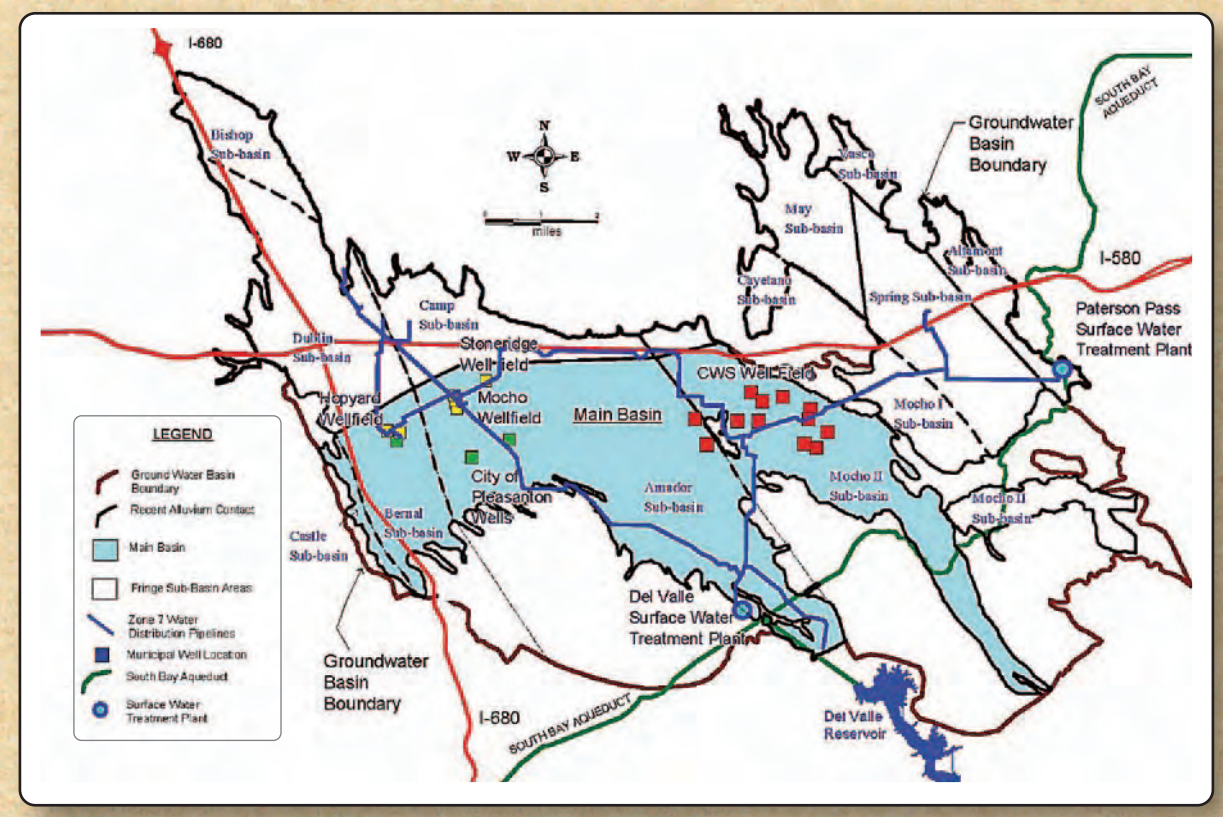
Groundwater Management Plan

for Livermore-Amador Valley Groundwater Basin



September 2005

Prepared for:

Zone 7 Water Agency

Prepared by:

Jones & Stokes

Groundwater Management Plan for Livermore-Amador Valley Groundwater Basin

Prepared for:

Zone 7 Water Agency
(Alameda County Flood Control and Water Conservation District Zone 7)
100 North Canyons Parkway Livermore, CA 94551

Prepared by:

Jones & Stokes
2600 V Street
Sacramento, CA 95818-1914

September 2005

Jones & Stokes. 2005. G*roundwater Management Plan for Livermore-Amador Valley Groundwater Basin.* September. (J&S 04727.04.) Sacramento, CA. Prepared for Zone 7 Water Agency, Livermore, CA.

Contents

Page

Executive Summary ES-1

Chapter 1 Introduction 1-1
1.1 Alameda County Flood Control and Water Conservation District 1-1
1.2 Zone 7 Water Agency 1-2
1.3 Zone 7's Groundwater Management 1-3
1.4 Groundwater Basin Management Objectives 1-3
1.5 Purpose of Zone 7's GMP 1-6
1.6 GMP Components 1-6

Chapter 2 Background 2-1
2.1 History of Previous Area Investigations 2-1
2.2 Zone 7 Water Supply and Management 2-4
2.3 Overview of Zone 7's Basin Management 2-5

Chapter 3 Water Resources 3-1
3.1 Description of Zone 7 Groundwater Basin 3-1
3.1.1 Overview 3-1
3.1.2 Hydrogeology 3-2
3.1.3 Aquifer Zones 3-3
3.1.4 Main Basin 3-4
3.1.5 Main Basin Sub-Basins 3-5
3.2 Groundwater Levels and Storage 3-7
3.3 Groundwater Recharge 3-8
3.4 Water Use 3-9
3.5 Groundwater Quality 3-9

Chapter 4 Management Plan Elements 4-1
4.1 Groundwater Management Goal 4-1
4.2 Resource Management and Other Planning Efforts 4-1
4.3 Stakeholder Involvement 4-3
4.3.1 Involving the Public 4-3
4.4 Development of Relationships with State, Federal, and Local Agencies 4-4
4.5 Monitoring Programs and Protocols 4-5
4.5.1 Climatological Monitoring 4-8
4.5.2 Groundwater Elevation and Quality Monitoring 4-10

4.5.3 Surface Water Flow and Quality Monitoring 4-13
4.5.4 Land Surface Elevation and Inelastic Subsidence Monitoring 4-19
4.5.5 Mining Area Monitoring 4-22
4.5.6 Land Use Monitoring 4-24
4.5.7 Groundwater Production 4-25
4.5.8 Wastewater and Recycled Water Monitoring 4-26
4.6 Basin Evaluation Programs 4-28
4.6.1 Introduction 4-28
4.6.2 Recharge Calculations 4-28
4.6.3 Hydrologic Inventory and Water Balance 4-29
4.6.4 Groundwater Basin Storage 4-30
4.6.5 Salt Balance 4-30
4.7 Basin Management 4-32
4.7.1 Introduction 4-32
4.7.2 Key Wells 4-33
4.7.3 Supply and Demand Simulation Modeling 4-33
4.7.4 Groundwater Modeling 4-34

Chapter 5 Plan Implementation 5-1
5.1 Groundwater Management Program 5-1
5.1.1 Introduction 5-1
5.1.2 Salt Management 5-1
5.1.3 Integrated Water Resources/ Conjunctive Use 5-2
5.1.4 Groundwater Resource Protection 5-3
5.2 Future Review of This Groundwater Management Plan 5-8
5.3 Public Hearings and Plan Adoption 5-9
5.4 Actions 5-10

Chapter 6 References 6-1
6.1 Printed References 6-1

Appendix A Wells in 2005 Monitoring Program

Appendix B Toxic Site Surveillance Program Areas for Livermore, Pleasanton, and Dublin Areas

Appendix C Standard Operating Procedures

Appendix D Executive Summary of Salt Management Plan

Appendix E Resolutions and Policy Statements

Tables and Figures

Table		On Page
4-1	Monitoring Programs and Protocols	4-6
4-2	Precipitation Network	4-9
4-3	Evaporation Network	4-10
4-4	Water Quality Monitoring Constituents	4-12
4-5	2004 Surface Water Program Sites	4-14
4-6	Land Surface Elevation Monitoring Survey Points and Descriptions	4-20
4-7	Annual Supply and Demand	4-30
4-8	Main Basin Relative Salt Loading Sources, 1998 Water Year Controllable Portion of the Total Salt	4-32

Figure		Follows Page
1-1	Zone 7 Service Area Boundary	1-2
1-2	Livermore-Amador Valley Groundwater Basin Boundaries	1-4
3-1	Groundwater Basin Map—Annual Monitoring Report	3-2
3-2	Historic Low Water Levels in the Deep Aquifer	3-8
3-3	Stream Recharge Rates and TDS	3-8
3-4	Water Operations Plan	3-10
4-1	Groundwater Program Wells 2003 Water Year	4-8
4-2	Map of Climatological Network	4-8
4-3	Locations of Sites in 2004 Surface Water Program	4-14
4-4	Benchmark Locations	4-20
4-5	Location of Gravel Mining Pits	4-24
4-6	Livermore Valley Land Use 2004 Water Year	4-24
4-7	Land Use and Wastewater Disposal Changes Over 35 Years	4-28
4-8	Key Index Wells	4-34

Acronyms and Abbreviations

µg/l	micro grams per liter
1987 GWMP	Statement on Zone 7 Groundwater Management, approved by the Zone 7 Board on August 19, 1987
AB	Assembly Bill
ACEH	Alameda County Environmental Health
ACFCWCD	Alameda County Flood Control and Water Conservation District
af/y	acre-feet per year
afa	acre feet annually
ASR	aquifer storage and recovery
bgs	below ground surface
BMOs	basin management objectives
Board	Alameda County Flood Control and Water Conservation District Zone 7 Board of Directors
BTEX	benzene, toluene, ethylbenzene, xylene
CEQA	California Environmental Quality Act
CIMIS	California Irrigation Management Information System
Corps	U.S. Army Corps of Engineers
CWS	California Water Service Company
Delta	Sacramento–San Joaquin River Delta
DERWA	Dublin–San Ramon Services District–East Bay Municipal Utility District Recycled Water Authority (the JPA that handles the San Ramon Valley Recycled Water Program)
DFG	California Department of Fish and Game
DHS	California Department of Health Services
District Act	California Uncodified Water Act
DSRSD	Dublin–San Ramon Services District
DWR	California Department of Water Resources
DWSAP	Drinking Water Source Assessment and Protection
EC	electrical conductivity
GAMA	Groundwater Ambient Monitoring and Assessment
GMAC	Groundwater Management Advisory Committee
GMP	Groundwater Management Plan (this document)
gpm	gallons per minute
GPP	Groundwater Protection and Projects Section at Zone 7

GWMP	1987 Groundwater Management Policy (Statement on Zone 7 Groundwater Management, adopted August 19, 1987)
LAVWMA	Livermore-Amador Valley Waste Management Agency
LDV	Lake Del Valle
LIA	local implementing agency
LLNL	Lawrence Livermore National Laboratory
LUFT	leaking underground fuel tanks
LWRP	Livermore Water Reclamation Plant
M&I	Municipal and Industrial
MCL	maximum contaminant limit
mg/l	milligrams per liter
MOU	Memorandum of Understanding
MtBE	Methyl tertiary-Butyl Ether (gasoline additive)
NPDES	National Pollutant Discharge Elimination System
O&M	operations and management
PCE	tetrachlorethene
QA/QC	quality assurance/quality control
RMC	Raines, Melton & Carella, Inc.
RWQCB	California Regional Water Quality Control Board—San Francisco Bay Region
SB	Senate Bill
SBA	South Bay Aqueduct
SFPUC	San Francisco Public Utilities Commission
SMMP	Stream Management Master Plan
SMP	Salt Management Plan
State Water Board	State Water Resources Control Board
Supply Reliability Policy	Resolution No. 04-2662, Reliability Policy for Municipal & Industrial Water Supplies, August 18, 2004
SWAMP	State Wide Ambient Monitoring Program
SWP	State Water Project
taf	thousand acre-feet
TAG	technical advisory group
TBA	tertiary-butyl alcohol
TCE	trichloroethene
TDS	total dissolved solids
TPHd	TPH from diesel
TPHg	total petroleum hydrocarbon from gasoline
TVG	Tri-Valley Retail Group
TVRGIS User Group	Tri-Valley Regional Geographic Information Systems User Group

USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VA	Veterans Administration
VOCs	volatile organic compounds
Water Quality Policy	Resolution No. 03-2494, Water Quality Policy for Potable and Non-potable Water, April 16, 2003
WMP	Wastewater Management Plan
WR	Water Rights
WRE	Water Resources Engineering Section at Zone 7
Z7sim	Zone 7's supply and demand simulation model
Zone 7	Zone 7 Water Agency

Executive Summary

The Zone 7 Groundwater Management Plan (GMP) is written to compile and document all of Zone 7's current groundwater management policies and programs in a single document and to satisfy the requirements set forth in the California Groundwater Management Planning Act (Water Code Sections 10750, et seq.). The GMP documents the starting point for local and surrounding agencies that are affiliated with Zone 7 to frame current groundwater management efforts and will be considered in developing future amendments to groundwater management policies and procedures.

Zone 7 works closely with the three tri-valley cities (Livermore, Pleasanton and Dublin), with the County, with agricultural land users, with its four major retail agencies and with other local agencies and groups to manage local groundwater resources. The Tri-Valley Water Retailers Group (TWRG) is a newly formed group, comprised of senior staff representing the four major retail agencies: Dublin–San Ramon Services District, City of Pleasanton, City of Livermore and California Water Service Company. Similarly, the Committee of Valley Water Retailers (CoVWR), composed of two elected officials or members of the governing body of each of the four retail water supply agencies. The TWRG and CoVWR serve as forums for the retailers to discuss regional retail issues. For decades, Zone 7 has actively solicited the cooperation and input of many groups and agencies within the area to most effectively manage the groundwater and to maintain beneficial uses for all residents of the tri-valley.

The GMP provides a detailed description of Zone 7's groundwater management practices throughout the Livermore-Amador Valley Groundwater Basin (DWR Basin No. 2-10) and a description of the regulatory setting that involves a GMP. In addition, this GMP contains the Zone 7 management plan elements, which involve the GMP goals, basin management objectives (BMOs), and stakeholder involvement. A large portion of this document addresses monitoring programs and protocols related to groundwater and conjunctive use of regional water supplies, ranging from groundwater level monitoring to recharge monitoring to groundwater quality monitoring to climatological monitoring to surface water flow and surface water quality monitoring.

Overall, this GMP characterizes the existing groundwater management efforts of Zone 7 to support existing and future beneficial uses of groundwater in the Livermore Amador Groundwater Basin. There are no new programs, policies or procedures in this Plan. Zone 7 considers this to be a compilation of existing policies and procedures as well as to serve as a living document which will provide background to future changes as new policies and procedures are

considered by Zone 7 working collaboratively with area stakeholders such as its four retail agencies.

The Board of Directors adopted a resolution of intent to draft and adopt a GMP pursuant to section 10753.2 of the California Water Code at its Regular Meeting held on August 17, 2005. Adoption of this resolution authorized staff to proceed with final preparation and distribution of this draft Groundwater Management Plan. Zone 7 tentatively plans to finalize the document and adopt the final GMP following a public hearing at its regular board meeting of September 21, 2005.

Table ES-1 provides a road map to this document, clarifying where each Groundwater Management Planning Act requirement (in relation to California Water Code sections) is addressed:

Table ES-1. Groundwater Management Planning Act Requirements

Water Code Reference	Requirement	Location in GMP
§10753.7(a)(3)	Description of groundwater area to be managed	
	• Map	Figures 1-1 and 1-2
	• Description	Overview located in Chapter 1; also see Section 3.1.1.
§10753.7(a)(1)	Basin Management Objectives	Section 1.3
§10753.7(a)(2)	Plan to involve other agencies and the public	Section 4.3
§10753.7(a)(4)	Monitoring protocols	Sections 3.2, 3.3, and 4.4
§10753.8	Plan components	
	• Control of saline water intrusion	Sections 4.6.5 and 5.1.2
	• Identification and management of wellhead protection areas and recharge areas	Sections 3.3, 5.1.4.2, and 5.1.4.4
	• Regulation of the migration of contaminated groundwater	Sections 3.5 and 5.1.4.5
	• Administration of a well abandonment and well destruction program	Section 5.1.4.2
	• Mitigation of conditions of overdraft	Sections 3.2, 3.3, 4.6.2, and 4.6.3
	• Replenishment of groundwater extracted by water producers	Sections 3.3, 4.5.7, 4.6.2, and 4.6.3
	• Monitoring of groundwater levels and storage	Section 4.5.2
	• Facilitating conjunctive use operations	Section 5.1.3
	• Identification of well construction policies	Section 5.1.4.2
	• Construction and operation by the local agency of groundwater contamination cleanup, recharge, storage, conservation, water recycling and extraction projects	Section 5.1.4
	• Development of relationships with state and federal regulatory agencies	Section 4.4

Water Code Reference	Requirement	Location in GMP
	• Review of land use plans and coordination with land use planning agencies to assess activities which create a reasonable risk of groundwater contamination	Section 4.5
§10753.2	Details of Public Hearing(s) and Plan Adoption	Section 5.3

Chapter 1
Introduction

Groundwater is one of California's most valuable natural resources and requires proper protection and management in order to maintain its beneficial uses. The California Department of Water Resources (DWR) defines groundwater management as the planned and coordinated monitoring, operation, and administration of a groundwater basin with the long-term goal of sustainability of the resources. In an average water supply year, groundwater meets about 30% of California's urban and agriculture demand and during drought years, 40% or more.[1] In 1995, approximately 43% of Californians used groundwater for at least a portion of their public supply needs.[2]

Many agencies managing groundwater resources lack the appropriate management and coordination between local agencies to properly manage their local groundwater basin. In the years to come, demand on groundwater is expected to increase significantly as the population in California is projected to reach nearly 46 million. Many agencies throughout California are unable to maintain beneficial uses of groundwater, with problems such as overdraft and poor water quality arising because of lack of management and/or coordination between agencies. The California Groundwater Management Planning Act (Water Code Sections 10750, *et seq.*) was adopted with the intent of encouraging local agencies to work cooperatively to manage groundwater resources within their jurisdictions. This Groundwater Management Plan is a compendium of Zone 7 Water Agency's existing groundwater management policies and programs, documenting Zone 7's compliance with the requirements of the Groundwater Management Planning Act.

1.1 Alameda County Flood Control and Water Conservation District

The Alameda County Flood Control and Water Conservation District (ACFCWCD) was created in 1949 by the state legislature through passage of Act 205 of the California Uncodified Water Act (District Act). ACFCWCD was formed to provide control of flood and stormwater and to conserve and manage local water for beneficial uses. ACFCWCD is vested with the power to store

[1] California Department of Water Resources 2003.
[2] Solley et al. 1998.

water in surface or underground reservoirs within or outside of the district for the common benefit of the district; to conserve and reclaim water for present and future use within the district; to appropriate and acquire water and water rights; and to import water into the district. ACFCWCD is further authorized by statute to 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 and to prevent contamination, pollution or otherwise rendering unfit for beneficial use the surface or subsurface water used or useful in the district. ACFCWCD is also authorized to levy replenishment assessments upon the production of groundwater from all water-producing facilities, whether public or private, in the district.

