.62	500	12	218 - 500
3S/1E 20C 3	supply	Fairgrounds Potable Backup	ALAMEDA FAIRGROUNDS	Bernal	Lower	340.31	110		74 - 107
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	monitor	20Q2	CITY OF PLEASANTON	Bernal	Upper	325.82	65	10	45 - 53
3S/1E 22D 2	monitor	vineyard trailer	ZONE 7	Amador	Upper	368.05	72	2.5	62 - 67
3S/1E 23J 1	monitor	1627 vineyard trailer	D. SAFRENO	Amador	Upper	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 1J 1	monitor	DSRSD MW-1	DSRSD	Dublin	Upper	334.36	70		47 - 64
3S/1W 2A 2	monitor	McNamara's	ZONE 7	Dublin	Upper	369.4	47	2.5	37 - 42
3S/1W 12A 9	monitor	DSRSD NW-75	DSRSD	Dublin	Upper	332.14	74	2	49 - 69
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	1037 portola - trailer	TRAILER RANCH	Mocho II	Lower	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	AmWest	Lower	422	162	2	132 - 152
3S/2E 7P 3	muni	CWS STA 24	CAL WATER SERVICE	Amador	Lower	431.46	510	16	300 - 490
3S/2E 7R 2	monitor	CWS STA 31 Monitoring	CAL WATER SERVICE	Mocho II	Deep	446	805	2	750 - 805
3S/2E 7R 3	muni	CWS STA 31	CAL WATER SERVICE	Mocho II	Lower	446	583	16	410 - 528
3S/2E 8F 1	muni	CWS STA 10	CAL WATER SERVICE	Mocho II	Lower	456.24	576	16	143 - 433
3S/2E 8G 1	muni	CWS STA 19	CAL WATER SERVICE	Mocho II	Lower	465.05	465	16	120 - 455
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

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3S/2E 8N 2	muni	CWS STA 14	CAL WATER SERVICE	Mocho II	Lower	453.64	526	10	140 - 515
3S/2E 8P 1	muni	CWS STA 8	CAL WATER SERVICE	Mocho II	Lower	468.2	273	10	122 - 263
3S/2E 8Q 8	monitor	D-1	B&C GAS	Mocho II	Lower	464.7	125	2	110 - 125
3S/2E 9L 1	muni	CWS STA 17	CAL WATER SERVICE	Mocho II	Lower	499.39	516	16	136 - 496
3S/2E 9P 1	muni	CWS STA 12	CAL WATER SERVICE	Mocho II	Lower	501.28	515	16	192 - 492
3S/2E 9Q 1	muni	CWS STA 9	CAL WATER SERVICE	Mocho II	Lower	518.15	572	14	180 - 492
3S/2E 9Q 4	monitor	school st	ZONE 7	Mocho II	Upper	504.35	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 13R 1	potable		ROBERT MOLINARO	Mocho I	Upper	708.92	82	7	0 - 82
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 15B 1	supply		Stephen & Amanda Leeds	Mocho II	Lower	584	423	0	0 - 423
3S/2E 15E 2	irrigation	Retzlaff Winery	BOB TAYLOR	Mocho II	Lower	549.69	192	8	104 - 189
3S/2E 15L 1	monitor	Concannon2	CONCANNON	Mocho II	Upper	561.5	40.5	2	20 - 40.5
3S/2E 15M 2	monitor	Concannon1	CONCANNON	Mocho II	Upper	549.46	45	2	25 - 45
3S/2E 15Q 6	irrigation	Concannon	CONCANNON	Mocho II	Lower	577.56	301	12	220 - 301
3S/2E 15R 6	supply	2383 Buena Vista	John Howard	Mocho II	Upper	590.97	58	6	0 - 58
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 16B 1	muni	CWS STA 5	CAL WATER SERVICE	Mocho II	Lower	520.22	410	14	140 - 390
3S/2E 16C 1	muni	CWS STA 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 17E 2	supply	Mocho Street	JOHN & BARBARA STEIGE	Mocho II	Upper	467.71	94	6	0 - 94
3S/2E 18B 1	muni	CWS STA 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
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 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 30D 2	monitor	vineyard	ZONE 7	Amador	Upper	431.6	44	4	24 - 39
3S/2E 30G 1	domestic	genesis farms	GENISIS FARMS	Amador	Lower	453.69	390	12	150 - 370
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 7D 2	monitor	7D 2	ZONE 7	Spring	Upper	622.84	74	2.5	64 - 69
3S/3E 7M 2	supply	lupin way	LEON MOORE	Spring	Lower	628.64	199	6	171 - 188
3S/3E 17N 1	domestic	17N 1	DENCER	Mocho I	Lower	814	240	0	50 - 201
3S/3E 18P 1	domestic	18P1		Mocho I	Lower	800	147	0	0 - 147

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/3E 18P 4	domestic	18P 4		Mocho I	Unknown	0	300	0	60 - 300
3S/3E 19C 2	supply	8437 TESLA ROAD well 2	KEN TARANTINO	Mocho I	Upper	740.7	66	8	0 - 66
3S/3E 19D 1	supply	19D1	JAMES MILLS	Mocho I	Lower	719.7	220	10	70 - 207
3S/3E 20H 1	domestic	20H1	OTIS CLAMP	Mocho I	Upper	0	250	10	75 - 106
3S/3E 20R 4	domestic	20R 4	Dr. Anne Buonanno	Mocho I	Upper	0	0	0	0 - 0

RP = Reference Point Elevation (in feet above MSL)
TD = Total Depth of well (in feet below ground surface)
Dia = Diameter of well casing (in inches)
Perf = Preferated interval (in feet below ground surface), uppermost - lowermost

APPENDIX C-2
GROUNDWATER ELEVATION PROGRAM
WELLS AND RESPECTIVE MONITORING FREQUENCY
2015 WATER YEAR

SITE INFORMATION				*Montoring Frequency*	*Other GW Elevation Programs*			
State Name	*Well Name*	*Subbasin*	*Aq*		*WR*	*CASGEM*	*Muni*	*Key*
1S/4E 31P 5	CASGEM Tracy WAPA	Tracy	U	SA		√		
2S/1E 32E 1	End of Arnold Rd	Camp	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	Camp	U	SA				
2S/1E 33P 2	Central Pkwy at Emerald Glen	Camp	U	SA				
2S/1E 33R 1	Central Pkwy @ Grafton	Camp	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	Mocho II	U	SA				
3S/1E 1H 3	Collier Canyon g1	Mocho II	U	SA				
3S/1E 1J 3	Triad Vineyard	Mocho II	L	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				

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

SITE INFORMATION				Montoring Frequency	Other GW Elevation Programs			
State Name	Well Name	Subbasin	Aq		WR	CASGEM	Muni	Key
3S/1E 5P 6	Owens Park	Camp	U	SA				
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 6N 3	DSRSD MW-4	Dublin	U	SA				
3S/1E 6N 6	DSRSD NE-76	Dublin	U	SA				
3S/1E 7B 2	Hopyard rd	Dublin	L	SA				
3S/1E 7B12	Hacienda Arch	Dublin	U	SA				
3S/1E 7D 1	DSRSD SW-75	Dublin	U	SA				
3S/1E 7D 3	DSRSD SE-70	Dublin	U	SA				
3S/1E 7G 7	Chabot Well	Dublin	U	SA				
3S/1E 7J 5	Thomas Hart School	Dublin	U	SA				
3S/1E 7M 2	DSRSD Sub	Dublin	U	SA				
3S/1E 7R 8	Mocho Canal North at Willow	Bernal	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	M				
3S/1E 8H10	Mocho 4 Nested Middle	Amador	L	M				
3S/1E 8H11	Mocho 4 Nested deep	Amador	D	M				
3S/1E 8H13	Mocho 3 mon	Amador	D	M				
3S/1E 8H18	Mocho 4	Amador	L	R			√	
3S/1E 8K 1	sutter gate	Amador	U	SA				
3S/1E 8N 1	sports park	Bernal	U	SA				
3S/1E 9B 1	Stoneridge	Amador	L	R			√	
3S/1E 9G 1	3775 trenery - Kamp	Amador	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				√	
3S/1E 9M 3	Mocho 2	Amador	L	M			√	
3S/1E 9M 4	Mocho 3	Amador	L	R			√	
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	M				
3S/1E 10B15	COL 5	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	NorthWest Cope Lake	Amador	L	M				

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SITE INFORMATION				Montoring Frequency	Other GW Elevation Programs			
State Name	Well Name	Subbasin	Aq		WR	CASGEM	Muni	Key
3S/1E 10K 3	COL 1	Amador	L	SA			√	
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	M				
3S/1E 11M 3	COL 2	Amador	L	SA			√	
3S/1E 11P 6	New Jamieson Residence	Amador	L	SA				
3S/1E 12A 2	Airport South	Amador	U	SA				
3S/1E 12G 1	Oaks Park Shallow	Amador	U	M				
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	R		√		
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	SA				
3S/1E 13P 6	LGA Grant Nested 2	Amador	L	SA				
3S/1E 13P 7	LGA Grant Nested 3	Amador	L	SA				
3S/1E 13P 8	LGA Grant Nested 4	Amador	L	SA				
3S/1E 14B 1	Industrial Asphalt	Amador	L	SA				
3S/1E 14D 2	South Cope Lake	Amador	L	SA				
3S/1E 14K 2	lone star ind	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 2	Pleas 8	AmWest	L	M			√	
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	U	M				
3S/1E 16L 5	Pleas 5	Amador	L	M			√	
3S/1E 16L 7	Pleas 6	Amador	L	M			√	
3S/1E 16P 5	Vervais Monitor	Amador	U	R	√			
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	M				
3S/1E 17D 4	Hopyard Nested Middle 1	Bernal	L	M				
3S/1E 17D 5	Hopyard Nested Middle 2	Bernal	L	M				
3S/1E 17D 6	Hopyard Nested Middle 3	Bernal	L	M				
3S/1E 17D 7	Hopyard Nested Deep	Bernal	D	M				
3S/1E 17D10	Hopyard 7	Bernal	L	SA				
3S/1E 17D11	Hopyard 9 Monitoring Well	Bernal	L	SA				

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OTHER: WR = Water Rights; Muni = Municipal wells; Key = Key Wells

SITE INFORMATION				***Montoring Frequency***	***Other GW Elevation Programs***			
State Name	***Well Name***	***Subbasin***	***Aq***		***WR***	***CASGEM***	***Muni***	***Key***
3S/1E 17D12	Hopyard 9	Bernal	L	R			√	
3S/1E 18A 5	Pleas 7	Bernal	L	M			√	
3S/1E 18A 6	Hopyard 6	Bernal	L	R			√	
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 3	Fairgrounds Potable Backup	Bernal	L	SA			√	
3S/1E 20C 7	Key_Bern_U	Bernal	U	R	√	√		√
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				
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	U	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 1J 1	DSRSD MW-1	Dublin	U	SA				
3S/1W 2A 2	McNamara's	Dublin	U	SA				
3S/1W 12A 9	DSRSD NW-75	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	1037 portola - trailer	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	AmWest	L	SA				
3S/2E 7P 3	CWS 24	Amador	L	M			√	
3S/2E 7R 2	CWS STA 31 Monitoring	Mocho II	D	M				
3S/2E 7R 3	CWS 31	Mocho II	L	M			√	
3S/2E 8F 1	CWS 10	Mocho II	L	M			√	
3S/2E 8G 1	CWS 19	Mocho II	L	M			√	
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	R		√		√
3S/2E 8N 2	CWS 14	Mocho II	L	M			√	