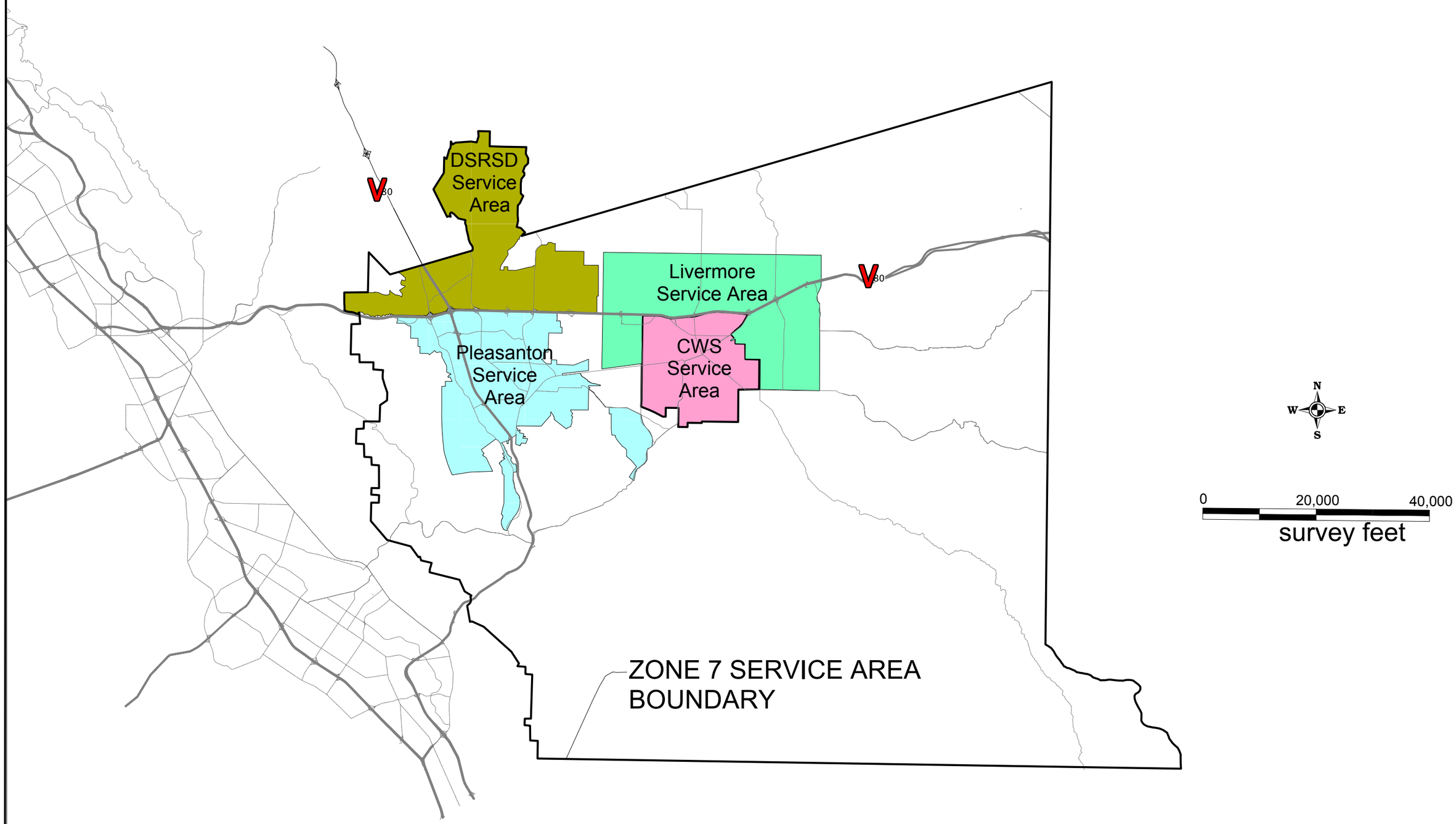
1.2 Zone 7 Water Agency

ACFCWCD comprises 10 active zones, of which Zone 7 covers the eastern portion of Alameda County, which includes the cities of Dublin, Pleasanton, and Livermore. Pursuant to Section 36 of the District Act, Zone 7 of the ACFCWCD (Zone 7 Water Agency, or Zone 7) was established in 1957 to address regional and water supply issues. Zone 7 is governed by an elected seven-member board of directors who, with the passage of Assembly Bill (AB) 1125 in 2003, 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 ACFCWCD.

As one of the 29 state water contractors, Zone 7 is the water wholesaler for the Tri-Valley Area (Dublin, Pleasanton, and Livermore; also known as the Livermore-Amador Valley), as well as the area's flood control agency. Zone 7 imports surface water from the State Water Project (SWP) through the South Bay Aqueduct (SBA) for treatment, storage, and recharge. Zone 7 Water Agency supplies treated drinking water to four water retail agencies: Dublin San Ramon Services District, the City of Pleasanton, the City of Livermore, and California Water Service Company (see Figure 1-1). These water retailers deliver water to homes in their specific service areas. The four retail agencies have formed both the Committee of Valley Water Retailers (CoVWR) and, on the staff level, the Tri-Valley Water Retailers Group (TWRG). The water retailers, in turn, deliver water to homes 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 190,000 people.

One of Zone 7 Water Agency's main missions is to serve as guardian of the groundwater in the Tri-Valley (Livermore, Dublin, Pleasanton) area; this role is recognized by the California Regional Water Quality Control Board—San Francisco Bay Region (RWQCB). For more than thirty years, Zone 7 has managed regional water supplies, including DWR Basin 2-10, in a complex, interrelated program that defines groundwater extraction goals for major regional pumpers. Zone 7 also operates local flood control and recharge facilities to optimize instream recharge. In addition, Zone 7 works closely with DWR, which

Figure 1-1



ZONE 7 WATER AGENCY 100 NORTH CANYONS PKWY, LIVERMORE, CA 94551	DRAWN BY: Gerald Gates DESIGNED BY: Gerald Gates CHECKED BY: APPROVED BY:	WATER RESOURCES ZONE 7 SERVICE AREA BOUNDARY	SCALE: 1" = 6000' DATE: 18 FEBRUARY 2002 FILE NO.:

manages Lake Del Valle and dam to augment imported water supplies with local watershed runoff.

In summary, Zone 7 Water Agency imports surface water via the SWP's SBA, stores local runoff in Lake Del Valle, maintains flood control, maintains and operates recharge facilities in the area, manages both surface and groundwater supplies to maximize conjunctive use of the supplies, treats regional drinking water, and wholesales potable water to local retail water supply agencies, who in turn retail it to residents and other customers.

1.3 Zone 7's Groundwater Management

Zone 7 manages both surface and groundwater supplies to maximize conjunctive use and reliability of water supplies. Zone 7 has actively managed DWR Groundwater Basin Number 2-10, the Livermore-Amador Valley Groundwater Basin (underlying the Tri-Valley, as shown in DWR Bulletin118 Update 2003; see Figure 1-2, for more than 30 years. Groundwater typically makes up 20–25% of the water supplied by Zone 7 to its retail water supply agencies; in addition, two of the four retailers independently operate supply wells, so total groundwater makes up a higher percentage of the total regional supply (30%).

Over the 30 years of regional groundwater management, Zone 7 Water Agency has developed numerous interrelated programs to monitor, assess, and manage the basin. These programs are outlined below. The various existing programs and resolutions, taken together, satisfy the intent of the Groundwater Management Planning Act.

This document serves to clarify the various components of Zone 7's existing groundwater management and conjunctive use programs and policies, incorporate them by reference in this new Groundwater Management Plan, and to serve as the framework for discussing future changes to groundwater policy and procedures. Any such changes would be developed in a collaborative effort with the Tri-Valley Water Retailers Group (TWRG) and its member agencies.

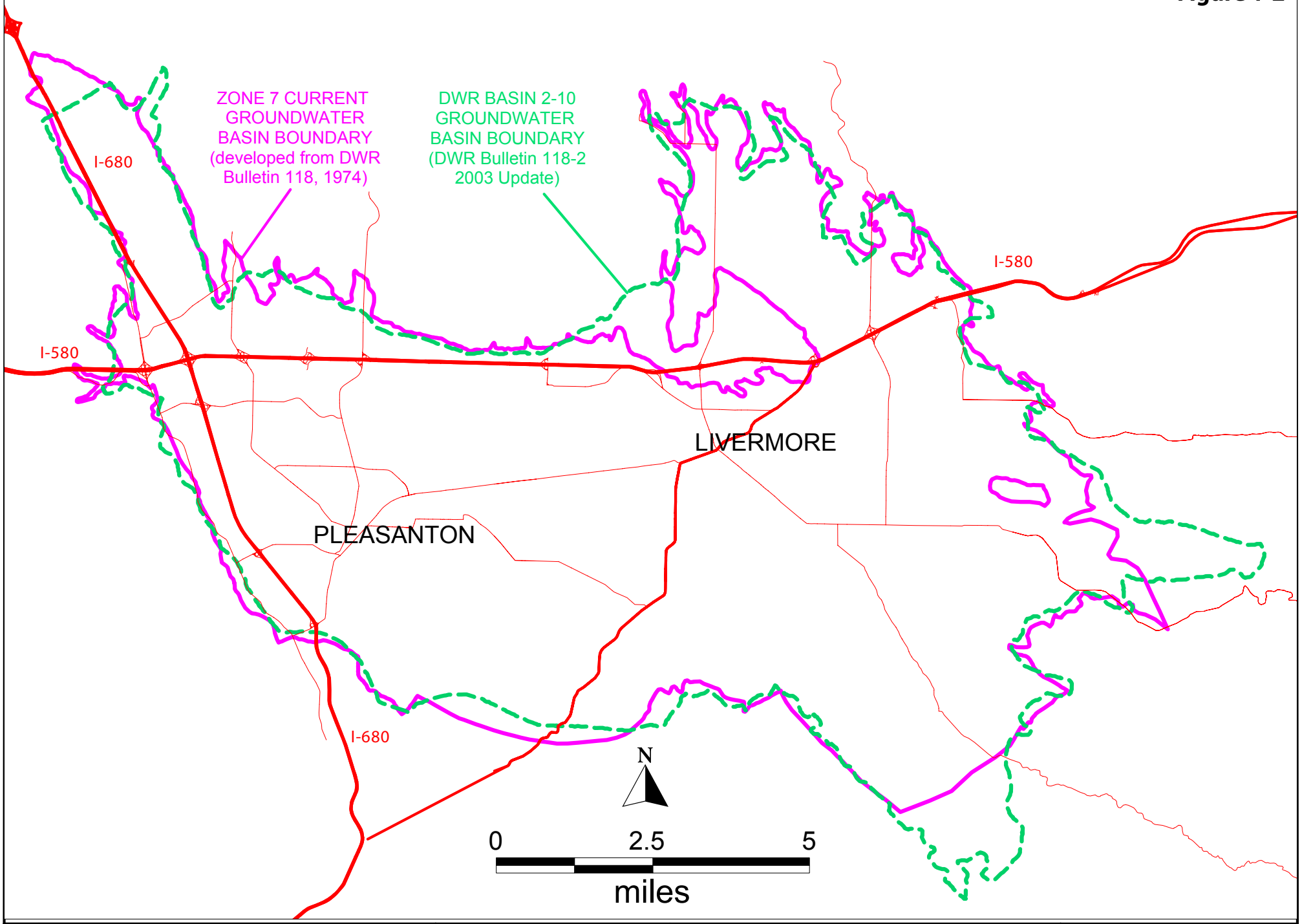
1.4 Groundwater Basin Management Objectives

The primary groundwater Basin Management Objectives (BMOs) of Zone 7 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 provide water storage for imported surface water used during drought periods.

The primary BMOs implemented by Zone 7 include:

- Monitoring and maintenance of groundwater levels through conjunctive use and management of regional water supplies:
  - 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 to allow for gravel mining 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, as well as tracking and addressing any degradation:
  - protect and enhance the quality of the groundwater,
  - halt degradation from salt buildup,
  - reduce flow of poor quality shallow groundwater into deep aquifers,
  - offset impacts of water recycling and wastewater disposal through integrated Salt Management Plan (SMP),
  - recharge with relatively low total dissolved solids (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 described in Chapter 3), and
  - minimize threats of groundwater pollution through groundwater protection;
- Monitor and prevent inelastic land surface subsidence from occurring as a result of groundwater withdrawals:
  - 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;

Figure 1-2



ZONE 7 WATER AGENCY 100 N. CANYONS PARKWAY LIVERMORE CA 94551	DRAWN BY: Gerald Gates DESIGNED BY: Gerald Gates CHECKED BY: APPROVED BY:	WATER RESOURCES LIVERMORE-AMADOR VALLEY GROUNDWATER BASIN BOUNDARIES	SCALE: 1" = 2 MILES DATE: 22 JULY 2005 FILE NO.: MAPINFO\GEODATA\HYDROBASINS\DWR BASINS.WOR

- Monitor and manage changes in surface flow and surface quality, especially as they affect groundwater levels or quality, or are caused by groundwater pumping in the basin:
  - Augment stream flow through artificial recharge releases to improve groundwater supply and quality, and
  - monitor and protect recharge capacity of local arroyos.

Following is a list of some key Zone 7 objectives and policies that are included in Appendix E and which articulate objectives to:

- provide sustainable water supply,
- provide sustainable water quality,
- minimize operational costs, and
- manage the groundwater basin.

In addition, Zone 7 has adopted policies related to protection of the groundwater basin through wastewater management. These include:

- Wastewater Management Policy (Resolution 1137), and
- prohibition against use of septic tanks for new development zoned for commercial or industrial use (Resolution 1165).

Zone 7's Board of Directors adopted the Water Quality Policy (Resolution 03-2494), as well as the Salt Management Plan, which includes:

- protect and enhance the quality of groundwater,
- offset current and future salt loading,
- maintain or improve groundwater mineral quality,
- provide more comparable delivered water quality to retailers, and
- utilize Water Operations Plan to achieve these goals.

Furthermore, Zone 7's Board of Directors adopted the Reliability Policy for Municipal and Industrial (M&I) Water Supplies (Resolution 04-2662), which includes:

- Meet 100% of its treated water customers' water supply needs in accordance with Zone 7's most current retail contracts.
- Provide sufficient treated water production capacity and infrastructure to meet at least 75% of Zone 7's maximum daily M&I contractual demands should any single one of Zone 7's major supply, production, or transmission facilities experience an extended, unplanned outage.

Zone 7 has also had a long-standing policy of managing the groundwater basin to maximize conjunctive use, reliability and storage opportunities. The "Statement on Zone 7 Groundwater Management" was adopted on August 19, 1987 and is incorporated herein by reference.

The Salt Management Plan (SMP), also incorporated herein by reference (see Executive Summary in Appendix D), was originally prepared in fulfillment of Master Water Recycling Permit Order No. 93-159 Provision D.1.c.ii and General Water Recycling Permit Order No. 96-011 Provision D.4. This document not only provides a comprehensive and effective approach for administering, regulating and encouraging water recycling in the Livermore-Amador Valley, it also provides guidance to the area's agencies in ways to address the historical trend of increasing TDS in the main groundwater basin. It was developed by Zone 7 staff and consultants in partnership with a technical advisory group (TAG) composed of local water retailers, and a Zone 7 citizens committee—the Groundwater Management Advisory Committee (GMAC). The RWQCB accepted the SMP in October 2004.

All Zone 7 objectives include a basic philosophy of working cooperatively with the public, the Tri-Valley Retail Group and the four individual retail agencies (Dublin San Ramon Services District [DSRSD], City of Livermore, City of Pleasanton and the California Water Service Company [CWS]). These objectives include:

- to develop information, policies, and procedures for the effective long-term management of the groundwater basin;
- to 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
- to work cooperatively with the gravel mining industry to implement the Chain of Lakes reclamation plan.

1.5 Purpose of Zone 7's GMP

The purpose of Zone 7's Groundwater Management Plan (GMP) is to document and compile in one place all of Zone 7's existing programs and policies that together serve as the basis for successfully manageing groundwater resources and to develop a framework for considering future amendments to policy and procedures collaboratively with other basin users such as the Tri-Valley Retail Group and its member agencies, DSRSD, CWS, Pleasanton and Livermore. Simply put, this GMP revises the Statement on Zone 7 Groundwater Management, approved by the Zone 7 Board on August 19, 1987 (1987 GWMP), incorporating by reference all current related programs and policies at Zone 7 (especially the SMP) and demonstrating overall program compliance with the requirements of the Groundwater Management Planning Act.

1.6 GMP Components

In developing GMP components, the California Department of Water Resources (DWR) recognizes that the goal of a GMP is to ensure a long-term, sustainable, reliable, high-quality groundwater supply. Of the required and recommended

components found in Appendix C of DWR Bulletin 118 Update, this Zone 7 GMP includes:

1. Control of saline water intrusion—although saline water intrusion, per se, is not an issue for Zone 7 (which is inland from bays and oceans), the level of salt and minerals in the groundwater basin is of significant concern to Zone 7. The following address salt management and are incorporated by reference:

    a. Salt Management Plan, approved by the California Regional Water Quality Control Board—San Francisco Bay Region, October 2004;

    b. Salt Management Program Implementation Plan (Zone 7 Resolution 99-2068);

    c. Master Water Recycling Permit (RWQCB–San Francisco Bay Region Order No. 93-159); and

    d. Wastewater Management Plan for the Unsewered, Unincorporated Area of Alameda Creek Watershed Above Niles and Related Policies (Resolutions 1037 and 1165).

2. Identification and management of wellhead protection areas throughout the whole basin and specific requirements for recharge areas. The following address wellhead protection and are incorporated by reference:

    a. Drinking Water Source Assessment and Protection (DWSAP) Plan for each Zone 7 well, as submitted to the California Department of Health Services (DHS) Division of Drinking Water;

    b. groundwater protection ordinance program;

    c. commercial septic tank program and related policy statements and resolutions, including Wastewater Management Plan for the Unsewered, Unincorporated Area of Alameda Creek Watershed Above Niles (WMP);

    d. mapping of known contamination plumes;

    e. referral program which includes ongoing reviews and coordination of proposed development projects through lead local land use and planning agencies (cities and county);

    f. sub-watershed–based monitoring of all recharge areas; and

    g. protection of key stream recharge reaches (i.e., creek cleanups, monitoring, kiosks).

3. Regulation of the migration of contaminated groundwater. The following programs have been developed to address contaminated groundwater:

    a. toxic site surveillance program, assisting lead agencies in groundwater cleanup efforts;

    b. Geotracker program (active participation in development and public outreach elements with Lawrence Livermore National Laboratory (LLNL) and GMAC which assisted Zone 7 in its development of the SMP); and

c. Groundwater Ambient Monitoring and Assessment (GAMA) program (active participation in development and public outreach elements with LLNL and GMAC).

4. Administration of a well-abandonment and well-destruction program:

   a. Well Ordinance Administration (Well Ordinance adopted 1973, County Ordinance No. 73-68; similar City Well Ordinances)—addresses well construction/destruction, soil borings, etc., in compliance with state standards and additional requirements as required (case-by-case basis);

   b. agreements with cities to administer City Well Ordinances; and

   c. identification of abandoned wells through development review process and subsequent issuance of requests for destruction.

5. Mitigation of conditions of overdraft through management, recharge and development of alternate water supplies. The following program components outline Zone 7's approach that has been developed over the years to mitigate historical conditions of overdraft:

   a. initial contractual groundwater pumping quotas established to manage retailer pumping/extractions from the main groundwater basin;

   b. manage Zone 7 pumping so groundwater levels do not fall below historic lows to recover from overdraft conditions;

   c. regional recycled water programs (DSRSD–EBMUD Recycled Water Authority [DERWA] and Livermore);

   d. chain of lakes/mining fees;

   e. SWP imports to reduce demand on groundwater supplies;

   f. use of SWP imports in temporary off-stream recharge facility in the 1960's and '70's (Las Positas Recharge Pit);

   g. instream natural and artificial recharge, latter using imported SWP water, allowing conjunctive use and storage of imported supplies in groundwater basin;

   h. expansion of existing recharge facilities to include off-stream storage and recharge (future Chain of Lakes);

   i. management of local runoff (Lake Del Valle);

   j. water conservation;

   k. maintain records of basin-wide groundwater pumping to guard against future overdraft conditions; and

   l. maintain records of groundwater basin safe/sustainable yield.

6. Replenishment of groundwater extracted by water producers. The following conjunctive use program components outline Zone 7's approach that has been developed over the years to replenish historically depleted groundwater

supplies. Note that Zone 7 has artificially recharged approximately 66,000 acre-feet more than has been extracted:

a. SWP imports,

b. instream recharge (natural and artificial),

c. annual hydrologic inventory monitoring in preparation of following year's water supply operations planning documents,

d. chain of lakes recharge program (future), and

e. groundwater model.

7. Monitoring of groundwater levels and storage (Appendix A). The following monitoring program components outline Zone 7's approach that has been developed over the years to track regional groundwater levels and storage:

   a. continuous monitoring of water levels in certain key wells;

   b. monthly and semiannual well monitoring programs;

   c. climatological monitoring program;

   d. recharge monitoring (both natural and artificial);

   e. metering and data management of groundwater pumping quantities (municipal);

   f. groundwater model and associated databases; and

   g. complete hydrologic inventory of basin supply, use, and storage.

8. Facilitating conjunctive use operations. The following conjunctive use program components outline Zone 7's approach that has been developed over the years to replenish historically depleted groundwater supplies:

   a. multi-year conjunctive use modeling for sustainable water supply report;

   b. water supply forecast to determine possible conjunctive use opportunities;

   c. integrated water supply operations plan to coordinate conjunctive use;

   d. artificial stream recharge program;

   e. flood control management such as Lake del Valle flood releases;

   f. expanded artificial recharge with chain of lakes (future);

   g. reporting of water supply operations and planning;

   h. stream recharge management/reporting (e.g., monthly groundwater supply and utilization report)—using imported water delivered from SWP;

   i. annual water balance/hydrologic inventory/water levels;

   j. monitor new supply well plans through well permit program;

   k. meet with local agency planners periodically; and

l. attend/participate in: agricultural committee meetings, Fisheries Restoration workgroups, Watershed Advisory Committee meetings.