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SITE INFORMATION				Montoring Frequency	Other GW Elevation Programs			
State Name	Well Name	Subbasin	Aq		WR	CASGEM	Muni	Key
3S/2E 8P 1	CWS 8	Mocho II	L	M			√	
3S/2E 8Q 8	D-1	Mocho II	L	SA				
3S/2E 9L 1	CWS 17	Mocho II	L	M				
3S/2E 9P 1	CWS 12	Mocho II	L	M			√	
3S/2E 9Q 1	CWS 9	Mocho II	L	M			√	
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	Concannon2	Mocho II	U	SA				
3S/2E 15M 2	Concannon1	Mocho II	U	SA				
3S/2E 15Q 6	Concannon	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 16B 1	CWS 5	Mocho II	L	M			√	
3S/2E 16C 1	CWS 15	Mocho II	L	M			√	
3S/2E 16E 4	pepper tree	Mocho II	U	SA				
3S/2E 17E 2	Mocho Street	Mocho II	U	SA				
3S/2E 18B 1	CWS 20	Amador	L	M			√	
3S/2E 18E 1	E. stanley	Amador	U	SA				
3S/2E 19D 7	Isabel Shallow	Amador	U	SA		√		
3S/2E 19D 8	Isabel Middle 1	Amador	L	SA				
3S/2E 19D 9	Isabel Middle 2	Amador	L	SA				
3S/2E 19D10	Isabel Deep	Amador	L	SA				
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 30D 2	vineyard	Amador	U	R	√*			
3S/2E 30G 1	genesis farms	Amador	L	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 7D 2	7D 2	Spring	U	SA				
3S/3E 7M 2	lupin way	Spring	L	SA				
		TOTALS:		241	6	14	29	8

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APPENDIX C-3
GROUNDWATER QUALITY PROGRAM
TABLE OF PROGRAM WELLS WITH SAMPLING FREQUENCY
2015 WATER YEAR

SITE INFORMATION				*Sampling Frequency*	*Other Programs*			
State Name	***Well Name***	***Subbasin***	***Aq***		***WR***	***Muni***	***SMP***	***NMP***
2S/1E 32E 1	End of Arnold Rd	Camp	U	A			T-HAC-1	
2S/1E 32N 1	Camp Parks	Camp	U	A			T-HAC-2	
2S/1E 32Q 1	Summer Glen Dr	Camp	U	A			32Q1	
2S/1E 33L 1	Gleason Dr @ Tassajara	Camp	U	A			33L1	
2S/1E 33P 2	Central Pkwy at Emerald Glen	Camp	U	A			33P2	
2S/1E 33R 1	Central Pkwy @ Grafton	Camp	U	A			T-DUB-1	
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			36E3	
2S/1W 36F 1	Dublin High shallow	Dublin	L	A				
2S/1W 36F 2	Dublin High mid	Dublin	L	A				
2S/1W 36F 3	Dublin High deep	Dublin	L	A				
2S/2E 27P 2	hartford ave east	Spring	U	A				
2S/2E 28D 2	May School	May	U	A			T-MAY-1	
2S/2E 28J 2	FCC Well	May	L	A				
2S/2E 28Q 1	hartford ave	May	U	A			T-MAY-2	
2S/2E 32K 2	jenson's N liv. Ave	Cayetano	U	A				
2S/2E 34E 1	mud city	May	U	A			T-MAY-3	
2S/2E 34Q 2	Hollyhock & Crocus	Spring	U	A			T-SPR-2	
3S/1E 1F 2	Constitution Dr	Mocho II	U	A			T-AIR-1	
3S/1E 1H 3	Collier Canyon g1	Mocho II	U	Q			1H3	
3S/1E 1L 1	Kitty Hawk	Camp	U	A			T-AIR-2	
3S/1E 1P 2	airport gas g5	Amador	U	A			T-AIR-3	
3S/1E 1P 3	New airport well	Amador	L	Q				
3S/1E 2J 2	Maint. Bldg	Camp	U	A			T-GLF-2	
3S/1E 2J 3	Doolan Rd East	Camp	U	A			T-GLF-1	
3S/1E 2K 2	Doolan Rd West	Camp	U	A			2K2	
3S/1E 2M 3	Friesman Rd North	Camp	U	A			T-FRI-1	
3S/1E 2N 6	Friesman Rd South	Amador	U	A			T-FRI-3	
3S/1E 2P 3	Crosswinds Church	Camp	L	A				
3S/1E 2Q 1	LPGC #1	Amador	U	A			T-GLF-3	
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			T-DUB-2	
3S/1E 4J 5	Pimlico shallow	Camp	U	A			T-DUB-3	
3S/1E 4J 6	Pimlico deep	Camp	U	A			T-DUB-4	
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			T-HAC-3	
3S/1E 5P 6	Owens Park	Camp	U	A			T-HAC-4	
3S/1E 6F 3	Dublin Ct	Dublin	U	A			6F3	
3S/1E 6N 2	DSRSD MW-3	Dublin	U	A				
3S/1E 6N 3	DSRSD MW-4	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; Key = Key Wells; SMP = Salt Management Plan; NMP = Nutrient Management Plan

SITE INFORMATION				Sampling Frequency	Other Programs			
State Name	Well Name	Subbasin	Aq		WR	Muni	SMP	NMP
3S/1E 6N 6	DSRSD NE-76	Dublin	U	A				
3S/1E 7B 2	Hopyard rd	Dublin	L	A				
3S/1E 7B12	Hacienda Arch	Dublin	U	A			T-CHA-1	
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			T-CHA-2	
3S/1E 7J 5	Thomas Hart School	Dublin	U	A			T-CHA-3	
3S/1E 7M 2	DSRSD Sub	Dublin	U	A			7M2	
3S/1E 7R 8	Mocho Canal North at Willow	Bernal	U	A			T-CHA-4	
3S/1E 8B 1	Lizard Well	Amador	U	A			T-HAC-5	
3S/1E 8G 4	Apache	Amador	U	A			T-HAC-6	
3S/1E 8H 9	Mocho 4 Nested Shallow	Amador	L	A				
3S/1E 8H10	Mocho 4 Nested Middle	Amador	L	A				
3S/1E 8H11	Mocho 4 Nested deep	Amador	D	A				
3S/1E 8H13	Mocho 3 mon	Amador	D	A				
3S/1E 8H18	Mocho 4	Amador	L	Q		√		
3S/1E 8K 1	sutter gate	Amador	U	A				
3S/1E 8N 1	sports park	Bernal	U	A				
3S/1E 9B 1	Stoneridge	Amador	L	Q		√		
3S/1E 9G 1	3775 trenery - Kamp	Amador	U	A				
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	Q		√		
3S/1E 9M 3	Mocho 2	Amador	L	Q		√		
3S/1E 9M 4	Mocho 3	Amador	L	Q		√		
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 10B15	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	NorthWest Cope Lake	Amador	L	A				
3S/1E 10K 3	COL 1	Amador	L	A		√		
3S/1E 11B 1	Airport West	Amador	U	Q			11B1	
3S/1E 11C 3	LAVWMA ROW	Amador	U	A			T-GLF-4	
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	A				
3S/1E 11M 3	COL 2	Amador	L	A		√		

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OTHER: WR = Water Rights; Muni = Municipal wells; Key = Key Wells; SMP = Salt Management Plan; NMP = Nutrient Management Plan

SITE INFORMATION				Sampling Frequency	Other Programs			
State Name	Well Name	Subbasin	Aq		WR	Muni	SMP	NMP
3S/1E 11P 6	New Jamieson Residence	Amador	L	A				
3S/1E 12A 2	Airport South	Amador	U	Q			12A2	
3S/1E 12D 2	LWRP G6	Amador	U	Q				
3S/1E 12G 1	Oaks Park Shallow	Amador	U	Q				
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	AmWest	L	A		√		
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 2	Pleas 4	Amador	U	A				
3S/1E 16L 5	Pleas 5	Amador	L	A		√		
3S/1E 16L 7	Pleas 6	Amador	L	A		√		
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	A				
3S/1E 17D 4	Hopyard Nested Middle 1	Bernal	L	A				
3S/1E 17D 5	Hopyard Nested Middle 2	Bernal	L	A				
3S/1E 17D 6	Hopyard Nested Middle 3	Bernal	L	A				
3S/1E 17D 7	Hopyard Nested Deep	Bernal	D	A				
3S/1E 17D11	Hopyard 9 Monitoring Well	Bernal	L	A				
3S/1E 17D12	Hopyard 9	Bernal	L	Q		√		
3S/1E 18A 5	Pleas 7	Bernal	L	A		√		
3S/1E 18A 6	Hopyard 6	Bernal	L	Q		√		
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	A		√		
3S/1E 19A11	SFWD North (A)	Bernal	L	A		√		
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				

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

OTHER: WR = Water Rights; Muni = Municipal wells; Key = Key Wells; SMP = Salt Management Plan; NMP = Nutrient Management Plan

SITE INFORMATION				Sampling Frequency	Other Programs			
State Name	Well Name	Subbasin	Aq		WR	Muni	SMP	NMP
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			T-PLE-3	
3S/1E 22D 2	vineyard trailer	Amador	U	A			T-BER-3	
3S/1E 23J 1	1627 vineyard trailer	Amador	U	A				
3S/1E 25C 3	Katz Winery Mansion	Amador	U	A				
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			1B11	
3S/1W 1J 1	DSRSD MW-1	Dublin	U	A				
3S/1W 2A 2	McNamara's	Dublin	U	A			2A2	
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			T-SPR-1	
3S/2E 3K 3	first & S. front rd	Mocho I	U	A			3K3	
3S/2E 5N 1	1037 portola - trailer	Mocho II	L	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	AmWest	L	A				
3S/2E 7P 3	CWS STA 24	Amador	L	A		√		
3S/2E 7R 3	CWS STA 31	Mocho II	L	A		√		
3S/2E 8F 1	CWS STA 10	Mocho II	L	A		√		
3S/2E 8G 1	CWS STA 19	Mocho II	L	A		√		
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 STA 14	Mocho II	L	A		√		
3S/2E 8P 1	CWS STA 8	Mocho II	L	A		√		
3S/2E 8Q 8	D-1	Mocho II	L	A				
3S/2E 9P 1	CWS STA 12	Mocho II	L	A		√		
3S/2E 9Q 1	CWS STA 9	Mocho II	L	A		√		
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			11C1	
3S/2E 12C 4	LLNL W-486	Spring	U	A				
3S/2E 12J 3	LLNL W-017A	Spring	L	A				
3S/2E 13R 1		Mocho I	U					√
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 15B 1		Mocho II	L					√
3S/2E 15E 2	Retzlaff Winery	Mocho II	L	A				
3S/2E 15L 1	Concannon2	Mocho II	U	A				

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SITE INFORMATION				Sampling Frequency	Other Programs			
State Name	Well Name	Subbasin	Aq		WR	Muni	SMP	NMP
3S/2E 15M 2	Concannon1	Mocho II	U	A				
3S/2E 15Q 6	Concannon	Mocho II	L	A				
3S/2E 15R 6	2383 Buena Vista	Mocho II	U					√
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 16B 1	CWS STA 5	Mocho II	L	A		√		
3S/2E 16C 1	CWS STA 15	Mocho II	L	A		√		
3S/2E 16E 4	pepper tree	Mocho II	U	A				
3S/2E 17E 2	Mocho Street	Mocho II	U	A				
3S/2E 18B 1	CWS STA 20	Amador	L	A		√		
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				
3S/2E 19D10	Isabel Deep	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			24A1	
3S/2E 26J 2	mines rd	Mocho II	U	A				
3S/2E 29F 4	usgs wetmore	Amador	U	SA	√			
3S/2E 30D 2	vineyard	Amador	U	A			T-VIN-3	
3S/2E 33G 1	crohare	Amador	U	SA	√			
3S/2E 33K 1	VA	Amador	U	Q				
3S/2E 33L 1	VA/CROHARE FENCE	Amador	U	Q				
3S/3E 7D 2	7D 2	Spring	U	A				
3S/3E 17N 1	17N 1	Mocho I	L					√
3S/3E 18P 1	18P1	Mocho I	L					√
3S/3E 18P 4	18P 4	Mocho I	N					√
3S/3E 19C 2	8437 TESLA ROAD well 2	Mocho I	U					√
3S/3E 19D 1	19D1	Mocho I	L					√
3S/3E 20H 1	20H1	Mocho I	U					√
3S/3E 20R 4	20R 4	Mocho I	U					√
			Totals:	222	6	29	50	10