9. Identification of well construction policies:

   a. well ordinance administration—addresses well construction/destruction, soil borings, etc., in compliance with state standards and additional requirements as required (case-by-case basis).

10. Construction and operation by the local agency of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects. The following programs have been developed to address contaminated groundwater remediation projects:

    a. monitoring through GPP and providing input/guidance to lead agencies, as necessary;

    b. water quality policy for potable and nonpotable water (Resolution 03-2494);

    c. groundwater demineralization project;

    d. well master plan;

    e. construction of production wells;

    f. construction of aquifer storage and recovery (ASR) wells for evaluation and potential future use;

    g. construction and/or replacement of monitoring wells, as needed;

    h. chain of lakes recharge facilities (future);

    i. investigating feasibility of recycled water storage facility at future chain of lakes site.

11. Development of relationships with state and federal regulatory agencies:

    a. DHS (regulating drinking water and municipal wells);

    b. DWR (state water project contract administrator; contributed to Bulletin 118-2 “Evaluation of Livermore Valley Groundwater Basin 1974; cooperative Well Sampling; joint management of local CIMIS station to enhance weather monitoring and improve water conservation efforts);

    c. RWQCB (lead agency for National Pollutant Discharge Elimination System [NPDES], recycled water, and basin planning; close cooperation over toxic spill sites; contributed to basin plan development; review all NPDES monitoring reports for mining discharges and wastewater dischargers; cooperate in State Wide Ambient Monitoring Program [SWAMP]);

    d. Alameda County environmental health (local implementing agency [LIA] for leaking underground fuel tanks [LUFT] sites where groundwater has been affected; septic tank ordinance update);

e. California Department of Fish and Game (DFG)/U.S. Fish and Wildlife Service (USFWS)—for recharge program operations and facilities;

f. U.S. Army Corps of Engineers (Corps)—for diversion and creek projects; and

g. Lawrence Livermore National Laboratory (LLNL)—for site cleanups, groundwater monitoring and scientific/technical support.

12. Review of land use plans and coordination with land use planning agencies to assess activities that create a reasonable risk of groundwater contamination and to assess groundwater use:

    a. DWSAP for each of Zone 7's wells;

    b. ongoing reviews and coordination through local land use and planning agencies (cities and county);

    c. development referrals; site review reporting, mapping and analysis;

    d. California Environmental Quality Act (CEQA) reviews (for new projects and developments);

    e. well permit and commercial septic tank programs;

    f. tracking and quantifying all groundwater pumping; and

    g. mapping, monitoring, and analyzing all recycled water use.

Chapter 2
Background

During the last few years, California has provided substantial funds to local agencies to enhance local groundwater management programs. One example is Proposition 13 (Water Bond 2000), which allocated $2 billion for groundwater feasibility studies and construction of groundwater recharge facilities. Additionally, the Local Groundwater Management Assistance Act of 2000 (AB 303) resulted in $15 million for groundwater studies and data collection in an effort to improve the quality of groundwater basins. AB 303 authorized grants to help local agencies develop better groundwater management strategies. AB 599 (2001) required the State Water Resources Control Board (State Water Board), in cooperation with other agencies, to develop a comprehensive monitoring program capable of assessing groundwater quality. These bills are significant with respect to groundwater because much of California's new development will rely on groundwater to satisfy its water needs.

Finally, the most relevant legislation passed in 2002 was Senate Bill (SB) 1938. SB 1938 was enacted to provide financial incentives to local agencies for improved groundwater management. The legislation modified the Water Code to require specific elements be included in a GMP for an agency to be eligible for such incentives, including possible award of AB 303 and Proposition 50 grant funds.

Zone 7 has a long history of groundwater basin management and a long history of cooperation with local and state agencies in the implementation of its basin management practices. This report is intended to compile the elements of the existing groundwater management programs and policies in a standardized format similar to other basin plans prepared in California. This Groundwater Management Plan (GMP) simply expands the goal stated in 1987 of "informing the public and relevant governmental agencies of the Zone's supply potential and management policies, and to solicit their input and cooperation" (1987 Statement On Groundwater Management).

2.1 History of Previous Area Investigations

In the early 1900's groundwater provided the majority of agricultural and domestic water demands of the Livermore Valley. Then, the Spring Valley Water Company collected hydrologic data on rainfall, streamflow, and groundwater levels. Spring Valley Water Company also pumped from wells in

Pleasanton and exported the water to provide a water supply for San Francisco. In 1930, San Francisco purchased Spring Valley Water Company. Early reports provide excellent descriptions of the sources and flow of groundwater. Early monitoring and development of the groundwater resources by Spring Valley helped early investigators understand the general structure of the groundwater basin. A key finding of these early studies was that the groundwater supply was not limitless but was actually less than about 20,000 acre-feet per year (af/yr). These early studies also concluded that the majority of supply was derived from stream recharge through the very gravelly streambeds that cross the valley floor. Based on the results of this study, San Francisco decided to look to the Tuolumne River and constructed the Hetch Hetchy system to provide a much larger supply for San Francisco. San Francisco purchased Spring Valley Water Company in 1930 and continues to pump small amounts of water from wells in Pleasanton to provide water for the Castlewood area west of Pleasanton.

In the mid-1940s, significant overdraft in the Livermore Valley resulted in a call from local farmers to the state. DWR's predecessor (Department of Public Works, Division of Water Resources) undertook studies of this area in addition to other similar basin conditions statewide. Report No. 3 was published in 1952 entitled, *Groundwater Basins in California*. Report No. 3 identified 223 alluvium-filled valleys that were believed to be basins with usable groundwater in storage. This report was a major stepping-stone for groundwater investigations in California.[1]

In the 1950s groundwater and small stream diversions were the only source of water supply to the Livermore Valley. The area experienced severe floods in the winter of 1951 and 1955 with excessive water, only to be followed by dry summers with falling groundwater levels. To address these issues of water supply and flood control, the voters of the Livermore Valley formed Zone 7 with powers to manage surface and groundwater resources.

Several cooperative DWR and Zone 7 studies in the 1960s and 1970s established the scientific foundations for the Zone 7 Groundwater Management Plan. In 1963 DWR published Bulletin No. 13, which compiled the results of the Alameda County investigations. In 1966 DWR published the geology appendix to 118-2, and in 1974 DWR published Bulletin No. 118-2, "An Evaluation of Ground Water Resources: Livermore and Sunol Valleys" in cooperation with Zone 7. In the following years, Zone 7 built upon the framework of Bulletin No. 118-2 and the DWR groundwater model. The current hydrologic inventory 1974–2004 is merely an extension of the lessons learned from this early work. The report concluded, "The results of operations-economics studies recommended will be of significant use to local government in making decisions on conservation, development and use of the county's water resources."

In 1975, DWR published its first version of Bulletin 118, *California's Ground Water*, a document that provided state-wide observations and findings. The original Bulletin 118 summarized available information from DWR, the U.S. Geological Survey (USGS), and other agencies dealing with individual

[1] California Department of Water Resources 2003.

groundwater basins. In contrast to basin-specific studies such as DWR Bulletin 118-2, the purpose of Bulletin 118 was to help decision-makers regarding the protection, use, and management of the state's groundwater resources. Subsequent joint investigations with USGS expanded on the monitoring programs. Zone 7 developed an interim groundwater basin management plan in the late 1970s.

Despite California's heavy reliance on groundwater, there was much basic information missing for many groundwater basins. In particular, data necessary to provide for both the protection and optimal beneficial use were not available for many areas. The California Legislature mandated in the Budget Act of 1999 that DWR update Bulletin 118. In response, DWR prepared Bulletin 118 Update 2003, which included important missing regulatory information, updates and data omitted from the original Bulletin 118.[2]

In the Livermore Valley, Zone 7 has built on the work of DWR and has continued to measure and compile important records and knowledge essential to good groundwater basin management. Prior to the 1960s, groundwater had been the only supply of water to meet urban and agricultural demands in the Livermore Valley. ACFCWC District Zone 7 (Zone 7 Water Agency) was created in 1957 by public vote. The intent of the formation was to resolve the water supply and flooding needs of the valley and in part to manage the groundwater basin and reverse the then-existing overdraft condition of the groundwater basin. In 1962 the first SWP water was imported into the watershed, and Zone 7 began providing wholesale treated water and water for groundwater basin recharge via stream recharge and off-site percolation ponds.

Currently, groundwater provides about one third of the urban and agricultural demands of the valley. Zone 7 Water Agency manages the groundwater basin and, through an active conjunctive use program, manages both the supply and demand of water from the basin and the long-term water quality of the basin. Several retail water supply agencies continue to pump water from the basin to supply about 12% of the urban demands, and Zone 7 provides the remaining wholesale supply to meet the full urban and agricultural demands of the valley. Zone 7's supply comes from local runoff captured by the Del Valle dam and imported surface water. The Zone 7 supplies are either used directly or artificially recharged into the groundwater basin for storage and subsequently pumped via Zone 7's production wells.

In the late 1980's Zone 7 developed a Statement on Groundwater Management that was approved by the Zone 7 Board on August 19 1987. See Appendix E.

In the 1990's Zone 7 started a decade-long investigation of basin water quality with the goal of halting the slow degradation of groundwater quality evidenced by rising hardness and TDS levels in the main basin. This resulted in the development of an SMP. The related implementation plan was adopted by the Zone 7 Board in August 1999, expanded in the full SMP in early 2004 and approved by the RWQCB in September 2004. The Groundwater Basin is

[2] California Department of Water Resources 2003.

managed as part of a basin-wide integrated water management process. The goals are implemented primarily through the Zone 7 Water Operations Plan through an adaptive management process that integrates groundwater basin management with the conjunctive use of surface water and other available water resources.

2.2 Zone 7 Water Supply and Management

Zone 7 provides water resources management services to about 190,000 residents of the Livermore Valley. Zone 7 serves a large population as a water wholesaler of potable water to its retail contractors for municipal and industrial (M&I) use. In addition, Zone 7 supplies untreated water for agriculture, golf courses, and other nonpotable uses. The four major retail water supply agencies to which Zone 7 supplies treated water are the City of Pleasanton, the DSRSD, the City of Livermore, and California Water Service Company. Zone 7's water supply comes from three sources: (1) imported surface water from the SWP, (2) local runoff into Lake Del Valle, and (3) surface water stored in the groundwater basin.[3] Several retailers also pump water from the groundwater basin and have been doing so for at least four decades. Zone 7 provides groundwater basin management services to ensure that the historical pumping can continue as a reliable supply for the retailers.

Currently, Zone 7 has a contract with DWR for water deliveries through the SWP facilities. The SWP facilities include imported water from Lake Oroville via the Sacramento River, Sacramento–San Joaquin River Delta (Delta), and the SBA. In 2004, Zone 7 had an annual maximum allocation of 80,619 af/yr. Zone 7 has also contracted with Byron-Bethany Irrigation District and DWR for an additional 2,000–5,000 af/yr through SWP facilities. In addition, Zone 7 has also purchased water storage rights (65 thousand acre-feet [taf]) in the Semitropic Water Storage District groundwater basin located in south-central California, near Bakersfield, which will allow up to 3,250 afa minimum pumpback. Zone 7 is also negotiating for future purchased water storage rights for drought year protection with Cawelo Water District (up to 10,000 afa minimum pumpback).

Zone 7 shares the water rights of local runoff from Lake Del Valle with Alameda County Water District. The average local runoff into Lake Del Valle is about 22,000 af/yr. The average take of Lake Del Valle runoff by Zone 7 is approximately 8,000 af/yr, and is expected to rise to 9,300 af/yr with projected increases in local demand.[4]

The Zone 7 local groundwater basin has a storage capacity of over 240,000 acre-feet, with an annual average natural recharge into the basin of about 13,000 acre-feet. One method of artificial recharge used by Zone 7 is to release water into various streambeds (with extremely high percolation rates) managed by Zone 7.

[3] Salt Management Plan 2004a.
[4] Salt Management Plan 2004a; water can be captured as storage only to the extent that storage is available. Additional water can be captured if there is a place to use the water ("direct use"). The increase is based on a projected increase in demands through "direct use" rather than any change in storage capacity.

The amount of release is carefully monitored and various flows along the streams are measured to quantify the condition of the streambeds and the amount of water being introduced into the groundwater basin. A future recharge project will add the Chain of Lakes system, which are old mining pits where surface water can be stored and recharged. For more information about natural and artificial recharge into the groundwater basin, refer to Section 3.3, Groundwater Recharge.

2.3 Overview of Zone 7's Basin Management

Zone 7 manages the groundwater basin as part of a basin wide–watershed wide integrated water management process. The short-term goals are conveyed to the participants primarily through the Zone 7 Water Operations Plan and through an adaptive management process that integrates groundwater basin management with the conjunctive use of surface water and other available water resources. However, there are six key documents that provide the framework for Zone 7's groundwater management policies and programs, in general, and specifically for the preparation of such operational planning documents. These four documents are included in Appendix E and are incorporated by reference:

1. *Statement on Zone 7 Groundwater Management*, August 19, 1987 (1987 GWMP);
2. Resolution No. 1037, Adoption of *Wastewater Management Plan for the Unsewered, Unincorporated Area of Alameda Creek Watershed Above Niles*, May 19, 1982;
3. Resolution No. 1165, *Prohibition on Use of Septic Tanks in New Commercial and Industrial Developments*, August 28, 1985;
4. Resolution No. 03-2494, *Water Quality Policy for Potable and Non-Potable Water*, April 16, 2003 (Water Quality Policy);
5. Resolution No. 04-2662, *Reliability Policy for Municipal & Industrial Water Supplies*, August 18, 2004 (Supply Reliability Policy); and
6. *Salt Management Plan*, May 2004—note that the SMP Executive Summary is included in the appendix for reference; this document is fairly lengthy and a complete copy of the SMP can be reviewed upon request at the Zone 7 office.

The various programs that make up the overall basin management program of Zone 7 are divided into four focus categories: water supply objectives, water quality objectives, operational goals and groundwater protection objectives.

Water Supply Objectives:

- To maintain the balance between the combination of natural and artificial recharge and withdrawal (1987 GWMP).

- To maintain water levels high enough to provide emergency reserves adequate for the worst credible drought (1987 GWMP).
- Meet 100% of Zone 7's treated water customers' water supply needs, including existing and projected demands for the next 20 years, as set forth in Zone 7's 2005 Urban Water Management Plan (Supply Reliability Policy).
- Provide sufficient treated water production capacity and infrastructure to meet at least 75% of the maximum daily contractual demands with any one major supply, production or transmission facility experience an extended unplanned outage (Supply Reliability Policy).

Water Quality Objectives:

- Zone 7 shall continue to meet all state and federal primary standards for potable water deliveries (Water Quality Policy).
- Zone 7 shall meet all state and federal secondary (aesthetic) standards and, within technical and fiscal constraints, proactively reduce hardness levels to "moderately hard (75 to 150 milligrams per liter [mg/l]).
- Protect, enhance and improve the quality of the groundwater, including mineral quality (1987 GWMP; Water Quality Policy).
- Offset current and future salt loading (2004 SMP).

Operational Goals:

- Pump groundwater for municipal use in a way that, to the extent feasible, provides comparable delivered potable water quality to all retailers in the Zone 7 service area (2004 SMP).
- Utilize the Water Operations Plan to achieve water supply goals (2004 SMP).
- Inform the public and relevant governmental agencies of the Zone's supply potential and management policies, and to solicit their input and cooperation (1987 GWMP)
- Minimize water and operational costs through an adaptive management plan (2004 SMP).

Groundwater Protection Objectives:

- Require adequate well seals between surface level and well completion zone through imposition of appropriate well permitting conditions.
- Require destruction of abandoned wells to eliminate potential to act as a conduit for contaminant migration.

- Prevent build-up of nitrates through implementation of Wastewater Management Plan for the Unsewered, Unincorporated Area of Alameda Creek Watershed Above Niles.
- Identify high risk contamination cases and coordinate with lead oversight agency to require timely assessments and cleanups.

Note that *1987 GWMP* refers to the Board-approved 1987 Statement on Zone 7 Groundwater Management and *2004 SMP* refers to the Board-approved and RWQCB-accepted SMP.

Chapter 3
Water Resources

3.1 Description of Zone 7 Groundwater Basin

3.1.1 Overview

The Livermore Valley, an east-west trending, inland structural basin located in northeastern Alameda County, is surrounded primarily by north-south trending faults and hills of the Diablo Range. The valley covers about 42,000 acres, extends approximately 14 miles in an east-west direction and varies from 3 to 6 miles in width. It is separated from San Francisco Bay by several northwesterly trending ridges of the California Coast Ranges, including the Pleasanton Ridge. The valley floor slopes gently west and southwest from an elevation of approximately 700 feet above sea level in the east to approximately 320 feet above sea level in the southwest.

The Livermore Valley Watershed covers more than 400 square miles (250,000 acres) and extends north almost to Mt Diablo and south almost to Mt Hamilton. Six principal streams flow into and/or through the valley, and join in the southeast where the Arroyo de Laguna flows out of the valley. The other five arroyos, namely the Arroyo Valle, Arroyo Mocho, Arroyo Las Positas, Tassajara Creek, and Alamo Creek, are essentially tributaries to the Arroyo de Laguna. Average precipitation rates range from 16 inches per year at the valley floor to over 20 inches per year in the southeast and northwest portions of the valley.

The Livermore-Amador Valley Groundwater Basin is located in the heart of the Livermore Valley and watershed and extends south into the hills south of Pleasanton and Livermore. It includes 65,000 acres occupied by both the Livermore Valley (42,000 acres) and the Livermore uplands (23,000 acres). The Basin is designated DWR 2-10 in Bulletin 118 and includes the areas occupied by both Livermore Valley and Livermore uplands (see Figure 3-1).

The Main Basin is bounded on the:

- west by northwesterly trending ridges of the California Coast Ranges (including Pleasanton Ridge) and the Calaveras fault,
- north by the Tassajara Uplands and the steeply dipping east west trending Tassajara Formation,

- east by the Greenville Fault and by the marine formations exposed in the Altamont Hills, and
- south by the Verona Fault and Livermore Uplands and the steeper Livermore Highlands.

The Main Basin (described in more detail in the following subsections) is a portion of the Livermore-Amador Groundwater Basin (DWR 2-10). The Main Basin covers 17,000 acres and contains the highest yielding aquifers and best quality water within the DWR Basin 2-10.

3.1.2 Hydrogeology

Structural uplift of the entire Coast Ranges occurred during the late middle Pliocene and Pleistocene, causing extensive folding and faulting of the region. The Livermore Valley, a structural valley, formed by a faulted asymmetric syncline, was created as a result of downwarping of the Miocene-Pliocene sandstones and conglomerates between the western bordering Calaveras Fault and the eastern bordering Greenville Fault. Continued deposition, uplift, and faulting have led to the current Livermore Valley stratigraphy.[1]

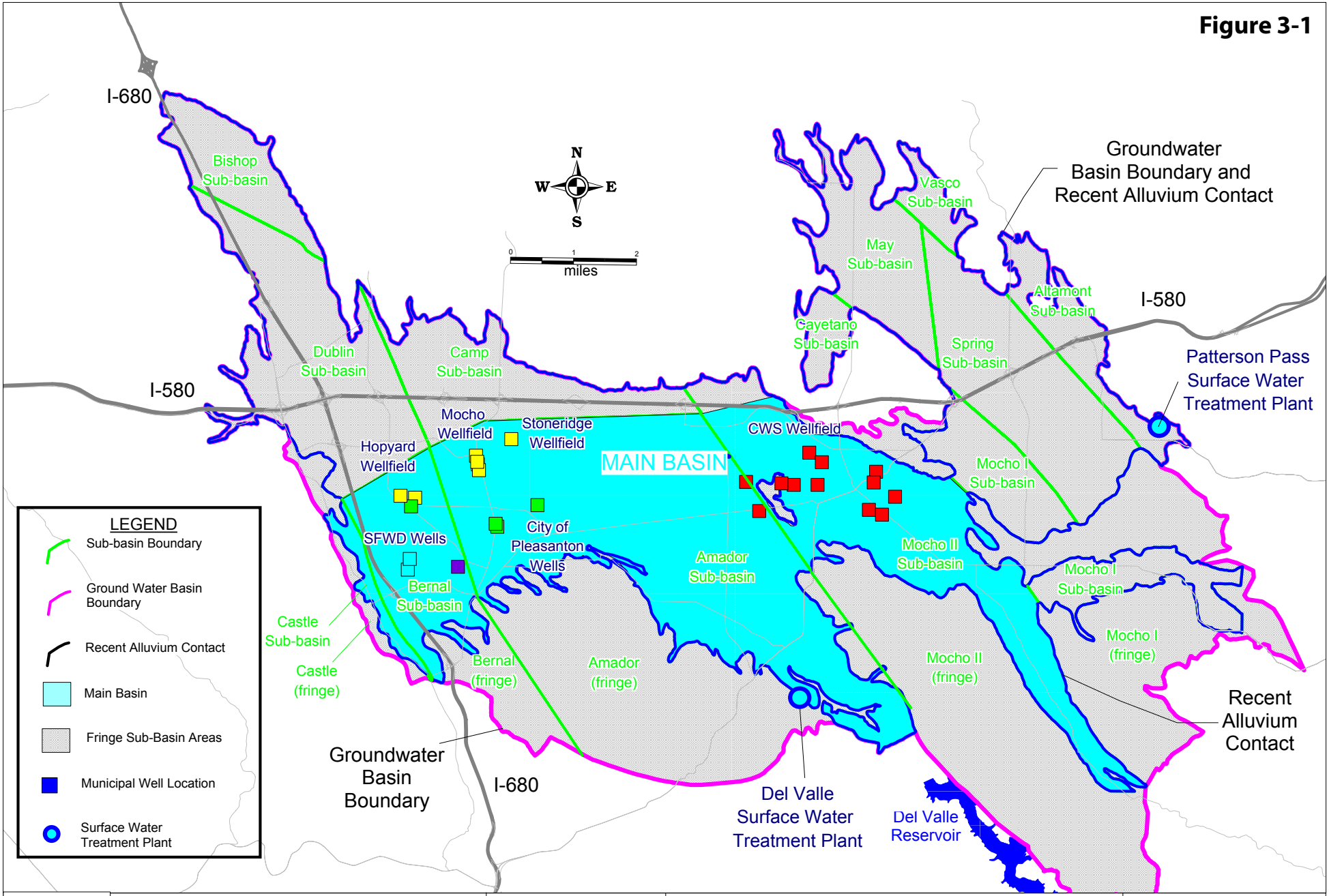
The valley is partially filled with Pleistocene-Holocene age (recent alluvium) alluvial fan, stream and lake deposits, which range in thickness from a few feet along the margins to nearly 400 (and possibly 800) feet in the west-central portion. The alluvium consists of unconsolidated gravel, sand, silt, and clay. The southern region of the Livermore Valley, the most important groundwater recharge area, consists mainly of sand and gravel that was deposited by the ancestral and present Arroyo Valle and Arroyo Mocho.

The eastern and northern regions of the valley contain thinner deposits and consist of alternating layers of gravel, sand, silt, and clay that are laterally discontinuous and resulted from the deposition of smaller streams. The western region of the valley has extensive gravel layers alternating with thick clay beds totaling approximately 400 feet in thickness. The alternation of sand/gravel layers and silt/clay layers form the basic aquifers for the area.[2]

In general, multiple aquifers are recognized in the alluvium of the Livermore Valley. The alluvium increases in thickness from east to west across the basin and thins both north and south at its boundaries. The alluvium also thickens from north to south to the central portion of the groundwater basin and then thins from the center toward the south. Although the upper portions of the alluvium appear to be very thick and continuous in the middle of the basin, the deeper aquifers are often discontinuous and/or poorly interconnected.

The Livermore Formation consists of beds of clayey gravels and sands, silt, and clay that are unconsolidated to semi-consolidated and estimated to be 4,000 feet

[1] California Department of Water Resources 1964b, 1974; Crane 1988; Hall 1958.
[2] California Department of Water Resources 1966, 1974, and Zone 7.



ZONE 7 WATER AGENCY
100 NORTH CANYONS PKWY, LIVERMORE, CA 94551

DRAWN	GERALD GATES TOM ROOZE
DESIGNED	GERALD GATES STEWART SMITH
CHECKED	DAVID LUNN
APPROVED	DAVID LUNN

GROUNDWATER BASIN MAP

Groundwater Annual Monitoring Report

SCALE	1" = 2 Miles
DATE	October 31, 2003
FILE NO.	E:\monitor\GM\2004wy\Annual\Figures

thick in the southern and western portion of the basin.[3] These sediments display lower yields in the upland areas. Groundwater from this formation is sodium bicarbonate in nature and of moderately good quality. Minor amounts of groundwater are believed to move along the strike of the beds to the northwest and enter the Main Basin (see detailed description below) at the southern portions of the Bernal and Amador sub-basins.

The Tassajara and Green Valley Formations, located in uplands north of the valley, are roughly Pliocene in age and were deposited under both brackish and freshwater conditions. They basically consist of sandstone, tuffaceous sandstone/siltstone, conglomerate, shale, and limestone. Water movement from these formations to the Main Basin is precluded by either structural alteration where beds dip away from the general groundwater flow of the valley or by non-water bearing stringers (tuff and clay particles). The near-vertical structural dip of the Tassajara and Green Valley formations is believed to prevent the commingling of waters among these formations and the alluvium, essentially cutting this water off from the groundwater basin.[4] Groundwater from these formations is sodium bicarbonate in nature and of moderately good quality.

3.1.3 Aquifer Zones

Within the groundwater basin, there is often a difference in water level fluctuations and water quality with depth. This difference is attributable to the existence of multiple aquifers that are poorly interconnected. Although multiple aquifers have been identified, wells have been classified generally as being in one of two aquifer zones, primarily to simplify the description of this complex basin:

- **Upper Aquifer Zone**—The upper aquifer zone consists of alluvial materials, including primarily sandy gravel and sandy clayey gravels. These gravels are usually encountered underneath the surficial clays (typically 20 to 40 feet below ground surface [bgs]) to about 80–150 feet bgs. This aquifer extends throughout the majority of the groundwater basin. Groundwater in this zone is generally unconfined. In the center portion of the groundwater basin, the upper aquifer is underlain by a relatively continuous, silty clay aquiclude up to 50 feet thick which is underlain by the Lower Aquifer Zone. In the eastern portion of the groundwater basin, the Livermore Formation underlies the upper aquifer. In the Zone 7 groundwater model, the Upper Aquifer Zone is referred to as Layer 1.
- **Lower Aquifer Zone**—Because of a lack of detailed hydrostratigraphic evaluation, all materials encountered below the clay aquiclude/aquitard in the center portion of the basin have been known collectively as the Lower Aquifer Zone. The aquifer materials consist of semi-confined to confined, leaky, coarse-grained, water-bearing units interbedded with relatively impermeable, fine-grained units. Based on localized hydrostratigraphic evaluation in the vicinity of Zone 7 well fields and as additional geologic

[3] California Department of Water Resources 1964b.
[4] California Department of Water Resources 1966, 1974; Zone 7 files.

information and hydrologic data become available, it is possible that this zone can be further subdivided into more laterally extensive, distinct hydrostratigraphic units. Currently the Zone 7 groundwater model groups the entire lower aquifer zone into Layer 3, with the aquiclude/aquitard zone as Layer 2.

3.1.4 Main Basin

The groundwater basin has been divided into two major parts based on importance. For the past 20 years the term *Main Basin* has been used for that portion of the groundwater basin covering the 17,000 acres that contain the highest-yielding aquifers and best quality water within the Livermore-Amador Valley Groundwater Basin. The less important area is called the fringe basin. The Main Basin is located in the central and southwestern portion of the groundwater basin. This area has a much larger capacity than the surrounding areas to store and convey groundwater, particularly in the lower zone. Since the early 1900s, this area has been very significant for the local groundwater supply. Between about 1980 and 1988, this area was called the central basin. Since 1988, the central basin, except for the eastern portion of Livermore, has been referred to as the Main Basin (see Figure 3-1).

Several subsurface barriers to lateral groundwater movement form the boundaries of the Main Basin. Observations and investigations by Zone 7 and others continue to confirm the existence of these groundwater barriers. Faults are the major structural features known to have marked effects on the movement of groundwater in this region. Faults in this region tend to act as barriers to the lateral movement of groundwater.

The Main Basin is comprised of the Castle, Bernal, Amador and Mocho II Sub-Basins and is bounded on the:

- north by the Parks Boundary (which was initially considered to be fault-related, but may actually be a depositional boundary between recent alluvium and older material);
- east by shallow bedrock separating Mocho I from Mocho II sub-basins;
- south by shallow bedrock and the Livermore Uplands; and
- west by the Coastal Ranges and the Calaveras Fault.

Particular Sub-Basin boundaries and features are shown on Figure 3-1 and described in more detail, below.

The portion of the groundwater basin that is outside the Main Basin is called the fringe basin. The majority of the connectivity between the fringe and Main Basins is through the Upper Aquifer Zone. Subsurface inflow from the Lower Aquifer Zone is considered negligible.

3.1.5 Main Basin Sub-Basins

3.1.5.1 Castle Sub-Basin

The Castle sub-basin 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 sub-basin is not used for municipal groundwater production. Only small production wells are located in this area. Water occurs in both shallow valley fill sediments and the Livermore Formation. The water from the Livermore Formation is of a sodium bicarbonate nature. This sub-basin functions as a westward extension of the Bernal sub-basin.

3.1.5.2 Bernal Sub-Basin

The Bernal sub-basin 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 Pleasanton Fault, to the north by the Parks Boundary, and to the south in part by contact with non-water-bearing formations and partly by contact with the Verona Fault. Both unconfined and confined aquifers exist in the water-bearing sediments. Waters from the northern and central portions of this sub-basin are of fair to excellent quality. However, much of the upper aquifer water has high TDS exceeding 600 mg/l. The water from the northern and southern portions of the sub-basin are of sodium bicarbonate nature, while the central portion is of the magnesium bicarbonate type and the western and south-central portions are of calcium bicarbonate character.

The area overlying the Bernal sub-basin is the point of convergence for all major streams that drain the Livermore Valley. The area overlying the sub-basin is subsequently drained by the Arroyo de la Laguna. Like surface water, groundwater also historically converges in this sub-basin, which allows for the mixing of the dominant cations of sodium, magnesium, and calcium.

The Quaternary alluvium is estimated to have a thickness of at least 800 feet in this sub-basin and overlies the Livermore Formation. Well production (primarily by Zone 7) in this sub-basin currently ranges up to 3,500 gallons per minute (gpm), and specific capacities range from 3 to 260 gpm per foot of drawdown. Other basin pumpers include the City of Pleasanton (although much of City of Pleasanton's pumping has shifted to the West Amador sub-basin, discussed below), San Francisco PUC (supplying the Castlewood area) and the Alameda County Fairgrounds. Historically, this Sub-Basin was overdrafted but has since been partially refilled and is used less for regional supply due to Zone 7's groundwater management efforts, including the importation of surface water from the SWP.

3.1.5.3 Amador Sub-Basin

The Amador sub-basin is located in the west central portion of the groundwater basin and is bounded to the west by the Pleasanton Fault, to the east by the Livermore Fault, to the north by a permeability barrier of inter-fingering of alluvial deposits and partly by the Parks Boundary, and to the south by the drainage divide and partly by contact with non-water-bearing formations. This sub-basin is host to the majority of high production wells and has both unconfined and confined aquifers. Waters from this sub-basin are of good to excellent quality, characterized by sodium bicarbonate, magnesium bicarbonate, and calcium bicarbonate with few instances of elevated levels of boron and nitrate.

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

3.1.5.4 Mocho II Sub-Basin

The Mocho sub-basin has been divided into two distinct areas, Mocho I and Mocho II, by a line of very low hills thought to be exposures of the Livermore Formation. The basins are further distinguished by a change in aquifer characteristics from a sodium bicarbonate (Mocho I) to a magnesium bicarbonate water type (Mocho II).

Of the entire Mocho sub-basin, only a portion of the Mocho II sub-basin is in the Main Basin. This portion of the Mocho II sub-basin 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 Tassajara Formation that is not hydraulically connected to the sub-basin and the Parks Boundary, and to the south by the Livermore Uplands and contact with non-water-bearing marine formations.

Both unconfined and confined aquifers exist in the water-bearing sediments. Waters from this sub-basin are of fair to excellent quality sodium bicarbonate (Mocho I) and magnesium bicarbonate character (Mocho II), with some instances of elevated boron and sodium ions.

The recent alluvium ranges in thickness from approximately 10–50 feet in Mocho I and up to 150 feet in Mocho II. In both sub-basins the alluvium overlies the Livermore Formation, both conformably and unconformably. The silty/clayey overburden is mostly missing. The Upper Aquifer is exposed at the surface in much of the area. Mocho I and Mocho II appear to be hydraulically connected only in the shallow alluvial deposits. Well production in this sub-basin (primarily by CWS) ranges up to 950 gpm with specific capacities of 2 to 50 gpm per foot of drawdown.

3.2 Groundwater Levels and Storage

Historically, much of the Main Basin experienced artesian conditions. In the late 1800s, the pre-development groundwater levels in the basin created a gradient, causing groundwater to flow from east to west and naturally exit the basin as surface flow in 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 where groundwater would naturally rise into Arroyo de la Laguna and exit the basin via streamflow.[5] Water levels continued to drop in the Main Basin through the 1960s. The trend began to reverse in 1962 when Zone 7 Water Agency 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 utilized in 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.

Thus, after experiencing historical groundwater lows in the 1960s (see Figure 3-2), 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. Groundwater levels approached the "historic low" again during the 1977 and 1987–1992 droughts, although 1992 water levels in many monitoring wells were significantly below the previous historic lows of the 1960s.

Today groundwater in both aquifer zones generally follows a westerly flow pattern, like the surface water streams, along the structural central axis of the valley toward municipal pumping centers. The majority of subsurface inflow, however, occurs across the northern boundaries of the Main Basin—in particular the Dublin and western Camp sub-basins—and flows in a southerly direction.[6] These sources of groundwater commingle in the Bernal and Amador sub-basins and have a general flow toward municipal or gravel mining company groundwater pumping wells or pits.[7]

The relatively low hydraulic conductivity of the aquitard layers impedes the vertical movement of groundwater between the Upper and Lower Aquifer Zones. The exchange between the two aquifers, as indicated by the groundwater monitoring data, varies depending upon the thickness and permeability of the separating aquitard and the potential gradient. Even though the movement of water and salts from the upper aquifer to the lower aquifer is slow, it is still the major sources of recharge to the lower aquifer.[8]

The Main Basin has a storage capacity of more than 250,000 acre-feet. The Main Basin was full in early 1900 and full again in 1983. Groundwater has been withdrawn down to historical low storage in 1962 and 1966 with an estimated remaining storage of 128,000 acre-feet. (Groundwater levels approached the

[5] Zone 7 2004b.
[6] Zone 7 2004b.
[7] Zone 7 2004b.
[8] Zone 7 2004b.

"historic low" in some parts of the basin during the droughts of 1977 and 1987–1992.) In 1987, Zone 7 adopted a Groundwater Management Policy (see Appendix E) that included maintaining groundwater levels high enough to provide emergency reserves adequate for the worst credible drought. For planning purposes, Zone 7 maintains this reserve above historical lows. The remaining half of the groundwater (that portion above historical lows) is actively managed for supply reliability and is used for water supply storage, and recovery during times of drought or emergency.[9] In 2002, as part of the development of Zone 7's Well Master Plan, Zone 7 further defined "historic lows" as a piezometric surface used to manage groundwater levels.

3.3 Groundwater Recharge

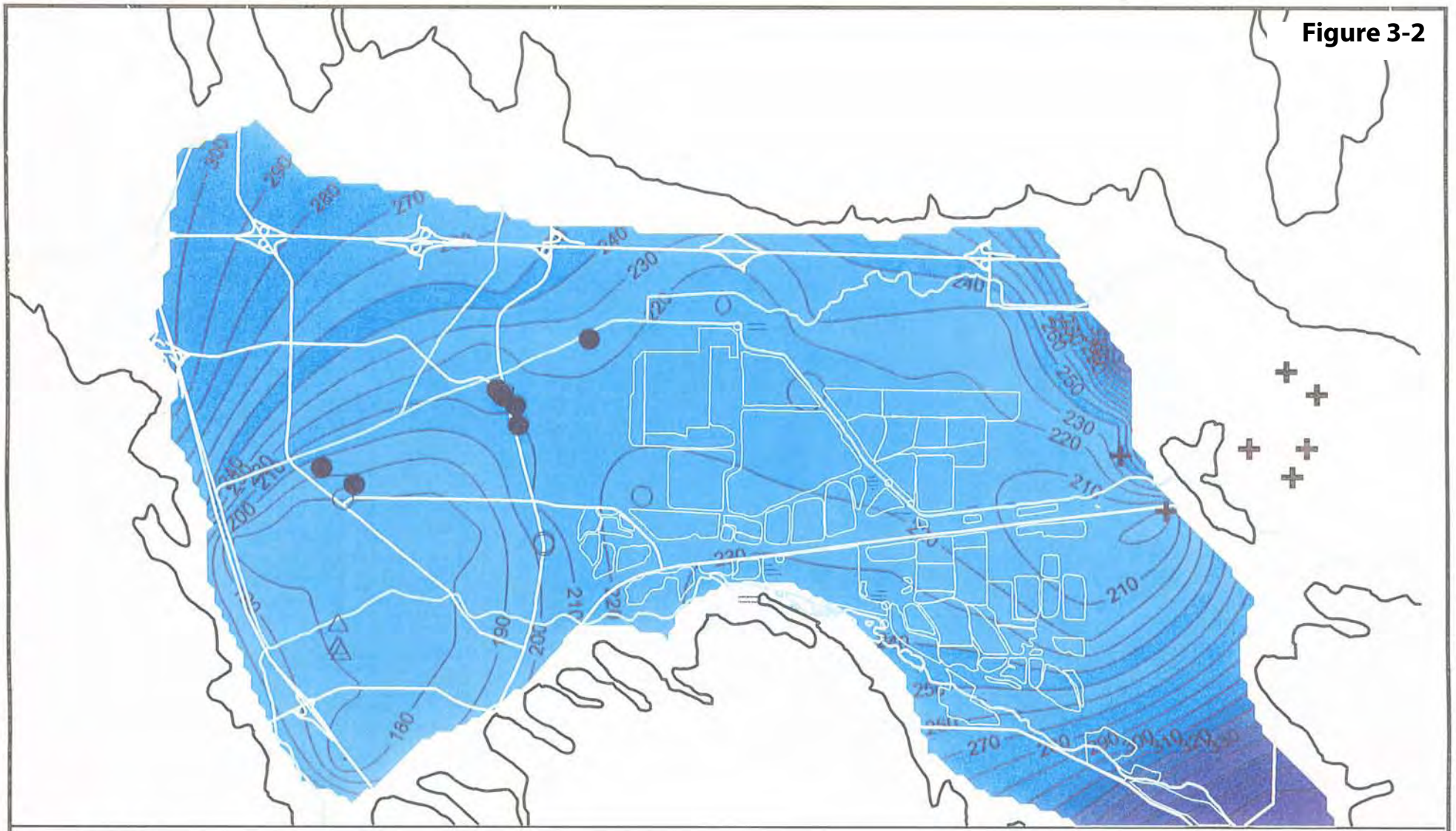
Management of groundwater recharge involves both quantity and quality aspects. The annual average natural recharge into the groundwater basin is approximately 13,400 af/y. Zone 7 artificially recharges the basin with additional surface water supplies by releasing water into the Arroyo Mocho and Arroyo Valle. The existing artificial recharge capacity ranges from 12,300 af/y to 20,000 af/y. In years when the streams are dry, there is more capacity. Adding artificial recharge essentially doubles the natural yield of the basin.[10] In addition, Zone 7 actively monitors the quality of water at many of the key stream recharge areas to ensure the protection of the quality of both surface and ground water.