Salt Management Plan (SMP) Designations

T-AIR = Airport Transect
T-BER = Bernal Transect
T-CHA = Chabot Transect
T-DUB = East Dublin Transect
T-FRI = Friesman Transect
T-HAC = Hacienda Transect
T-HV = Happy Valley Transect
T-LIV = South Livermore Transect
T-MAY = May Transect
T-PLE = Pleasanton Transect
T-RH = Ruby Hill Transect
T-SPR = Springtown Transect
T-VIN = Vineyard Transect
T-WEN = Wente Transect

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APPENDIX D

CEQA DOCUMENTATION

State of California - Department of Fish and Wildlife

2016 ENVIRONMENTAL FILING FEE CASH RECEIPT

DFW 753.5a (Rev. 12/15/15) Previously DFG 753.5a

RECEIPT NUMBER:
01 — 12222016 — 501

STATE CLEARINGHOUSE NUMBER *(If applicable)*

SEE INSTRUCTIONS ON REVERSE. TYPE OR PRINT CLEARLY.

LEAD AGENCY	LEADAGENCY EMAIL	DATE
ZCNE 7 WATER AGENCY		12/22/2016

COUNTY/STATE AGENCY OF FILING	DOCUMENT NUMBER
Alameda	16-501

PROJECT TITLE
GROUNDWATER SUSTAINABILITY AGENCY AND ALTERNATIVE GROUNDWATER SUSTAINABILITY PLAN

PROJECT APPLICANT NAME	PROJECT APPLICANT EMAIL	PHONE NUMBER
MATT KATEN		(925) 454-5071

PROJECT APPLICANT ADDRESS	CITY	STATE	ZIP CODE
100 NORTH CANYONS PARKWAY	LIVERMORE	CA	94551

PROJECT APPLICANT *(Check appropriate box)*

- [x] Local Public Agency
- [ ] School District
- [ ] Other Special District
- [ ] State Agency
- [ ] Private Entity

CHECK APPLICABLE FEES:

[ ] Environmental Impact Report (EIR)	$3,070.00	$	0.00
[ ] Mitigated/Negative Declaration (MND)(ND)	$2,210.25	$	0.00
[ ] Certified Regulatory Program document (CRP)	$1,043.75	$	0.00

- [x] Exempt from fee
  - [x] Notice of Exemption (attach)
  - [ ] CDFW No Effect Determination (attach)
- [ ] Fee previously paid (attach previously issued cash receipt copy)

[ ] Water Right Application or Petition Fee (State Water Resources Control Board only)	$850.00	$	0.00
[x] County documentary handling fee		$	50.00
[ ] Other		$	

PAYMENT METHOD:

- [ ] Cash
- [ ] Credit
- [ ] Check
- [x] Other

TOTAL RECEIVED $ 50.00

SIGNATURE	AGENCY OF FILING PRINTED NAME AND TITLE
X [signature]	A. MORAN/DEPUTY CLERK

ENDORSED
FILED
ALAMEDA COUNTY

DEC 22 2016

STEVE MANNING, County Clerk
By ______ Deputy

*ENVIRONMENTAL DECLARATION

(CALIFORNIA FISH AND GAME CODE SECTION 711.4)

LEAD AGENCY NAME AND ADDRESS	FOR COUNTY CLERK USE ONLY
Alameda County Flood Control & Water Conservation District 100 North Canyons Pkwy Livermore, CA 94551 Attn: Elke Rank	FILE NO: 16-501

CLASSIFICATION OF ENVIRONMENTAL DOCUMENT:

(PLEASE MARK ONLY ONE CLASSIFICATION)

1. NOTICE OF EXEMPTION / STATEMENT OF EXEMPTION

[X] A - STATUTORILY OR CATEGORICALLY EXEMPT

$ 50.00 - COUNTY CLERK HANDLING FEE

2. NOTICE OF DETERMINATION (NOD)

[ ] A - NEGATIVE DECLARATION (OR MITIGATED NEG. DEC.)

$ 2,210.25 - STATE FILING FEE

$ 50.00 - COUNTY CLERK HANDLING FEE

[ ] B - ENVIRONMENTAL IMPACT REPORT (EIR)

$ 3,070.00 - STATE FILING FEE

$ 50.00 - COUNTY CLERK HANDLING FEE

***A COPY OF THIS FORM MUST BE COMPLETED AND SUBMITTED WITH EACH COPY OF AN ENVIRONMENTAL DECLARATION BEING FILED WITH THE ALAMEDA COUNTY CLERK.**

FOUR (4) COPIES OF ALL NECESSARY DOCUMENTS ARE REQUIRED FOR FILINGS SUBMITTED BY MAIL. FIVE (5) COPIES ARE REQUIRED FOR IN-OFFICE FILINGS.

ALL APPLICABLE FEES MUST BE PAID AT THE TIME OF FILING.

FEES ARE EFFECTIVE JANUARY 1, 2016

MAKE CHECKS PAYABLE TO: ALAMEDA COUNTY CLERK

Zone 7 Water Agency
Livermore, CA

NOTICE OF EXEMPTION

To: ☐ Office of Planning and Research

For U.S. Mail:	*Street Address:*
P.O. Box 3044	1400 Tenth Street, Room 121
Sacramento, CA 95812-3044	Sacramento, CA 94514

From: ZONE 7 WATER AGENCY
100 North Canyons Parkway
Livermore, CA 94551
925-454-5000
Attn. Elke Rank

To: ☒ County Clerk
County of Alameda
1106 Madison Street
Oakland, CA 94612

Date: 12/22/16

ENDORSED
FILED
ALAMEDA COUNTY
DEC 22 2016
STEVE MANNING, County Clerk
By ________ Deputy

Project Title: Groundwater Sustainability Agency and Alternative Groundwater Sustainability Plan

Project Number (Zone 7):

Project Location – Specific: Livermore Valley Groundwater Basin (DWR Basin No.2-10)

Project Location – City: Livermore, Pleasanton, Dublin, and San Ramon

Project Location – County: Alameda and Contra Costa Counties

Description of Nature, Purpose, and Beneficiaries of Project:

As part of its role in providing drinking water supply to the cities of Pleasanton, Livermore, Dublin, and portions of San Ramon, Zone 7 Water Agency has been managing local groundwater basins sustainably for over 40 years. Zone 7 is undertaking two actions in accordance with the Sustainable Groundwater Management Act (SGMA):

1. Groundwater Sustainability Agency: The Sustainable Groundwater Management Act (SGMA) (Part 2.74 of Division 6 of the Water Code) requires the formation of Groundwater Sustainability Agencies (GSAs) for all medium- and high-priority basins by June 30, 2017 (including the Livermore Valley Groundwater Basin). In addition, SGMA designated Zone 7 as the exclusive GSA for the groundwater basins within its service area if the Agency elects to be the GSA. The Livermore Valley and Sunol Groundwater Basins are within Zone 7's service area, which is largely in east Alameda County. A small portion of the Livermore Valley Groundwater Basin also extends into Contra Costa County.

2. Alternate Groundwater Sustainability Plan: SGMA also requires that all medium- and high-priority basins be managed under a Groundwater Sustainability Plan (GSP) by 2022 (2020 if the basin is in overdraft). The elements of a GSP are prescribed in the GSP emergency regulations adopted by the California Water Commission in August 2016. The Livermore Valley Groundwater Basin is ranked a "medium priority" basin per DWR. As an alternative, agencies managing groundwater basins sustainably for 10 years or more are eligible to submit an Alternative GSP that is "functionally equivalent" to a GSP as specified in the recent emergency regulations for Groundwater Sustainability Plans (California Code of Regulations, Title 23).

Zone 7 has been managing the Livermore Valley Groundwater Basin sustainably for over 40 years. Becoming the GSA and submitting an Alternative GSP will continue the existing monitoring programs of basin parameters and analysis of data collected.

Name of Public Agency Approving Project: Zone 7 Water Agency

Name of Person or Agency Carrying Out Project: Zone 7 Water Agency

Exempt Status: *(check one)*

- ☐ Ministerial (Sec. 21080(b)(1); 15268);
- ☐ Declared Emergency (Sec. 21080(b)(3); 15269(a));
- ☐ Emergency Project (Sec. 21080(b)(4); 15269(b)(c));
- ☐ Categorical Exemption. State type and section number:
- ☐ Statutory Exemptions. State code number:
- ☒ General Rule (Sec. 15061(b)(3))

Reasons Why Project is Exempt:

The two actions herein (i.e., becoming the GSA and submitting an Alternative GSP) are exempt from CEQA under the "general rule" that CEQA only applies to projects with the potential for significant effects on the environment (section 15061.b.3). Becoming the GSA for the groundwater basins in Zone 7's service area will allow Zone 7 to continue to manage the groundwater basin sustainably and will give Zone 7 the authority to take action if undesirable results were to occur. The Alternative GSP shows that Zone 7 will continue to operate the Livermore Valley Groundwater Basin sustainably, as it has for over 40 years. Further, no new "on-the-ground" activities are planned as part of these actions. Should Zone 7 wish to undertake such a project in the future to help meet GSP related goals, that action would require project-specific analysis under CEQA.

Lead Agency Contact Person: Matt Katen **Area Code/Telephone/Ext:** 925-454-5071

	Project Engineer/Manager:	*Environmental Review:*
Signature:	Matt Katen	[signature]
Title	Principal Hydrogeologist Zone 7 Water Agency	Associate Water Resources Planner Zone 7 Water Agency

Date received for filing at County Clerk: ______

Date received for filing at OPR: ______

Form No. 110-37 (Rev. 4/81 B30)

White & Yellow - Auditor
Pink - Furnishing Dept.
Goldenrod - Ordering Dept.

COUNTY OF ALAMEDA
INTER - DEPARTMENT SERVICE ORDER

№ 81209

IDSO Acct: 5215

Service ordered by: ________ (Name)

Dept.: Zone 7 Water Agency   No.: 270722

Phone: 925-454-5000   QIC: 90201

Service furnished by: Kevin Hing (Name)

Dept.: Clerk-Recorder   No.: 140300

Phone: 26362   QIC: 20201

DESCRIPTION OF SERVICES	ESTIMATED COST	ACCOUNT	ACTUAL CHARGE
CEQA Filing Fee for GSA/GSP	$50.00	610361	
		610361	
		610361	
		610361	
		610361	
	$50.00		

Name of Contact Person: Teri Yasuda or Margaret Chun

Phone: 925-454-5045/ 5051   QIC: 90201

Date Ordered: 12/06/2016

Authorized Signature: Margaret Chun

Teri Yasuda/ Margaret Chun

Date Completed: ________

Authorized Signature: ________

ALAMEDA COUNTY CLERK-RECORDER
1106 MADISON STREET
OAKLAND, CA 94607
(510)272-6362

ISSUED TO:
IDSO - ZONE 7 WATER AGENCY

RECEIPT # 2243876
12/22/2016 09:42:58 AM

SERVICE	PAGES	QTY	FEE
GENERAL BUS	1	1	50.00

Total Amount Due $50.00

[illegible]

State of California - Department of Fish and Wildlife

2016 ENVIRONMENTAL FILING FEE CASH RECEIPT

DFW 753.5a (Rev. 12/15/15) Previously DFG 753.5a

RECEIPT NUMBER: 07 — 12222016 — 0042

STATE CLEARINGHOUSE NUMBER *(If applicable)*

SEE INSTRUCTIONS ON REVERSE. TYPE OR PRINT CLEARLY.