Groundwater recharge from streams has the following components:

- natural recharge—rain runoff into streams,
- artificial recharge—releases from the SBA or Lake Del Valle into recharge streams, and
- gravel mining recharge—recharge from gravel mining pits or discharges into the streams.

Figure 3-3 shows the relative groundwater recharge capacity associated with each major stream in the watershed and the associated water quality (represented as concentration of TDS in mg/l). Note that the dashed lines represent areas of rising groundwater rather than areas of stream recharge. TDS in the local surface water varies significantly throughout the watershed from approximately 350 mg/l TDS to more than 1,000 mg/l. The highest quality surface water recharging the basin occurs through Arroyo Mocho and Arroyo Valle where the TDS is generally less than 500 mg/l. The poorest quality surface water recharging the basin has a TDS of approximately 1,000 mg/l and occurs in Arroyo Las Positas. On average, given 1997 land use conditions, approximately 2,700 af/y of natural recharge occurs via Arroyo Mocho, 1,200 af/y via Arroyo Las Positas, and 2,700 af/y via Arroyo Valle.

[9] Zone 7 2004b.
[10] Salt Management Plan 2004a.



LEGEND

- Zone 7 wells
- City of Pleasanton wells
- City of San Francisco wells
- Cal-Water wells

N

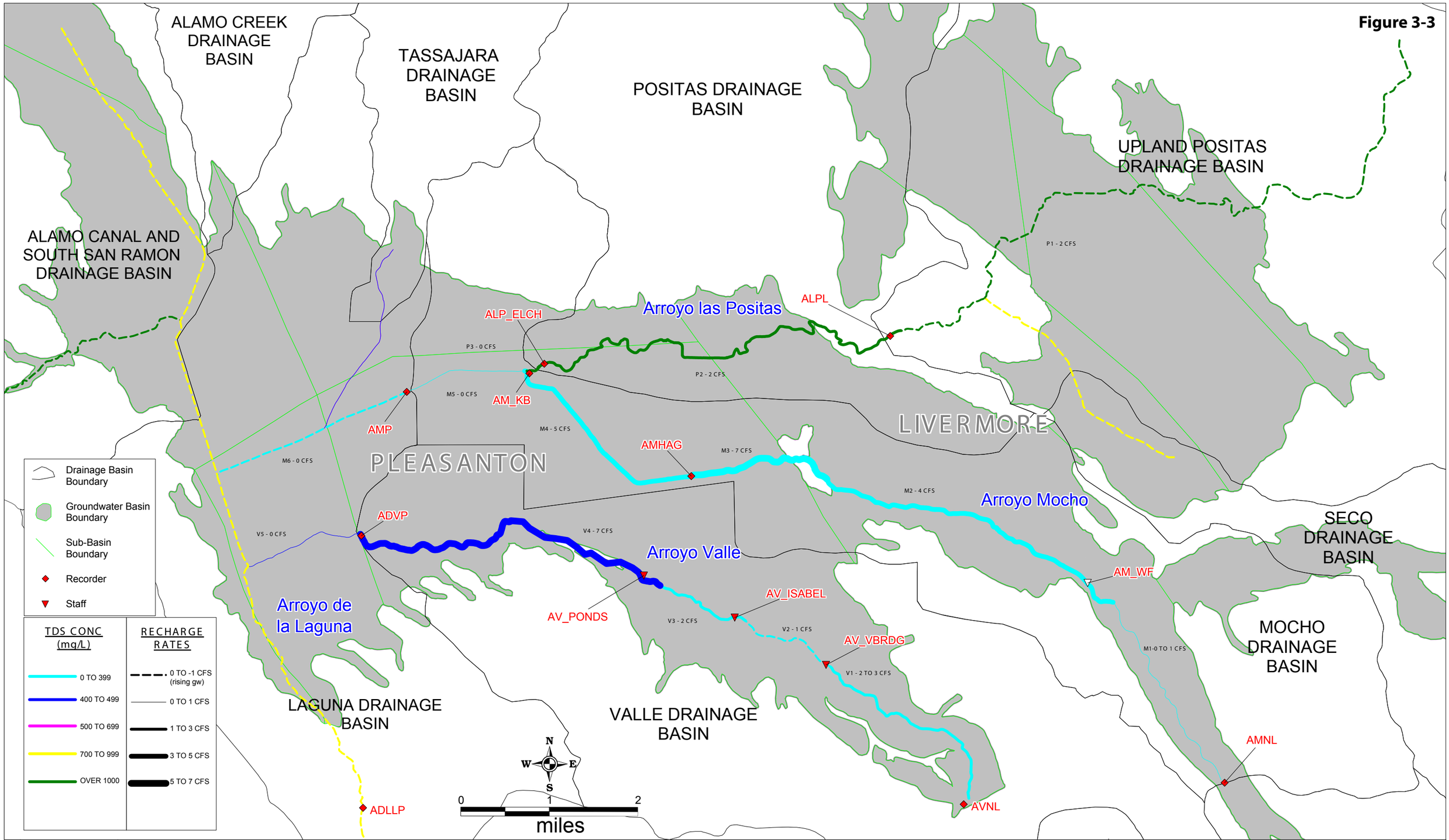
0 feet 5280 feet 10560 feet 15840 feet

HISTORIC LOW WATER LEVELS IN THE DEEP AQUIFER

ZONE 7 WATER AGENCY
WELL WATER PLAN

CH2MHILL

163304.WM.06_W102003001SFO_Z7 FIGURE ES-2-2_10/10/03_ccc



ZONE 7 WATER AGENCY

100 NORTH CANYONS PKWY, LIVERMORE, CA 94551

DRAWN BY: GG/TR	SCALE: 1" = 1 MILE	WATER RESOURCES ENGINEERING
DESIGNED BY: GERALD GATES	Apr 7, 2005	STREAM RECHARGE RATES AND TDS
CHECKED BY: DAVID LUNN	REVISED BY: TR	
FILE: E:\MONITOR\SW\2004wy\annual\FigsTbls\Fig2-StreamRecharge.wor		

The Proposed Chain of Lakes Recharge Project will provide benefits by creating additional surface water storage and recharge capacity. This is a long-term project that involves Zone 7 acquisition of quarry pits dug by local mining companies. These former mining pits, as they get turned over to Zone 7, are incorporated into the regional water management programs. During wet weather, potentially low-cost, low-TDS surface water and/or runoff could be purchased/captured and stored/ recharged for future treated or untreated supply. Demineralized recycled water could potentially be stored in the Chain of Lakes area. The first two former mining pits, Lake-H and Lake-I, became available in May 2003. Plans for a diversion structure (to divert water from the stream into the Chain of Lakes) are still needed and are not anticipated to be completed until 2008. The complete Chain of Lakes (all nine lakes) will not be available until about 2030.

3.4 Water Use

Zone 7 monitors water usage to ensure that sufficient supply and adequate quality is delivered to all its water retailers. Stored water pumped from the groundwater basin (resulting from the artificial recharge program discussed above) is a critical component of Zone 7's water supply. On average, 25% of the potable water produced by Zone 7 is this groundwater supply. However, including pumping by other entities, on the average, over 35% of Valley-Wide potable water is from the groundwater basin. A conceptual diagram of the Livermore-Amador Valley water supply and use is included in Figure 3-4. This figure demonstrates how Zone 7's water sources are integrated with other pumping to meet regional water demands.

In addition to Zone 7's groundwater pumping (about 12,000 af/y), groundwater extractions from the basin include:

- Evaporative losses of mining water from the gravel pits (~3,000 af/average year);
- municipal pumpage (~7,200 af/y) by several retailers;
- private pumpage (Fairgrounds, San Francisco Public Utilities Commission [SFPUC], industrial supply, domestic supply, others, ~1,200 af/y); and
- agricultural pumpage for irrigation (~500 af/y);

3.5 Groundwater Quality

In general, groundwater quality throughout most of the Main Basin is suitable for most types of urban and agriculture uses with some minor localized water quality degradation. The primary constituents of concern are high TDS (or hardness), nitrate, boron, and organic compounds.[11] In the western Main Basin,

[11] California Department of Water Resources 2003.

groundwater is a calcium-magnesium-bicarbonate water type and has historically been considered "hard." The rising salinity is associated with several factors (see Section 4.6.5, Salt Balance) but is primarily associated with the saline fringe basin shallow groundwater flowing into the basin or flowing into recharging streams. Imported water brings additional salts into the basin some of which are left in the soil as evapotranspiration occurs (subsequent leaching with rain or further application of irrigation water transports salts to the groundwater table). Increased salinity attributable to irrigation in a semi-arid region is another major issue (see Salt Balance Section).

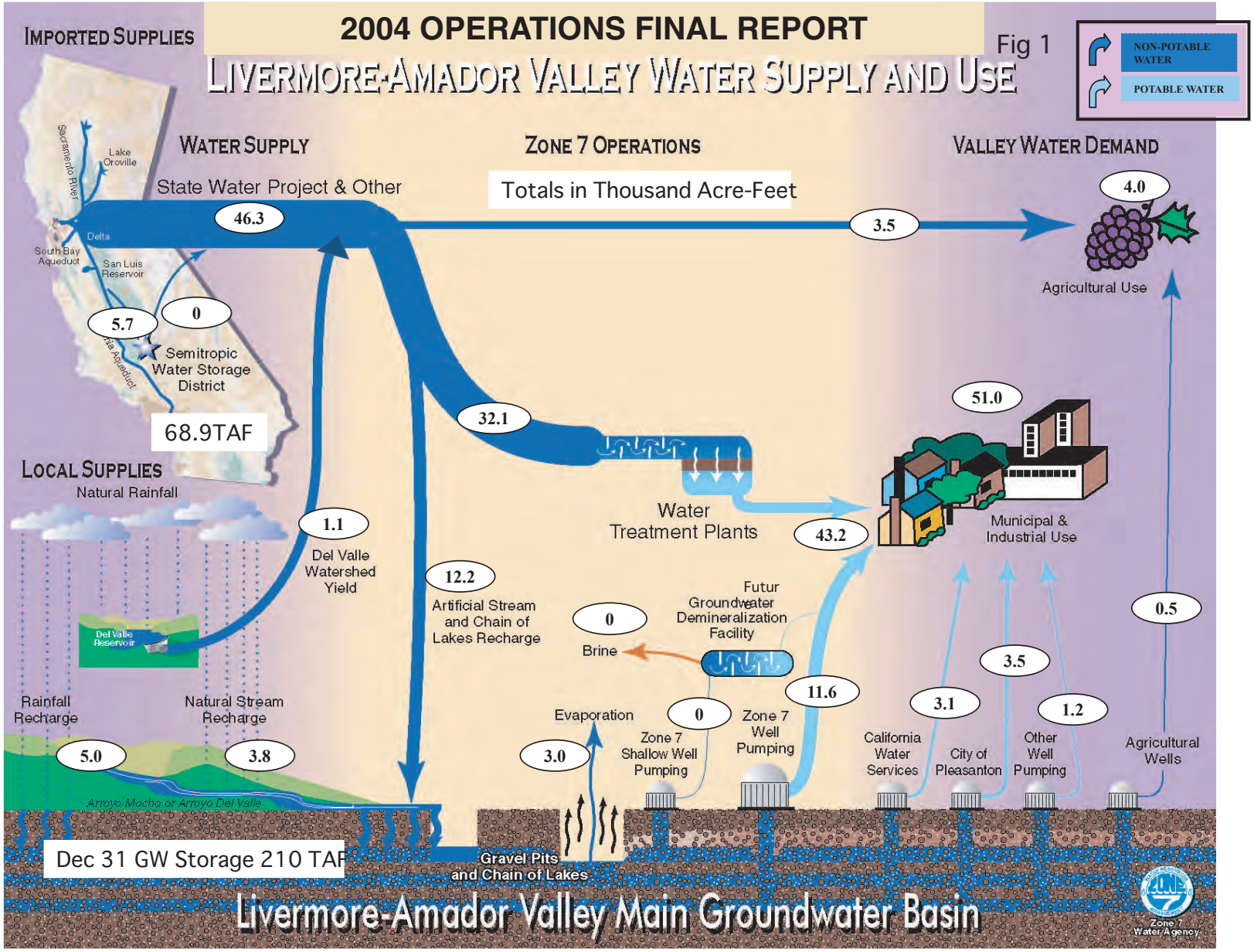
Trace amounts of boron are present in the eastern fringe basins (associated with marine formations) and with shallow groundwater in the northern fringe basins. High boron levels and lower yields can limit the use of some fringe basins for extensive agricultural irrigation.[12] Zone 7 monitors all the wells in its groundwater quality monitoring program for major minerals and select metals, including boron. Water quality samples are analyzed by the Zone 7 Water Quality Laboratory located at the Del Valle Water Treatment Plant.

The northern extent of the Livermore-Amador Valley is dominated by a sodium-rich water, while much of the western part of the basin near Pleasanton has a magnesium-sodium characteristic (i.e., both magnesium and sodium are dominant cations). The area along the eastern portion of the basin, beneath the Livermore area, has magnesium as the predominant cation.[13] Local impairments include some areas with boron concentrations exceeding 2 mg/l.

Nitrates have also impaired portions of the Main Basin, especially in the east. Nitrate levels between 30 and 65 mg/l have been identified in the nitrate study area, which covers an area of 670 acres of unincorporated residential and agricultural land in the South Livermore area. Nitrates from in-Basin wastewater disposal (less common since 1980) contributed to this problem historically. This issue is discussed in more detail in Section 5.1.4.4, Wastewater Management.

Releases of fuel hydrocarbons from leaking underground storage tanks and spills of organic solvents at industrial sites have caused minor-to-significant groundwater impacts in specific parts of the region. Detailed discussion is presented in Section 5.1.4.5. Zone 7 participated in the development of the GAMA project, which analyzed water from municipal wells for volatile organic compounds (VOCs) at ultra-low levels not detectable by standard laboratory analysis. The results showed that very low levels of MTBE and other gasoline components were detected in a handful of wells. There are five fuel contamination sites within 2,000 feet of a municipal supply well that are being closely monitored. Proactive cooperation with regulatory agencies on prevention, early detection and site cleanup is helping to protect the basin from fuel contamination (additional information on the Toxic Site Program is presented in Section 5.1.4.5, Toxic Site Management).

[12] California Department of Water Resources 2003.
[13] California Department of Water Resources 2003.



04727.04 GMP Final 08/05

Jones & Stokes

Figure 3-4
Water Operations Plan

Chlorinated organic solvent releases to soil and groundwater are an issue in the region,[14] primarily in fringe basins and in upper aquifers. Again, detailed description is provided in Section 5.1.4.5. Cleanup programs at 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 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 project have made significant contributions to groundwater basin monitoring and to the groundwater protection effort. The GAMA project detected tetrachloroethene (PCE), a chlorinated solvent commonly used in dry cleaning, in nine of the 12 municipal wells tested in Livermore. Two of these wells have PCE levels detectable by standard laboratory procedures. The water from these two wells is currently either blended with clean water or treated at the well head to reduce the levels of PCE. One supply well at the Alameda County Fairgrounds in Pleasanton has been impacted by PCE. The water from this well is treated to remove the PCE prior to use.

Zone 7 samples approximately 250 wells under the groundwater quality monitoring program (described in Chapter 4) and reviews results from site cleanup projects made available through Geotracker and from cleanup reports routinely sent to Zone 7 for review (again, additional information on the Toxic Site Program is presented in Section 5.1.4.5, Toxic Site Management).

[14] California Department of Water Resources 2003.

Chapter 4

Management Plan Elements

4.1 Groundwater Management Goal

The management elements of this GMP include the primary goal of adequately addressing Zone 7's Groundwater Basin Management Objectives or BMOs (see Section 1.4): 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 serve as water storage for drought periods. This is accomplished through a set of Resource Management and Other Planning Efforts (described below) and a group of management plan components that identify the necessary actions for meeting goals and objectives. The purpose of this GMP is to compile and document the existing successful programs and policies for management of groundwater resources and to develop a framework for the implementation of future activities to ensure reliability and quality of regional groundwater.

4.2 Resource Management and Other Planning Efforts

Zone 7's primary groundwater BMOs 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 serve as water storage for drought periods. According to the 1987 "Statement on Zone 7 Groundwater Management" located in Appendix E, Zone 7's groundwater management goals include:

- to maintain the balance between the combination of natural and artificial recharge and withdrawal;
- to maintain water levels high enough to provide emergency reserves adequate for the worst credible drought;
- to protect and enhance the quality of the groundwater;
- to develop information, policies and procedures for effective long-term management of the groundwater basin; and

- to inform the public and relevant governmental agencies (including the TVG) and the four individual retailers, DSRSD, CWS, Livermore and Pleasanton) of the Zone's water supply potential and management policies, and to solicit their input and cooperation.

Examples of current groundwater basin management operations include:

- **Monitoring and maintenance of groundwater levels**—a long-term conjunctive use program at Zone 7. Underneath the Tri-Valley lies a groundwater basin that contains about 250,000 acre-feet of usable groundwater. An acre-foot is about 326,000 gallons, enough water to supply two households for a year. The groundwater basin provides the community with a "water savings account," which serves as a hedge against a prolonged dry period or a temporary inability to import surface water. In the event of a prolonged drought, this amount of water is enough to sustain the entire Tri-Valley for up to 6 years, depending on the amount of surface water available and the conservation efforts of water users.

  Zone 7 accesses the groundwater through wells at aboveground pumping facilities. Zone 7 pumps more groundwater during peak demand periods or in dry years when imported supplies are low. Local water retailers also access the groundwater basin for drinking water.

- **Artificial Recharge Program**—The groundwater basin is naturally refilled, or "recharged," by streamflow, underground flows, rainfall, and applied irrigation water seeping into the ground. Zone 7's groundwater management program ensures that water levels in the basin will remain at or above acceptable levels.

  In addition to natural recharge, Zone 7 manages an artificial recharge program. During spring, summer, and fall when the streams are typically dry, Zone 7 releases some of its purchased imported water into the Arroyo Valle and Arroyo Mocho. By allowing the water to flow through sections of these arroyos where the creek bottoms are very porous, the water quickly seeps into the ground, replenishing the groundwater basin. By artificially refilling or recharging the groundwater basin, and monitoring water levels throughout the valley, Zone 7 ensures that the water demands of the community are met.

  Specific objectives include managing the groundwater basin to:

  - maintain "emergency reserve" by keeping water levels above historical lows,
  - allow for gravel mining,
  - prevent overdraft from pumping (maintain total pumping at or below sustainable/safe yields), and
  - reserve storage for drought events.

- **Groundwater quality**—monitoring and management, as well as protection against any degradation:

  - mitigate degradation from salt buildup;

- minimize flow of poor quality shallow groundwater into deep aquifers;
- offset impacts of water recycling and wastewater disposal through integrated SMP;
- recharge with low TDS/hardness water;
- manage quality on a regional basis as measured at municipal wells, thus allowing localized degradation as long as the overall basin is protected
- minimize threats of groundwater pollution through groundwater protection;
- monitor and prevent inelastic land surface subsidence; and
- monitor changes in surface flow and surface quality, especially as they affect groundwater levels or quality or are caused by groundwater pumping in the basin.

4.3 Stakeholder Involvement

4.3.1 Involving the Public

A key purpose of this Groundwater Management Plan is to compile and document existing groundwater management plans and policies. One of the more recent contributions to this groundwater management toolbox is the development of the Salt Management Plan (SMP).

The SMP, incorporated herein by reference (a copy of the executive summary is included in Appendix D), was prepared in fulfillment of Master Water Recycling Permit Order No. 93-159 Provision D.1.c.ii and General Water Recycling Permit Order No. 96-011 Provision D.4. This document not only provides a comprehensive and effective approach for administering, regulating and encouraging water recycling in the Livermore-Amador Valley, it also provides guidance to the area's agencies on ways to address the historical trend of increasing TDS in the main groundwater basin. It was developed by Zone 7 staff and consultants in partnership with a TAG composed of local water retailers, and a Zone 7 citizens committee—the GMAC. The RWQCB approved the SMP in October 2004.