LEAD AGENCY	LEADAGENCY EMAIL	DATE
zone 7 water agency		12/22/2016

COUNTY/STATE AGENCY OF FILING	DOCUMENT NUMBER
Contra Costa	2016-529

PROJECT TITLE

Groundwater sustainability agency & alternative groundwater sustainability plan

PROJECT APPLICANT NAME	PROJECT APPLICANT EMAIL	PHONE NUMBER
Zone 7 water agency		(925) 454-5000

PROJECT APPLICANT ADDRESS	CITY	STATE	ZIP CODE
100 North Canyons Pkwy	Livermore	Ca	94551

PROJECT APPLICANT *(Check appropriate box)*

☑ Local Public Agency ☐ School District ☐ Other Special District ☐ State Agency ☐ Private Entity

CHECK APPLICABLE FEES:

☐ Environmental Impact Report (EIR)	$3,070.00	$	0.00
☐ Mitigated/Negative Declaration (MND)(ND)	$2,210.25	$	0.00
☐ Certified Regulatory Program document (CRP)	$1,043.75	$	0.00

☐ Exempt from fee
- ☑ Notice of Exemption (attach)
- ☐ CDFW No Effect Determination (attach)

☐ Fee previously paid (attach previously issued cash receipt copy)

☐ Water Right Application or Petition Fee (State Water Resources Control Board only)	$850.00	$	0.00
☑ County documentary handling fee		$	50.00
☐ Other		$	

PAYMENT METHOD: #2971468

☐ Cash ☐ Credit ☑ Check ☐ Other

TOTAL RECEIVED $ 50.00

SIGNATURE	AGENCY OF FILING PRINTED NAME AND TITLE
X CGarcia	C.Garcia Deputy Clerk

County Receipt Number 2807457

*ENVIRONMENTAL DECLARATION

(CALIFORNIA FISH AND GAME CODE SECTION 711.4)

LEAD AGENCY NAME AND ADDRESS	FOR COUNTY CLERK USE ONLY
Alameda County Flood Control & Water Conservation District 100 North Canyons Pkwy Livermore, CA 94551 Attn: Elke Rank	FILE NO: ______________

CLASSIFICATION OF ENVIRONMENTAL DOCUMENT:

(PLEASE MARK ONLY ONE CLASSIFICATION)

1. NOTICE OF EXEMPTION / STATEMENT OF EXEMPTION

[X] A - STATUTORILY OR CATEGORICALLY EXEMPT

$ 50.00 - COUNTY CLERK HANDLING FEE

2. NOTICE OF DETERMINATION (NOD)

[ ] A - NEGATIVE DECLARATION (OR MITIGATED NEG. DEC.)

$ 2,210.25 - STATE FILING FEE

$ 50.00 - COUNTY CLERK HANDLING FEE

[ ] B - ENVIRONMENTAL IMPACT REPORT (EIR)

$ 3,070.00 - STATE FILING FEE

$ 50.00 - COUNTY CLERK HANDLING FEE

***A COPY OF THIS FORM MUST BE COMPLETED AND SUBMITTED WITH EACH COPY OF AN ENVIRONMENTAL DECLARATION BEING FILED WITH THE CONTRA COSTA COUNTY CLERK.**

FOUR (4) COPIES OF ALL NECESSARY DOCUMENTS ARE REQUIRED FOR FILINGS SUBMITTED BY MAIL. FIVE (5) COPIES ARE REQUIRED FOR IN-OFFICE FILINGS.

ALL APPLICABLE FEES MUST BE PAID AT THE TIME OF FILING.

FEES ARE EFFECTIVE JANUARY 1, 2016

MAKE CHECKS PAYABLE TO: CONTRA COSTA COUNTY CLERK

Zone 7 Water Agency
Livermore, CA

NOTICE OF EXEMPTION

To: ☐ Office of Planning and Research
For U.S. Mail:
P.O. Box 3044
Sacramento, CA 95812-3044

Street Address:
1400 Tenth Street, Room 121
Sacramento, CA 95814

To: ☒ County Clerk
County of Contra Costa
555 Escobar Street
Martinez, CA 94553

FILED
DEC 22 2016
J.E. CANCIAMILLA COUNTY CLERK
CONTRA COSTA COUNTY
BY ______ DEPUTY

From: ZONE 7 WATER AGENCY
100 North Canyons Parkway
Livermore, CA 94551
925-454-5000
Attn. Elke Rank

Date: 12/22/16

Project Title: Groundwater Sustainability Agency and Alternative Groundwater Sustainability Plan

Project Number (Zone 7):

Project Location – Specific: Livermore Valley Groundwater Basin (DWR Basin No.2-10)

Project Location – City: Livermore, Pleasanton, Dublin, and San Ramon

Project Location – County: Alameda and Contra Costa Counties

Description of Nature, Purpose, and Beneficiaries of Project:

As part of its role in providing drinking water supply to the cities of Pleasanton, Livermore, Dublin, and portions of San Ramon, Zone 7 Water Agency has been managing local groundwater basins sustainably for over 40 years. Zone 7 is undertaking two actions in accordance with the Sustainable Groundwater Management Act (SGMA):

1. Groundwater Sustainability Agency: The Sustainable Groundwater Management Act (SGMA) (Part 2.74 of Division 6 of the Water Code) requires the formation of Groundwater Sustainability Agencies (GSAs) for all medium- and high-priority basins by June 30, 2017 (including the Livermore Valley Groundwater Basin). In addition, SGMA designated Zone 7 as the exclusive GSA for the groundwater basins within its service area if the Agency elects to be the GSA. The Livermore Valley and Sunol Groundwater Basins are within Zone 7's service area, which is largely in east Alameda County. A small portion of the Livermore Valley Groundwater Basin also extends into Contra Costa County.

2. Alternate Groundwater Sustainability Plan: SGMA also requires that all medium- and high-priority basins be managed under a Groundwater Sustainability Plan (GSP) by 2022 (2020 if the basin is in overdraft). The elements of a GSP are prescribed in the GSP emergency regulations adopted by the California Water Commission in August 2016. The Livermore Valley Groundwater Basin is ranked a "medium priority" basin per DWR. As an alternative, agencies managing groundwater basins sustainably for 10 years or more are eligible to submit an Alternative GSP that is "functionally equivalent" to a GSP as specified in the recent emergency regulations for Groundwater Sustainability Plans (California Code of Regulations, Title 23).

Zone 7 has been managing the Livermore Valley Groundwater Basin sustainably for over 40 years. Becoming the GSA and submitting an Alternative GSP will continue the existing monitoring programs of basin parameters and analysis of data collected.