As with the formal process utilized in developing the SMP, Zone 7 actively involves the public in all its programs through a variety of meetings, and through media such as the Internet. This approach has been included as an explicit operational policy in Zone 7's 1987 Statement on Groundwater Management (again incorporated herein by reference; a copy is included in Appendix E). Zone 7 holds monthly Board meetings that are open to the public and conducts frequent meetings with its water retailers. The public can also access the Zone 7 website for general information or download reports on a variety of topics. In addition, the public can get involved with Zone 7 planning and management through the RWQCB Basin Planning process. The Zone 7 website can be accessed at <http://www.zone7water.com>.

Examples of the different types of public involvement in Zone 7's groundwater management programs include:

- retailer contracts (including pumping quotas);
- meetings with retail water agencies (DSRSD, CalWater, Pleasanton and Livermore);
- Memorandum of Understanding (MOU) for well ordinance administration within respective city limits;
- stakeholders meetings (e.g., Alameda Creek Watershed Management Program);
- data-sharing with retailers, public and other agencies (RWQCB, DHS, and County Environmental Health);
- reports at public board meetings (three formal presentations to Board and public in 2004 on groundwater basin management);
- website postings, including annual reports, quarterly groundwater reports and water awareness fact sheets;
- kiosk stations (watershed, groundwater basin and artificial stream recharge information along footpaths that border key recharging streams), county fair booths, Earth Day events, etc.;
- press releases, Water Ways newsletter;
- Groundwater Management Advisory Committee or GMAC—10-member citizens committee formed 1995–2002 primarily in relation to the demonstration RO/groundwater injection project; however also assisted in the major review and update of the 1987 GMP, as reflected in the newly created Salt Management Plan or SMP;
- Technical Advisory Committee or TAC (technical staff from the four retail water agencies) formed in 1995–2002 in conjunction with GMAC to assist in the development of the SMP which included major review and update of the 1987 GMP;
- elementary school (K-8) program, using consultants; and
- secondary school science program—cooperative program with Zone 7 staff, LLNL, retailers, Tri-Valley ROP; brings water science and water industry career information into the high schools.

4.4 Development of Relationships with State, Federal, and Local Agencies

Working relationships between Zone 7 and the state, federal, and local agencies are critical to developing and implementing the various groundwater management strategies and actions detailed in this GMP.

Zone 7 has, and will continue to develop, an excellent working relationship with DWR, RWQCB and any relevant federal agency for the necessary means of protecting the beneficial uses of the Livermore-Amador Valley groundwater basin. For example, Zone 7 in conjunction with DWR wrote *Evaluation of the Groundwater Resources: Livermore and Sunol Valleys* in 1974. In addition, Zone 7 plans to continue working with DHS on regulating drinking water and municipal wells; the RWQCB on NPDES and Basin Planning (such as the SMP); Alameda County Environmental Health on issues where groundwater has been affected; DFG and USFWS on recharge program operations; and the Corps on diversion and creek projects.

Over the years, Zone 7 has fostered excellent working relationships with local entities through contracts, policies and resolutions such as those included in Appendix E of this document. In particular, Zone 7 solicits input from the TVRG and its four member agencies, DSRSD, CWS, Pleasanton and Livermore. As with the SMP, any future changes to this Groundwater Management Plan and Zone 7's existing groundwater management policies and procedures would be the result of collaboration with the TVRG and its member agencies.

Zone 7 also maintains relationships with the local water retailers and Planning Agencies (such as the County and the City of Dublin) to ensure that adequate land use planning and protocols are up to date to ensure the beneficial use of the groundwater basin. Zone 7 reviews CEQA documents for all new developments and coordinates with cities and counties to ensure accurate planning.

In addition, Zone 7 is a member of the Tri-Valley Regional Geographic Information Systems User Group (TVRGIS User Group). The TVRGIS was formed to address the electronic sharing of spatial data (e.g., parcel base-maps, centerlines, public trails, drainages, ortho-photography, zoning and general plan land use) and to minimize the overlap in spatial data that each agency uses. The TVRGIS, which includes GIS coordinators from the Town of Danville, City of Dublin, City of Livermore, City of Pleasanton, and Zone 7, addresses the sharing of spatial data for local and regional planning, management, and public safety purposes.

4.5 Monitoring Programs and Protocols

Zone 7 currently monitors the conditions of the groundwater basin. This section of the GMP describes Zone 7's monitoring programs. Standard Operating Procedures (SOPs) can be seen in Appendix C. Table 4-1, below, summarizes details regarding these programs.

Table 4-1. Monitoring Programs and Protocols

Monitoring Type	Location	Measurement Type	Date Started	Frequency	Notes
Climatological Monitoring Program					
Precipitation	9 stations including 8 with storage gages and 5 with recorders	Storage Gage (8) Recorder (5)	Jan 1871	Daily Continuous	Reported in: Climatological Reports (monthly/annually) and Stream Reports (daily/monthly/annually)
Evaporation	Lake Del Valle	Pan Evaporation	October 1969	Daily	Reported in: Climatological Reports
Evapotranspiration	CIMIS Station (Fairgrounds, Pleasanton)	Automated active weather station	June 2004	Daily	Reported in: Climatological Reports
Surface Water Monitoring Program					
Streamflow	47 Stations including 10 recorder stations on three streams: Arroyo Valle Arroyo Mocho Arroyo De Las Positas	 Stream Gages Meters Recorders	1912	 Daily Daily Continuous	Reports: Annual Stream Recharge Report; Daily Stream Flow Reports; Quarterly Water Supply Report; Monthly Groundwater Supply and Utilization Report
Surface Water Quality	16 stations		1948	Annually	Monitoring performed by Zone 7 beginning in 1974; Stormwater Quality Management Plan and Program, as required by RWQCB Orders R2-2003-0021 and 93-159; reported in SW Annual Report
Recharge	Three streams: Arroyo Valle Arroyo Mocho Arroyo Las Positas	Metered and gaged records	1974	Monthly	DWR calculated various forms of stream, artificial and natural recharge in 1966; currently reported in Monthly Groundwater Supply and Utilization Report
Groundwater Monitoring Program					
Well Inventory	By Township/Range: 2S/1E, 2S/2E, 2S/1W, 3S/1E, 3S/2E, 3S/1W	Data Base and Hard Copies	1973 Historic from 1906	Ongoing	Zone 7 began collecting and maintaining well inventory information in about the mid-1970's; information was initially collected by DWR for regional studies published in 1953, 1955, 1963, 1966 and 1974. Zone 7 obtained all historic well records and since 1973 has obtained all well records through the drilling permit process.

Monitoring Type	Location	Measurement Type	Date Started	Frequency	Notes
Groundwater Levels	Currently 224 wells measured semi-annually; 80 wells measured monthly; 9 wells continuously monitored	Pressure transducers Steel and electrical tapes	1946 Historic from 1900	Recorder, monthly and semiannual	Data collection began with three wells in about the mid-1940's when multi-year drought resulted in groundwater level drops and DWR began taking an interest in the area; Zone 7 has managed the program for the last 30 years, adding other wells to its growing program; reported in Groundwater Level Report (monthly/semi-annual)
Groundwater Quality	Currently 218 wells sampled and analyzed for TDS, major minerals and metals.	Analytical	1946 Historic to 1908	Annually	Focus has been on salt (mineral) concentrations, as represented by TDS levels; subsequently, program expanded to included pollutants and other WQ parameters; reported in Annual Groundwater Report, semiannual Groundwater Quality Summary; Monthly Municipal Groundwater Quality Report
Land Surface Elevation Monitoring Program					
Land Surface Elevations	50 Benchmarks	Surveying	Historic 1912 Elastic seasonal 2002	Periodic and Semiannually	Land Surface Elevation Report
Groundwater Production Monitoring Program					
Pumpage	Major pumping wells (Zone 7, retailers, etc.)	Metered	1974	Monthly	Reported in Water Users Reports; Annual groundwater Supply and Use Forecast Report; Monthly Municipal Water Supply Reports
Other Programs					
Wastewater Export/Disposal			1979	Monthly	Outside Agency Jurisdiction (Managed by DSRSD and City of Livermore; data includes flow, TDS, major minerals & metals)
Recycled Water Production & Use		Metered		Monthly	Outside Agency Jurisdiction (Managed by DSRSD and City of Livermore)

Zone 7's key monitoring programs include (and are described in detail below and on Table 4-1):

- climatological monitoring,
- groundwater elevation and quality monitoring,
- surface water flow and quality monitoring,
- land surface elevation and inelastic subsidence monitoring,
- mining area monitoring,
- land use monitoring,
- groundwater production monitoring, and
- wastewater disposal.

Figure 4-1 shows the entire basin well-monitoring program.

4.5.1 Climatological Monitoring

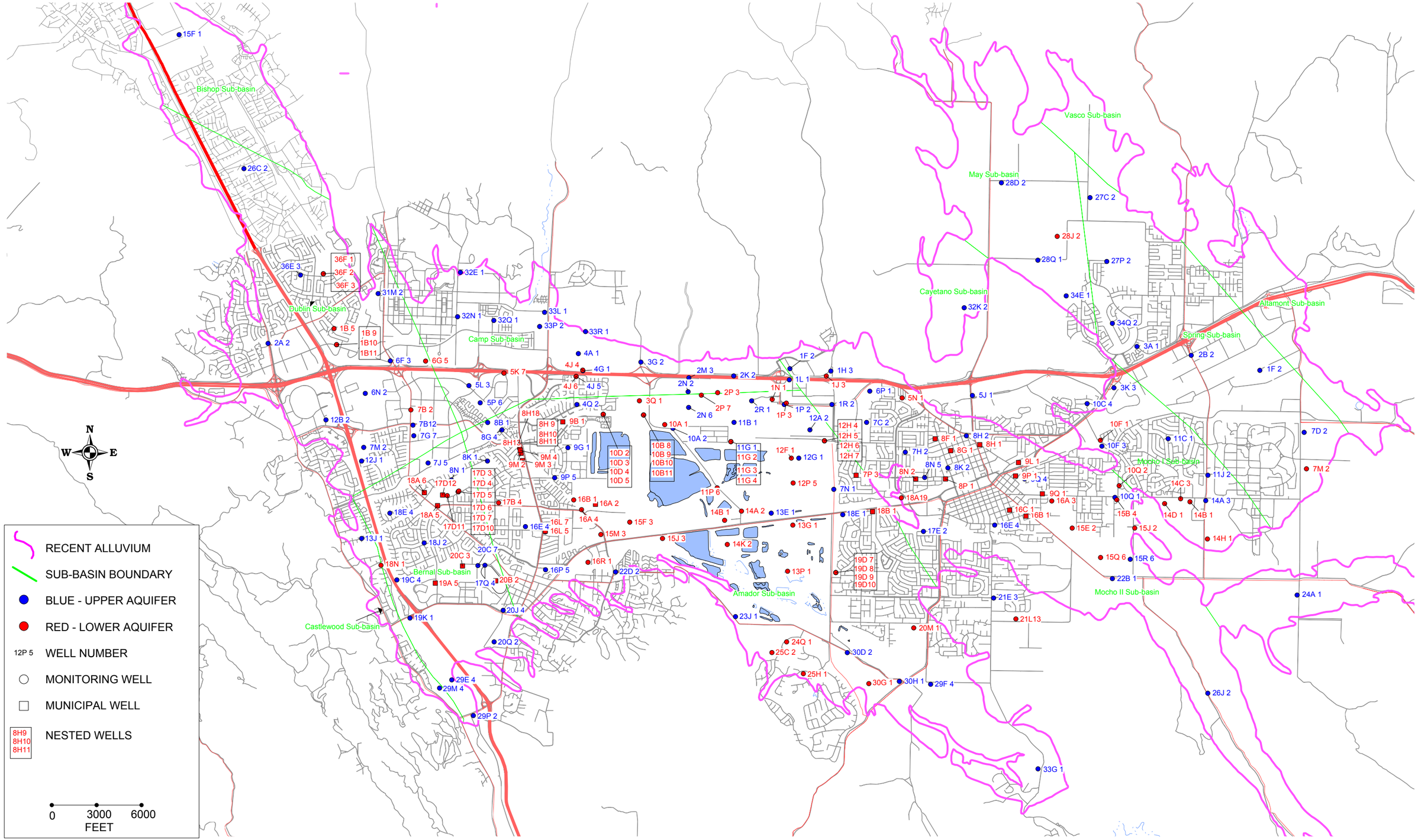
4.5.1.1 Background/Introduction

Zone 7 actively monitors and compiles climate data from a network of rainfall and evaporation stations throughout the Livermore-Amador Valley watershed. Climatological data are used to calculate specific components of the annual recharge totals, evaporative losses, and evapotranspiration demands.

4.5.1.2 Program Description

The Zone 7 climatological monitoring program network consists of nine rainfall stations and two pan evaporation stations located within the 400-square-mile Livermore Valley watershed (Tables 4-2 and 4-3). The locations of the stations and the lines of equal mean annual rainfall (isohyetals) are shown in Figure 4-2. There are three types of precipitation stations in the network:

- Four Daily Record Stations—consist of a storage gage that measures the depth of rain that has fallen during the preceding 24 hours. Three of these stations are operated by private observers.
- Four Recorder Stations—consist of a storage gage (same as those described above) and a computerized tipping bucket recorder that continuously record hourly rainfall. All four stations are operated by Zone 7.
- One California Irrigation Management Information System (CIMIS) Station—installed and operated with assistance from DWR, this station collects/records/calculates data for precipitation, air temperature, soil temperature, wind speed, wind direction, solar radiation and evapotranspiration



ZONE 7 WATER AGENCY

5997 PARKSIDE DRIVE, PLEASANTON CA 94588

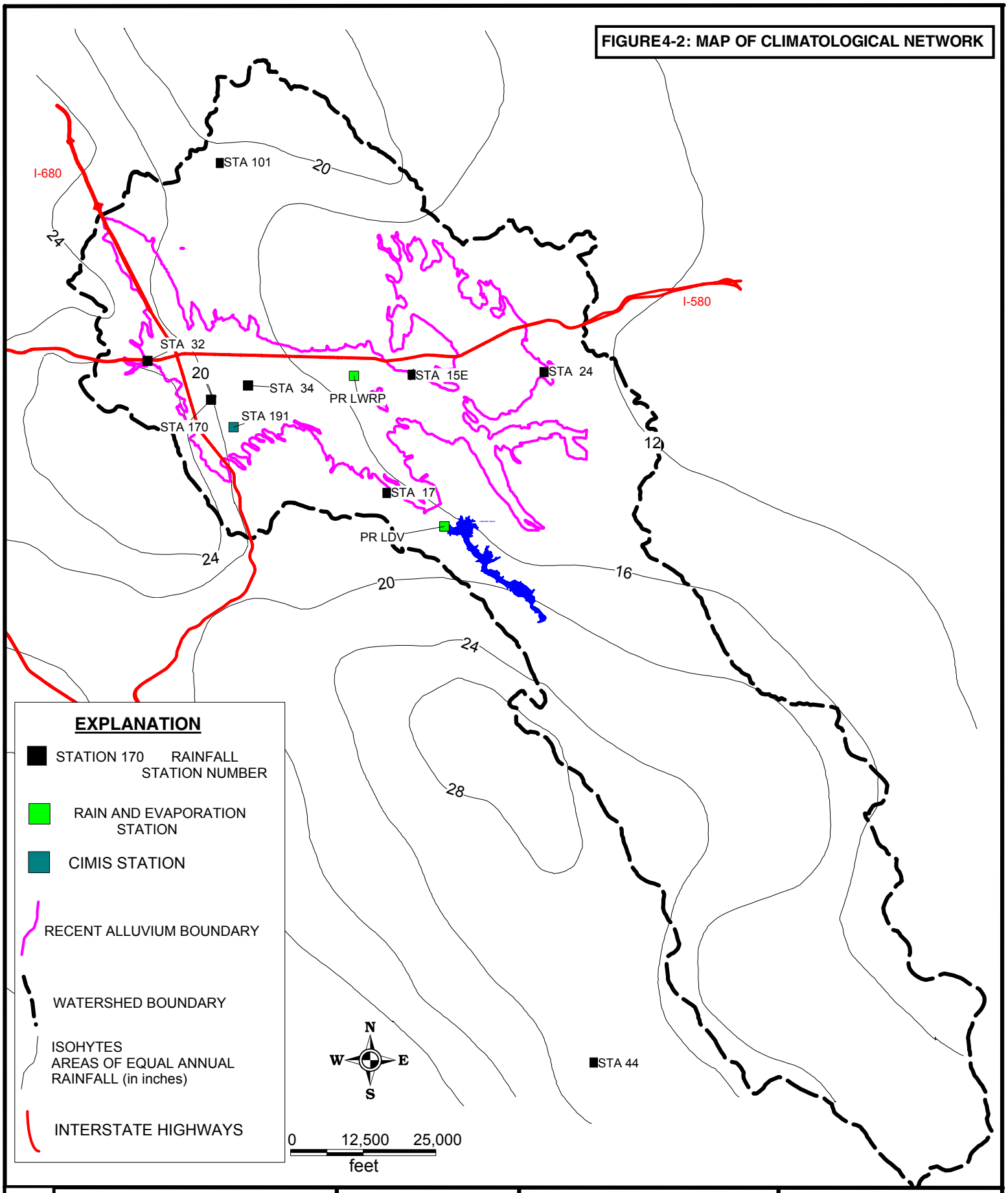
DRAWN BY: G GATES/T ROOZE
DESIGNED BY: GERALD GATES
FILE NO.: \\Zone7-file\wre\MONITOR\GM\2003wy\Annual\Figures\Fig3ProgramWells.WOR

WATER RESOURCES

GROUNDWATER PROGRAM WELLS

2003 WATER YEAR

SCALE: 1" = 6000'
DATE: August 9, 2004
FIGURE 4-1



ZONE 7 WATER AGENCY 5997 PARKSIDE DRIVE, PLEASANTON CA 94588	DRAWN BY: MIKE GARGUILO DESIGNED BY: MIKE GARGUILO CHECKED BY: GERALD GATES APPROVED BY:	WATER RESOURCES CLIMATOLOGICAL MONITORING NETWORK 2004 WATER YEAR	SCALE:1" = 24,000' DATE: 21 NOVEMBER 2003 FILE NO.: E:\MONITOR\PR\NETWORK03X.WOR

The program also includes two evaporation stations that collect data with an evaporation pan. The Lake Del Valle (LDV) station, operated by DWR is a part of LDV operations. The Livermore Water Reclamation Plant (LWRP) operates the LWRP station as part of their wastewater treatment plant operations.

Table 4-2. Precipitation Network

Station ID	Site ID	Station Name	Location	Observer	Elevation	Station Established		Mean Annual Precipitation Inches
						Storage Gage (Daily)	Recorder Record	
15E	CM_STA 15E	NOAA Livermore	Wellingham Drive, Livermore CCN: 2077172 CCE: 6194524	Mr. Ron Hafner	480	1871	–	14.60
17	CM_STA 17	Del Valle Plant	Vallecitos Road, Livermore CCN: 2054906 CCE: 6189667	Zone 7 Staff	640	1974	1978	16.26
24	CM_STA 24	Patterson Plant	Patterson Pass Road, Livermore CCN: 2077605 CCE: 6219168	Zone 7 Staff	680	1963	1969	13.09
32	CM_STA 32	Dublin Canyon	Dublin Canyon Road, Pleasanton CCN: 2079706 CCE: 6144577	Mr. H.W. Kolb	450	1937	–	23.27
34 and 34TB	CM_STA 34	Mocho Well Field	Santa Rita Road, Pleasanton CCN: 2075106 CCE: 6163467	Zone 7 Staff	340	1968	1970	17.88
44	CM_STA 44	Mt Hamilton	Lick Observatory, Mt Hamilton CCN: 1947881 CCE: 6228576	Lick Observatory Staff	4209	1881	–	24.63
101	CM_STA 101	Tassajara	Camino Tassajara Road, Danville CCN: 2116905 CCE: 6158368	Mrs. Joan Hansen	800	1912	–	18.34
170	CM_STA 170	Zone 7 Office - old	Parkside Drive, Pleasanton CCN: 2072426 CCE: 6156517	Zone 7 Staff	330	1986	1986	20.63

Station ID	Site ID	Station Name	Location	Observer	Elevation	Station Established		Mean Annual Precipitation Inches
						Storage Gage (Daily)	Recorder Record	
191	CM_STA 191	CIMIS Station	Alameda County Fairgrounds, Pleasanton CCN: 2067061 CCE: 6161028	DWR and Zone 7 Staff	335	–	2004	19.39

Table 4-3. Evaporation Network

Station ID	Site ID	Station Name	Location	Observer	Elevation	Station Established	Mean Annual Evaporation Inches
LDV	CM_EV_LDV	Lake Del Valle	Arroyo Road, Livermore CCN: 2048605 CCE: 6200367	DWR Staff	760	1969	65.84
LWRP	CM_EV_LWRP	Livermore Water Reclamation Plant	Kitty Hawk Road, Livermore CCN: 2076905 CCE: 6183367	LWRP Staff	405	1967	73.01

4.5.1.3 Reporting

Throughout the water year several reports are generated to display, review, and discuss the data that was gathered:

- Climatological Data Monthly Report,
- Climatological Monitoring Annual Report, and
- Climatological Monitoring Program Design Report—Annual Program Update.