Name of Public Agency Approving Project: Zone 7 Water Agency

Name of Person or Agency Carrying Out Project: Zone 7 Water Agency

Exempt Status: *(check one)*

- ☐ Ministerial (Sec. 21080(b)(1); 15268);
- ☐ Declared Emergency (Sec. 21080(b)(3); 15269(a));
- ☐ Emergency Project (Sec. 21080(b)(4); 15269(b)(c));
- ☐ Categorical Exemption. State type and section number:
- ☐ Statutory Exemptions. State code number:
- ☒ General Rule (Sec. 15061(b)(3))

Reasons Why Project is Exempt:

The two actions herein (i.e., becoming the GSA and submitting an Alternative GSP) are exempt from CEQA under the "general rule" that CEQA only applies to projects with the potential for significant effects on the environment (section 15061.b.3). Becoming the GSA for the groundwater basins in Zone 7's service area will allow Zone 7 to continue to manage the groundwater basin sustainably and will give Zone 7 the authority to take action if undesirable results were to occur. The Alternative GSP shows that Zone 7 will continue to operate the Livermore Valley Groundwater Basin sustainably, as it has for over 40 years. Further, no new "on-the-ground" activities are planned as part of these actions. Should Zone 7 wish to undertake such a project in the future to help meet GSP related goals, that action would require project-specific analysis under CEQA.

Lead Agency Contact Person: Matt Katen **Area Code/Telephone/Ext:** 925-454-5071

	Project Engineer/Manager:	*Environmental Review:*
Signature:	Matt Katen	[signature]
Title	Principal Hydrogeologist Zone 7 Water Agency	Associate Water Resources Planner Zone 7 Water Agency

Date received for filing at County Clerk: ______

Date received for filing at OPR: ______

REC'T # 0002807457
December 22, 2016 ----- 10:41:42

CONTRA COSTA Co Recorder Office
JOSEPH CANCIAMILLA, Clerk-Recorder

Document #16-ZONE7WA-TE

Check Number 2791468
REQD BY

Envir Qual	$50.00
Total fee	$50.00
Amount Tendered...	$50.00
Change	$0.00

cmg,CT/1/0

Your opinion matters!
Please tell us how well we did
by completing a brief web survey at
http://www.surveymonkey.com/s/RBKTBNH

APPENDIX E

ZONE 7 WATER AGENCY

RESOLUTION TO BECOME THE

GROUNDWATER SUSTAINABILITY AGENCY

FOR THE

LIVERMORE VALLEY GROUNDWATER BASIN

AND FILE AN ALTERNATIVE

GROUNDWATER SUSTAINABILITY PLAN

ZONE 7
ALAMEDA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT

BOARD OF DIRECTORS

RESOLUTION NO. 16-190

INTRODUCED BY DIRECTOR STEVENS
SECONDED BY DIRECTOR PALMER

Resolution to Become the Groundwater Sustainability Agency for the Livermore Valley Groundwater Basin and File an Alternative Groundwater Sustainability Plan

WHEREAS, Sustainable Groundwater Management Act of 2014 (SGMA), specifically California Water Code § 10723, requires the formation of local Groundwater Sustainability Agencies (GSAs) by June 30, 2017.

WHEREAS, the SGMA has already identified Zone 7 Water Agency as the exclusive GSA for groundwater basins within its service area; and

WHEREAS, Zone 7 currently exercises water supply and water management responsibilities within its service area, which service area overlies the majority of the Livermore Valley Groundwater Basin; and

WHEREAS, Zone 7 has Memoranda of Understanding (MOUs) with Contra Costa County, City of San Ramon, Dublin San Ramon Services District, and East Bay Municipal Utilities District acknowledging Zone 7 as the exclusive GSA for the Livermore Valley Groundwater Basin for the portion of the basin in Contra Costa County; and

WHEREAS, as required by Water Code § 10723(b), a notice of public hearing to consider this decision to become a GSA was published pursuant to Government Code section 6066, and the Board of Directors held the noticed public hearing before adopting this Resolution; and

WHEREAS, SGMA, specifically Water Code §10733.6, outlines the steps needed for the adoption of Groundwater Sustainability Plans (GSPs) or Alternative Plans for high- and medium-priority basins; and

WHEREAS, staff has prepared an Alternative GSP which is functionally equivalent to a GSP and shows that Zone 7 has sustainably managed the Livermore Valley Groundwater Basin for over 40 years;

NOW THEREFORE BE IT RESOLVED that the Board of Directors of Zone 7 of the Alameda County Flood Control and Water Conservation District does hereby find and determine as follows:

1. Zone 7 hereby elects to become the GSA for the entire portion of the Livermore Valley Groundwater Basin that underlies the District's service area including a small portion that underlies Contra Costa County and to undertake groundwater management within that area.

2. Zone 7 intends to provide broad opportunity for public involvement in the ongoing management of groundwater in the Livermore Valley Groundwater Basin.

3. Zone 7 will continue to coordinate with other local agencies that overlie the Livermore Valley Groundwater Basin and with other groundwater management entities that elect to be the GSA of neighboring groundwater basins or subbasins.

4. The decision to become a GSA is not a "Project" pursuant to Public Resources Code section 21065 and therefore is not subject to the requirements of the California Environmental Quality Act. (See Title 14, Cal. Code Regs. §15378(b) (5).)

5. Staff is directed to prepare notification of Zone 7's decision to become a GSA and to submit that notification, and all supporting documentation, to DWR in accordance with Water Code §10723.8(a).

6. Staff is directed to finalize and submit the Alternative GSP to DWR in accordance with Water Code §10733.6(b).

7. Staff is directed to file a Notice of Exemption with the County Clerks of Alameda County and Contra Costa County, in accordance with the law.

ADOPTED BY THE FOLLOWING VOTE:

AYES: DIRECTORS FIGUERS, GRECI, McGRAIL, PALMER, QUIGLEY, RAMIREZ HOLMES, STEVENS

NOES: NONE

ABSENT: NONE

ABSTAIN: NONE

I certify that the foregoing is a correct copy of a Resolution adopted by the Board of Directors of Zone 7 of the Alameda County Flood Control and Water Conservation District on December 21, 2016.

By: ______________________
President, Board of Directors

Zone 7 Water Agency
100 North Canyons Parkway, Livermore, CA 94551