The results of this monitoring program are used for operational decisions, monitoring decisions, and in recharge calculations (Section 4.6.2).

4.5.2 Groundwater Elevation and Quality Monitoring

4.5.2.1 Background/Introduction

Since the early 1900s there has been a long history of groundwater use, level measurements, and water quality testing in the Livermore-Amador Valley. Zone 7 has compiled a historical database of available water level and quality

data pertaining to the groundwater basin. Zone 7's historical database contains records compiled from many sources consisting of major mineral water quality data from 1,122 wells and groundwater level data from 2,319 wells.

Zone 7's groundwater monitoring program includes the monitoring of:

- groundwater elevations to determine the volume and movement of groundwater within the basin, and
- groundwater quality to determine the status of current water quality and long-term trends.

4.5.2.2 Program Description

Zone 7 monitors approximately 225 wells in the Main Basin. Groundwater wells in this program are defined as one of the following types:

- monitoring—used only for monitoring (i.e., no groundwater extraction), including at least 11 nested well sets for monitoring specific water bearing units;
- municipal—municipal water supply well owned by Zone 7, San Francisco Water District, City of Pleasanton, or Cal Water Service;
- potable—drinking water supply well for residences (potable domestic) or non-municipal public supply (potable public); or
- agriculture—extraction well for agriculture use.

Zone 7's Groundwater Monitoring Program includes monitoring for the following reasons:

- **Monthly basin levels**—includes a network of wells that are monitored, reported, and reviewed monthly for groundwater levels. These data are used for ongoing studies of subsurface inflow, identification and confirmation of hydrostratigraphic units, monitoring of groundwater extraction by others, tracking pumping and static water levels, and determining pumping costs.
- **Groundwater basin seasonal extremes**—to determine basin-wide water levels at the two extremes of the annual cycle.
- **Groundwater basin quality**—to track water quality in the groundwater basin and migration patterns of minerals and metals towards pumping wells.
- **Geologic Evaluation**—to identify geologic conditions of the basin and surrounding areas. This evaluation is preformed constantly and includes compiling historic geologic maps by others, evaluation of drilling logs and elogs, identifying water level and quality trends, and making outcrop field visits.
- **Water rights**—The conditions of this permit require that Zone 7 conduct a groundwater investigation that includes sampling of four groundwater wells along the Arroyo Valle semi-annually, measuring water levels from a

specific set of wells collected monthly, and collecting water level recorder measurements from two wells.

- **DWR**—in a cooperative agreement with the DWR, Zone 7 takes split groundwater samples from some wells to supply DWR with groundwater quality data and to supply quality assurance/quality control (QA/QC) data for Zone 7 sampling.

All of the wells to be monitored in the program fulfill some of the needs for a basin evaluation or a regulatory objective. Some wells are assigned to multiple purposes depending on the suitability of the well.

The program includes the monthly measurement of groundwater levels in about 80 wells and semiannual measurements in about 224 wells. Approximately 200 wells are sampled annually. These samples are tested in the field for EC, pH, and temperature. The samples are then submitted to the Zone 7 laboratory and are analyzed with various minerals, metals, and other parameters including those seen in Table 4-4.

Table 4-4. Water Quality Monitoring Constituents

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		

The Monitoring Protocols Table (Table 4-1) identifies the number of wells that are measured for groundwater levels and sampled for groundwater quality and the associated objective.

4.5.2.3 Reporting

Throughout the water year several reports are generated to display, review, analyze, and discuss the data that were gathered both internally and with interested stakeholders:

- Key Well Report—submitted to Zone 7 Board quarterly

- Groundwater Level Monitoring Monthly Report
- Quarterly Municipal Groundwater Quality Report
- Semi-Annual Groundwater Level Report
- Groundwater Annual Monitoring Report
- Groundwater Program Design Report—annually

Internal reports are also generated to review the data:

- Groundwater Level Hydrograph Report
- Groundwater Hydrochemograph Report (semiannually)
- Groundwater Quality Summary Report (semiannually)

The results of this program are used for groundwater storage calculations, supply and demand inventory, recharge calculations, salt management, and groundwater modeling.

4.5.3 Surface Water Flow and Quality Monitoring

4.5.3.1 Background/Introduction

Surface water in the Livermore-Amador Valley consists of:

- watershed runoff into Lake Del Valle;
- local natural runoff into four major streams (Arroyo Valle, Arroyo Mocho, Arroyo Las Positas, and Arroyo de la Laguna);
- rainfall and urban runoff;
- water from several quarry ponds (mining area);
- applied irrigation water seepage and runoff; and
- imported water conveyed in the SBA and released into local arroyos.

As part of its Groundwater Management Program, Zone 7 operates a surface water–monitoring program in the valley to measure the quantity and quality of stream water recharging the groundwater basin and to provide sufficiently detailed data to manage the local water supply. The monitoring program focuses on the streams that recharge the groundwater basin (Arroyo Valle, the Arroyo Mocho, the Arroyo Las Positas, and the Arroyo de la Laguna; see Figure 4-3) and the diversions and accretions that affect the flow along them. Zone 7 has compiled water flow data from these streams back to 1912 and water quality data back to 1948.

Zone 7, which is also responsible for streamflow management of controlled releases to various streams, has implemented a surface water monitoring program that includes a network of recorder, meter, and staff gage sites that monitor the

quality and quantity of stream flow 365 days a year. This network characterizes the flow and water quality in all major tributaries of the watershed.

4.5.3.2 Program Description

There are about 120 existing surface water monitoring sites in the Livermore Valley. For its surface water program, Zone 7 monitors 47 of these sites for flow and 16 for quality (see Figure 4-3 and Table 4-1). Sites are classified as:

- inflow/outflow—represents discharge or diversion sites where there is an inflow into or outflow from the stream, or
- monitoring—represents sites where flow and/or water quality monitoring occurs in the stream.

Sites have a measurement device to directly or indirectly record flow and/or water quality. These are listed in Figure 4-3 and Table 4-5 as:

- continuous recorder station—produces a continuous (15-minute) record of stream gage height and/or quality,
- meter—meter that records the volume of water flow,
- staff gage—a graduated tape or pole that measures the stream gage-height,
- calculated—virtual site where flow or quality is calculated,
- none/other—none of the above.

Table 4-5. 2004 Surface Water Program Sites

				Objectives					
				Std		Wtr Rts		NP	
Site	Location	Type	Device	Flw	Qlty	Flw	Qlty	Qlty	Notes
Arroyo De La Laguna—Line B									
HOP9_PC	Hopyard 9 Waste to Pleasanton Canal (ADLL)	Inflow/ Outflow	Meter	D					
ADLLV	Arroyo De La Laguna at Verona	Measurement	Recorder	R	A				Started in 2004. Std Analysis
ADLLP	Arroyo De La Laguna near Pleasanton	Measurement	Recorder	R					Discontinued in 2004
Arroyo Las Positas—Line H									
ALP_APPWTP	Arroyo Las Positas above PPWTP	Measurement	None					A	Dry in 2004
PPWTP_DISCH	PPWTP Discharge to Arroyo Las Positas	Inflow/ Outflow	Meter	D					
ALP_BPPWTP	Arroyo Las Positas Below PPWTP	Measurement	None					A	Dry in 2004

ZONE 7 WATER AGENCY

100 NORTH CANYONS PKWY, LIVERMORE CA 94551

DRAWN BY: MG/TR

DESIGNED BY: MIKE GARGUILO

FILE: \\Zone7-file\wre\MONITOR\SW\2004wy\annual\FigsTabls\Fig4-2004SWStations.WOR

Locations of Sites in 2004 Surface Water Program

SCALE: 1" = 1 MILE

DATE: Apr 7, 2005

FIGURE 4-3

				Objectives					
				Std		Wtr Rts		NP	
Site	Location	Type	Device	Flw	Qlty	Flw	Qlty	Qlty	Notes
LLNL_ALP	LLNL Treatment Effluent Discharge to ALP	Inflow/ Outflow	Meter	D	D				EC only, supplied by LLNL & annually by Zone 7 lab
LLNL_SECO	LLNL Treatment Effluent Discharge to SECO	Inflow/ Outflow	Meter	D	D				EC only, supplied by LLNL & annually by Zone 7 lab
ALPL	Arroyo Las Positas at Livermore	Measurement	Recorder	R	A				Std Analysis, Also EC Recorder data
ALPL_ELCH	Arroyo Las Positas at El Charro	Measurement	Recorder	R	A				Std Analysis
Altamont Creek—Line R									
SBA_ALTC	SBA Turnout to Altamont Creek	Inflow/ Outflow	Meter	D					
LIV_DIV_BPT	Livermore Diversion from Brushy Peak Trib	Inflow/ Outflow	Meter	D					
Arroyo Mocho—Line G									
AMNL	Arroyo Mocho near Livermore	Measurement	Recorder	R	A				Std Analysis, Also EC Recorder data
SBA_AM	SBA Turnout to Arroyo Mocho	Inflow/ Outflow	Meter	D					Std Analysis, Also EC Recorder data
AM_WF	Arroyo Mocho at Wente Ford	Measurement	Calculated	D					
WEN_DIV_AM	Wente Diversion from Arroyo Mocho	Inflow/ Outflow	Meter	D					
AMHAG	Arroyo Mocho at Livermore (Hagemann)	Measurement	Meter	R	A				Std Analysis, Also EC Recorder data
MA_CM_AM_E1	Calmat Discharge to AM at Site E1	Inflow/ Outflow	Recorder	D					Quality monitored at source in MA Program
MA_CM_AM_E2	Calmat Discharge to AM at Site E2	Inflow/ Outflow	Meter	D					Quality monitored at source in MA Program

				Objectives					
				Std		Wtr Rts		NP	
Site	Location	Type	Device	Flw	Qlty	Flw	Qlty	Qlty	Notes
MA_CM_AM_E3	Calmat Discharge to AM at Site E3	Inflow/ Outflow	Meter	D					Quality monitored at source in MA Program
MA_CM_AM	Calmat Discharge to Arroyo Mocho	Inflow/ Outflow	Calculated	D					Quality monitored at source in MA Program
MA_CM_AM_EXP	Calmat Discharge to AM—Exported from basin	Inflow/ Outflow	Calculated	D					Quality monitored at source in MA Program
AM_KB	Arroyo Mocho at Kaiser Bridge	Measurement	Calculated	R	A				Std Analysis
SR1_AM	Stoneridge 1 Waste to Arroyo Mocho	Inflow/ Outflow	Recorder	D					
AMP	Arroyo Mocho near Pleasanton	Measurement	Meter	R	A				Std Analysis; also EC Recorder
MOC1_AM	Mocho 1 Waste to Arroyo Mocho	Inflow/ Outflow	Recorder	D					
MOC3_AM	Mocho 3 Waste to Arroyo Mocho	Inflow/ Outflow	Meter	D					
MOC4_AM	Mocho 4 Waste to Arroyo Mocho	Inflow/ Outflow	Meter	D					
HOP6_AM	Hopyard 6 Waste Arroyo Mocho	Inflow/ Outflow	Meter	D					
Arroyo Valle—Line E									
AVBLC	Arroyo Valle below Lang Canyon	Measurement	Recorder	R	A				Std Analysis
LDV_FLD_GATE	LDV Flood Gate	Inflow/ Outflow	Meter	D					
LDV_FLD_TTL	LDV Total Flood Release	Inflow/ Outflow	Calculated	D					
SBA_TO2_AV	SBA Turnout 2 to Arroyo Valle	Inflow/ Outflow	Meter	D					
AVNL	Arroyo Valle Near Livermore	Measurement	Recorder	R	A	R	Q		Std Analysis
SBA_TO1_AV	SBA Turnout 1 to Arroyo Valle	Inflow/ Outflow	Meter	D					
SBA_AV_TTL	SBA Turnouts to Arroyo Valle Total	Inflow/ Outflow	Calculated	D					
AV_ASGP	Arroyo Valle above	Measurement	Calculated	D					

				Objectives					
				Std		Wtr Rts		NP	
Site	Location	Type	Device	Flw	Qlty	Flw	Qlty	Qlty	Notes
	Sycamore Grove Park								
AV_AVBRDG	Arroyo Valle above Vallecitos Bridge	Measurement	None	D					
AV_VBRDB	Arroyo Valle at Vallecitos Bridge	Measurement	Staff	D					
AV_ASTRIB	Arroyo Valle above South Trib	Measurement	None	D					
AV_ISABEL	Arroyo Valle at Isabel	Measurement	Staff	D					
AV_PONDS	Arroyo Valle at Ponds	Measurement	Staff	D					
MA_LS_SC	Lonestar Discharge to Shadow Cliffs	Inflow/ Outflow	Meter	D					
MA_LS_AV	Lonestar Discharge to Arroyo Valle	Inflow/ Outflow	Meter	D					
AV_DIV_SC	Arroyo Valle Diversion to Shadow Cliffs	Inflow/ Outflow	Meter	D					
MA_LS_AV_EXP	Lonestar Discharge to AV—exported from basin	Inflow/ Outflow	Calculated	D					
ADVP	Arroyo Valle at Pleasanton	Measurement	Recorder	R	A	R	Q		Std Analysis, Also EC Recorder data
South Tributary									
STRIB_ADVWTP	South Trib above DVWTP	Measurement	None					A	Dry in 2004
DVWTP_DISCH	DVWTP Discharge to South Trib	Inflow/ Outflow	Meter	D					Sample in February 2004
STRIB_KB	South Trib at Kalthoff Bridge	Measurement	Staff					A	Sample in February 2004
STRIP_AAV	South Trib above Arroyo Valle	Measurement	None	W					Sample in February 2004
Number of Sites in 2004 Programs: 51			**Totals:**	**47**	**12**	**2**	**2**	**4**	

Abbreviations: Objectives: Std = Standard; Wtr Rts = Water Rights; NP = NPDES; Flw = Flow; Qlty = Quality. Frequencies: A =Annual; Q = Quarterly; M = Monthly; W = Weekly; D = Daily; R = Recorder (15 minutes). Std Analysis = EC, T, pH, Minerals; EC = Electrical Conductivity, T = Temperature.

Updated Friday, May 20, 2005.

Zone 7's Surface Water Monitoring Program includes the monitoring of surface water stations for the following reasons and/or regulatory objectives:

- **Watershed Monitoring (Std in Table 4-5)**—to calculate the quantity and quality of surface water (natural and artificial) recharging into the main

basin, characterize seasonal water quality variations, and develop a historical database of base-flow water quality.

- **Water Rights (Wtr Rts in Table 4-5)**—The conditions of Zone 7's water rights permit require that Zone 7 conduct a groundwater investigation that includes quarterly sampling and continuous flow recording at two surface water recorder stations.
- **NPDES (NP in Table 4-5)**—The conditions of Zone 7's Water Treatment Facilities General NPDES permit and NPDES Storm Water (Non-Point Discharge) permit require that Zone 7 sample above and below existing treatment plant discharges to the streams and at other relevant points in the watershed.

Ten sites in the program are equipped with recorders that produce a continuous gage-height record (15-minute intervals), seven of which are operated by Zone 7, and the other three are owned and operated by the USGS. The other sites in the program (staff gages, meters, calculated, or other) have daily values for flow (except for STRIB_AAV which has weekly values).

Currently three recorder sites record 15-minute data sets for electrical conductivity (EC). Because of the recent relocation and maintenance issues, four other recorder stations are currently not configured to record EC, but are expected to be updated soon. The three USGS recorder stations are not configured for recording EC because they are in areas that have limited impacts on basin water quality.

Grab samples are taken monthly from all stations and field tested for EC. All ten recorder sites and four NPDES sites in the program are sampled annually and submitted to the laboratory for analysis. Zone 7 also collects an annual grab sample from two Lawrence Livermore National Laboratory (LLNL) discharge sites for laboratory analysis in addition to reviewing weekly EC data and monthly laboratory data reported by LLNL. Most of the LLNL water used on site for irrigation and is of adequate quality to be used off-site for irrigation of parks, landscaping or vineyards, if desired by the community.

As necessary, Zone 7 also performs synoptic studies designed to monitor the exchange of ground and surface waters, the rates of recharge along stream reaches, and the areas of basin or sub-basin groundwater outflow. These studies consist of a series of measurements made during periods of stable flow. The variations in flow from station to station generally represent steady-state groundwater recharge or discharge (rising water). Flow and water quality data are collected as part of each synoptic study.

4.5.3.3 Reporting

As part of the surface water program, Zone 7 compiles available current and historical data. The following reports are generated to present the data:

- Daily Stream Flow Report (internal use—primarily to manage the artificial stream recharge program),
- Weekly Surface Water Report (internal use only),
- Monthly Surface Water Report (includes a summary of stream flows from recorder stations, averaged and recorded daily, and a tabulation of stream conductivity),
- Surface Water Annual Monitoring Report, and
- Program Design Report for Surface Water Program.

The results of this program are used for the supply and demand inventory, recharge calculations, salt management, and groundwater modeling.

4.5.4 Land Surface Elevation and Inelastic Subsidence Monitoring

4.5.4.1 Background/Introduction

In accordance with DWR requirements for GMPs, Zone 7 established a formal Land Surface Elevation Monitoring Program in November 2002. The program, which focuses on identifying possible changes in land surface elevations resulting from groundwater pumping, is designed to document long-term land surface elevation changes and determine whether these changes are elastic and/or inelastic.[1]

4.5.4.2 Program Description

The program includes:

- compiling historical records of benchmark elevations;
- compiling any records of infrastructure failures that could possibly be associated with subsidence. This has included monitoring for surficial signs of possible subsidence (e.g., hardscape cracking, well casing failures, damaged pipelines); and
- semiannual surveying of a network of about 80 benchmarks and other survey points.

The majority of the points consist of a main circuit (A1) that:

- begins on Livermore Formation on the west side of the valley floor (Site A1-1.0),

[1] Zone 7 2004e.

- transverses the main basin across the Bernal and West Amador sub-basins to the northern boundary of the Main Basin (to Site A1-9.0), and then
- traverses to the southern boundary of the Main Basin on Livermore Formation (to Site A1-17.0).

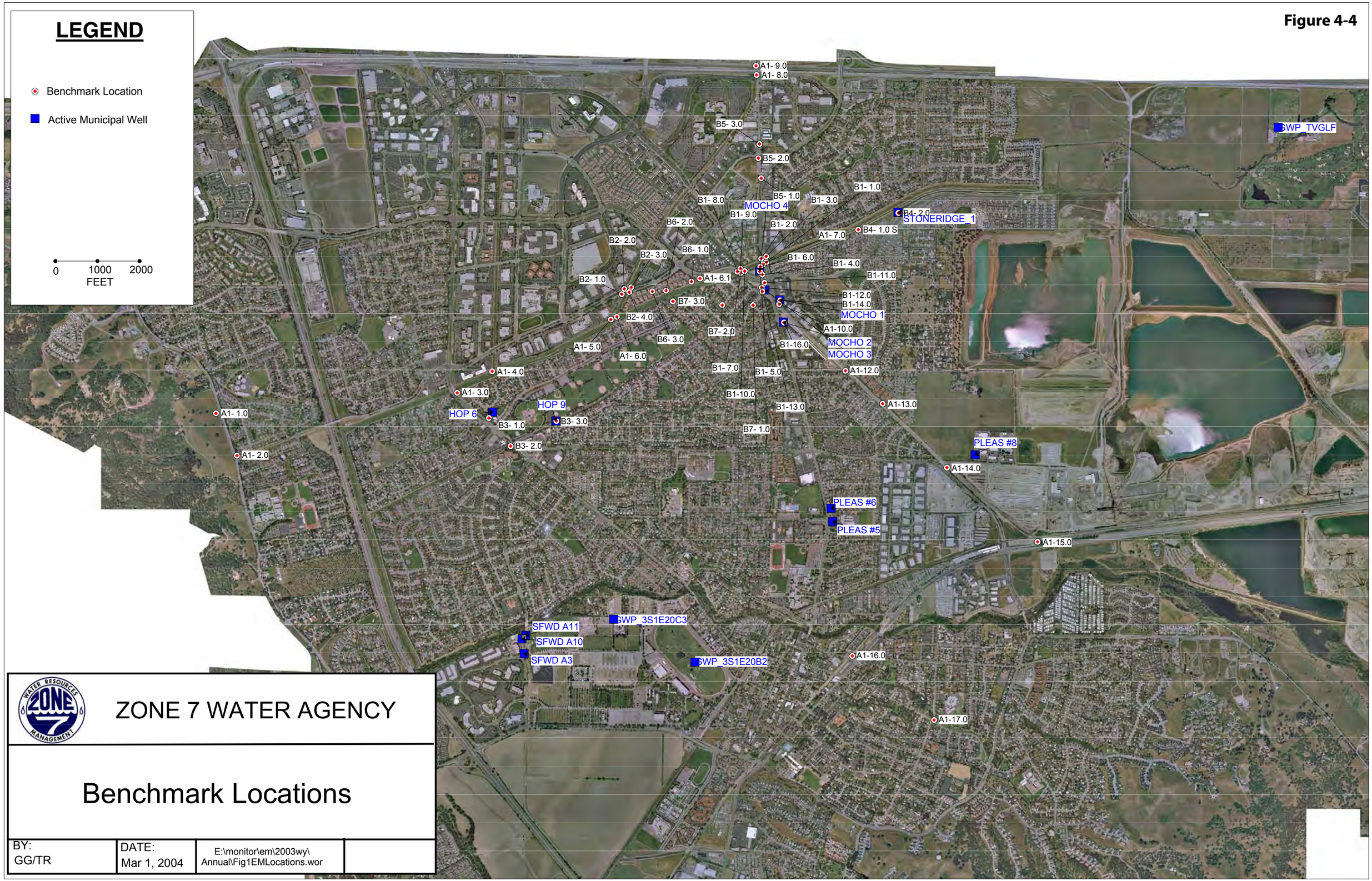
Several smaller circuits (B1 to B7) branch off of this main circuit. Table 4-5, above, lists the sites in the programs. Figure 4-4 shows the locations of the circuit benchmarks and active municipal pumping wells in the area.

For groundwater elevation reference points, Zone 7 also surveys small circuits in and around Zone 7 pumping wells. These small circuits, described in Table 4-6, branch off of the circuits discussed above. For map clarity, these points are not shown on Figure 4-4.

Table 4-6. Land Surface Elevation Monitoring Survey Points and Descriptions

Sites Monitored by Keir and Wright				Additional Well Sites Monitored by Zone 7			
Site ID	Well ID	Survey Points	Description	Site ID	Well ID	Survey Points	Description
A1-1.0*		G972	Brass disk located in sidewalk	AW1-P	3S/1E 8H 2	Army Well 1, Pedestal	Army Well 1 well pedestal
A1-2.0		Foot-La-Pos	Chisel mark on bridge footing	AW1-RP	3S/1E 8H 2	Army Well 1, RP	Army Well 1 reference point
A1-3.0		C972	Brass disk mounted on bridge platform	AW2-P	3S/1E 8H 3	Army Well 2, Pedestal	Army Well 2 well pedestal
A1-4.0		Mocho-Chabot	Brass disk located on access road	AW3-P	3S/1E 8H 4	Army Well 3, Pedestal	Army Well 3 well pedestal
A1-5.0		Mocho-Tass-W	Brass disk located on access road	H6-C	3S/1E 18A 6	Hopyard 6, Casing	Hop 6 casing/flange
A1-6.0		Mocho-Tass-E	Brass disk located on access road	H6-D	3S/1E 18A 6	Hopyard 6, Drain	Hop 6 drain
A1-7.0		Mocho_CB	Chisel mark on catch basin	H6-F	3S/1E 18A 6	Hopyard 6, Floor	Hop 6 chisel mark on pumphouse floor
A1-8.0		M1257	Brass disk mounted on bridge platform	H6-P	3S/1E 18A 6	Hopyard 6, Pedestal	Hop 6 well pedestal
A1-9.0*		Tass_Rose	Proposed disk on bridge foundation	H6-RP	3S/1E 18A 6	Hopyard 6, RP	Hop 6 reference point Hop 9 transformer pad
A1-10.0		L1257	Disk	H9-T	3S/1E 17D12	Hopyard 9, Transformer	
A1-11.0		Vine-Pipe	Brass disk in concrete	H9-C	3S/1E 17D12	Hopyard 9, Casing	Hop 9 casing/flange
A1-12.0		Mohr-RR	Spike at Mohr Ave and RR	H9-F	3S/1E 17D12	Hopyard 9, Floor	Hop 9 chisel mark on pumphouse floor
A1-13.0		TBM2		H9-P	3S/1E 17D12	Hopyard 9, Pedestal	Hop 9 well pedestal
A1-14.0		Bush-Valley	Brass disk (?) City benchmark	H9-RP	3S/1E 17D12	Hopyard 9, RP	Hop 9 reference point

Figure 4-4


LEGEND
Benchmark Location
Active Municipal Well
0
1000
2000
FEET
A1- 9.0
A1- 8.0
B5- 3.0
B5- 2.0
B5- 1.0
B1- 1.0
B1- 8.0
MOCHO 4
B1- 3.0
B1- 9.0
B4- 2.0
STONERIDGE_1
B6- 2.0
B1- 2.0
A1- 7.0
B4- 1.0 S
B2- 2.0
B6- 1.0
B2- 3.0
B1- 6.0
B1- 4.0
B1-11.0
B2- 1.0
A1- 6.1
B7- 3.0
B1-12.0
B1-14.0
MOCHO 1
B2- 4.0
B7- 2.0
A1-10.0
B6- 3.0
B1-16.0
MOCHO 2
MOCHO 3
A1- 5.0
A1- 6.0
B1- 7.0
B1- 5.0
A1-12.0
A1- 4.0
A1- 3.0
B1-10.0
B1-13.0
A1-13.0
A1- 1.0
HOP 6
HOP 9
B3- 1.0
B3- 3.0
B7- 1.0
B3- 2.0
PLEAS #8
A1- 2.0
A1-14.0
PLEAS #6
PLEAS #5
A1-15.0
SFWD A11
SFWD A10
SFWD A3
A1-16.0
A1-17.0
ZONE 7 WATER AGENCY
Benchmark Locations
BY:
GG/TR
DATE:
Mar 1, 2004
E:\monitor\em\2003wy\
Annual\Fig1EMLocations.wor

Sites Monitored by Keir and Wright				Additional Well Sites Monitored by Zone 7			
Site ID	Well ID	Survey Points	Description	Site ID	Well ID	Survey Points	Description
A1-15.0		D8	Brass disk on bridge foundation	M1-C	3S/1E 9M 2	Mocho 1, Casing	Mocho 1 casing/flange
A1-16.0		V1	Brass disk	M1-P	3S/1E 9M 2	Mocho 1, Pedestal	Mocho 1 well pedestal
A1-17.0*		K2	Brass disk (?) NGVD Benchmark	M1-RP	3S/1E 9M 2	Mocho 1, RP	Mocho 1 reference point
B1-1.0		Mocho-san MP3	Proposed disk on bridge Platform	M1-T	3S/1E 9M 2	Mocho 1, Transformer	Mocho 1 transformer pad
B1-2.0		Mocho-san MP2	Proposed disk on bridge Platform	M3-C	3S/1E 9M 4	Mocho 3, Casing	Mocho 3 casing/flange
B1-3.0		Mocho-san MP1	Proposed disk on bridge Platform	M3-P	3S/1E 9M 4	Mocho 3, Pedestal	Mocho 3 well pedestal
B1-4.0	3S/1E 8H 3	Army Well 2, Floor	Chisel mark on pumphouse floor	M3-RP	3S/1E 9M 4	Mocho 3, RP	Mocho 3 reference point
B1-5.0	3S/1E 8H 18	Mocho 4, Floor	Shiner at entrance door	M3-T	3S/1E 9M 4	Mocho 3, Transformer	Mocho 3 transformer pad
B1-6.0	3S/1E 8H 2	Army Well 1, Floor	Chisel mark on pumphouse floor	M4-C	3S/1E 8H18	Mocho 4, Casing	Mocho 4 casing/flange
B1-7.0		Mocho-Stone MP1	Proposed disk on bridge Platform	M4-P	3S/1E 8H18	Mocho 4, Pedestal	Mocho 4 well pedestal
B1-8.0		Mocho-Stone MP2	Proposed disk on bridge Platform	M4-RP	3S/1E 8H18	Mocho 4, RP	Mocho 4 reference point
B1-9.0		Mocho-Stone MP3	Proposed disk on bridge Platform	M4-T	3S/1E 8H18	Mocho 4, Transformer	Mocho 4 transformer pad
B1-10.0		Mocho-Stone MP4	Proposed disk on bridge Platform	S-D	3S/1E 9B 1	Stoneridge, Drain	Stoneridge drain
B1-11.0	3S/1E 8H 4	Army Well 3, Floor	Chisel mark on pumphouse floor	S-P	3S/1E 9B 1	Stoneridge, Pedestal	Stoneridge well pedestal
B1-12.0	3S/1E 8H 13	Obs. Well, Casing	Chisel mark on casing	S-RP	3S/1E 9B 1	Stoneridge, RP	Stoneridge reference point
B1-13.0	3S/1E 9M 4	Mocho 3, Shiner	Shiner at entrance door	S-C	3S/1E 9B 1	Stoneridge, Casing	Stoneridge casing/flange
B1-14.0	3S/1E 9M 2	Mocho 1, Floor	Chisel mark on pumphouse floor				
B1-16.0	3S/1E 9M 3	Mocho 2, Floor	Chisel mark on entrance door				
B2-1.0		Tass-Las-Pos MP1	Proposed disk on bridge Platform				
B2-2.0		Tass-Las-Pos MP2	Proposed disk on bridge Platform				
B2-3.0		Tass-Las-Pos MP3	Proposed disk on bridge Platform				
B2-4.0		Tass-Las-Pos MP4	Proposed disk on bridge Platform				
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				

Sites Monitored by Keir and Wright				Additional Well Sites Monitored by Zone 7			
Site ID	Well ID	Survey Points	Description	Site ID	Well ID	Survey Points	Description
B4-1.0		AMP-Ctl S	Brass Disk on Control				
B4-2.0	3S/1E 9B1	Stoneridge, Floor	Chisel mark at entrance door				
B5-1.0		OSRR-BC	New Monument Disk				
B5-2.0		OSRR-Andrew	New Monument Disk				
B5-3.0		OSRR-Café	New Monument Disk				
B6-1.0		5608 Belleza	New Monument Disk				
B6-2.0		FLORA-end	New Monument Disk				
B6-3.0		Belleza-Verd	New Monument Disk				
B7-1.0		Larame-Larame	New Monument Disk				
B7-2.0		Suttr-Larame	New Monument Disk				
B7-3.0		Suttr-Jones	New Monument Disk				
* Probable bedrock sites.							

Measurement Frequency

Circuit	Frequency
A1 Circuit	Semi-annually
B1 Mocho loop	Semi-annually
B2 Tassajara loop	Semi-annually
B3 Hopyard wells loop	Semi-annually
B4 Stoneridge well loop	Semi-annually
B5 Tassajara—Rosewood	Semi-annually
B6 Verona loop	Discontinued in 2004
B7 Suttergate loop	Discontinued in 2004
Additional Well Sites	Semi-annually

4.5.4.3 Reporting

Throughout the water year several reports are generated to display, review, and discuss the data that were gathered:

- Land Surface Elevation Semiannual Monitoring Report,
- Land Surface Elevation Monitoring Report—annually, and
- Land Surface Elevation Monitoring Program Design Report—annually.

The results of this monitoring program are used to measure and document any changes in land surface elevation that could possibly be associated with elastic or inelastic subsidence. The oldest benchmark in the program dates back to 1912 and has moved possibly about 3 inches. These records are used to help identify whether there are any negative impacts from groundwater pumping on ground surface elevations.

4.5.5 Mining Area Monitoring

4.5.5.1 Background/Introduction

Mining of sand and gravel in the Livermore-Amador Valley began prior to 1900. As demands continued to grow, and larger areas and volumes of sand and gravel were removed, the need for a regulatory system became apparent. In 1956 the County of Alameda adopted Ordinance 181 N.S. Ordinance 181 N.S. prohibited

pollution or contamination of usable water-bearing strata.[2] In addition, the early permits, as well as later permits, limited the mining to the uppermost aquifer. More recent permits, beginning in 1965, contained more specific language for protecting water resources and reclamation plans. In 1977, Alameda County adopted a new surface mining ordinance updating the 1956 Quarry Ordinance and incorporated reclamation requirements.[3]

In 1980 a gravel mining reclamation plan was adopted by Alameda County and local mining companies. The plan called for the completion of a "chain of inter-connected ponds which would allow routing of storm waters through the mining area and subsequent recharge in the west." This plan was designed to mitigate the loss of stream recharge capacity, loss of groundwater basin storage, loss of water through increased evaporation and loss of groundwater transport through the upper aquifer towards the sub-basins on the west side of the basin. When completed in 2030, Zone 7 will own and operate this "Chain of Lakes" for groundwater basin management purposes.

4.5.5.2 Program Description

Since gravel-mining operations have had an appreciable effect on groundwater levels and quality in the main groundwater basin, Zone 7 has incorporated a mining component into the monitoring network. A pit numbering system was developed by Zone 7 staff in 1972 and is still used today to identify active and inactive pit areas.

The current program consists primarily of monthly and semiannual monitoring. Monthly observations include determination of water surface elevations and water quality from twelve major pits. In addition, monthly observations included recording any change in mining operations. Water surface elevations and EC readings are done for each of the monthly pits. A TDS value is estimated based on the EC readings. Twice a year, in the spring and fall, all monthly monitored ponds are sampled for a complete mineralogical analysis at the Zone 7 laboratory. Monthly monitoring also includes a review of stream discharge reports received from the mining companies, which includes a compilation of daily and monthly stream discharge meters and data. The semiannual monitoring consists of a more extensive inventory of all significant pits and ponds in the mining areas. Semiannual monitoring includes surface water elevation measurements, EC, and determination of evapotranspiration rates. In addition, a water quality sample for laboratory analysis is collected from each pond on an annual basis. Figure 4-5 shows the location of the gravel mining pits.

[2] Alameda County 1981.
[3] Alameda County 1981.

4.5.5.3 Reporting

Throughout the water year several reports are generated to display, review, and discuss the data that were gathered:

- Gravel Mining Groundwater Export and Evaporation Report—monthly,
- Mining Area monthly and semiannual reports (internal), and
- Mining Area Annual Report.

The results of this program are used for the supply and demand inventory, recharge calculations, salt management, and groundwater modeling.

4.5.6 Land Use Monitoring

4.5.6.1 Background/Introduction

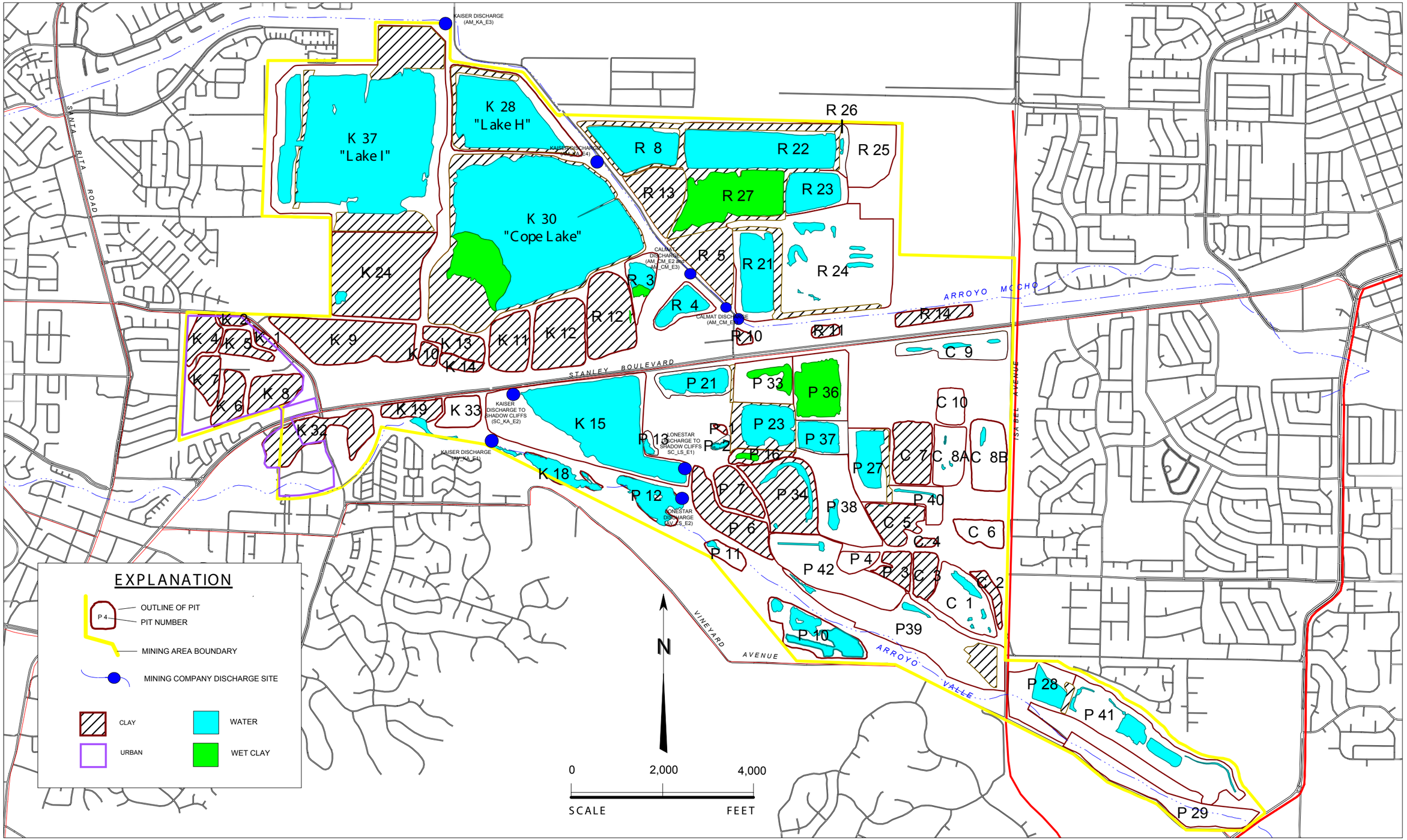
Collection of land use data is essential in understanding changes in land and water use over time that may affect infiltration and water quality in the groundwater basin. To properly assess water supply and water quality conditions and trends in the groundwater basin, accurate records of land and water use changes are needed. Zone 7 identifies and quantifies different types of land uses with irrigation significant enough to contribute groundwater recharge and affect the salt loading of the Main Basin. The program also identifies the type of water (potable, groundwater, or recycled) for use in the computation of salt loading to the Main Basin.

4.5.6.2 Program Description

As part of Zone 7's long-term monitoring program, land use in the Livermore-Amador Valley is monitored. Zone 7's Land Use Monitoring Program includes the identification of the following different land use type (see Figure 4-6):

- **Urban** land use includes residential and commercial areas, which typically are irrigated. Small vacant lots, non-irrigated fields and other undeveloped areas are included as urban land if they are smaller than about 20 acres and are located in urban areas.[4] Each urban classification is composed of several subcategories. For example, Urban Reclaimed Water lands are urban areas subject to reclaimed wastewater irrigation. Such urban areas include landscaped regions surrounding the valleys, two wastewater treatment facilities, the Livermore Airport, the Dublin Sports Grounds, parts of east Dublin and the area north of Interstate 580 along Canyons Parkway, including Las Positas College. Golf courses are included in the urban category and are divided into three subcategories: golf course groundwater, golf course surface water, and golf course reclaimed water.

[4] Zone 7 2003, 2004f.

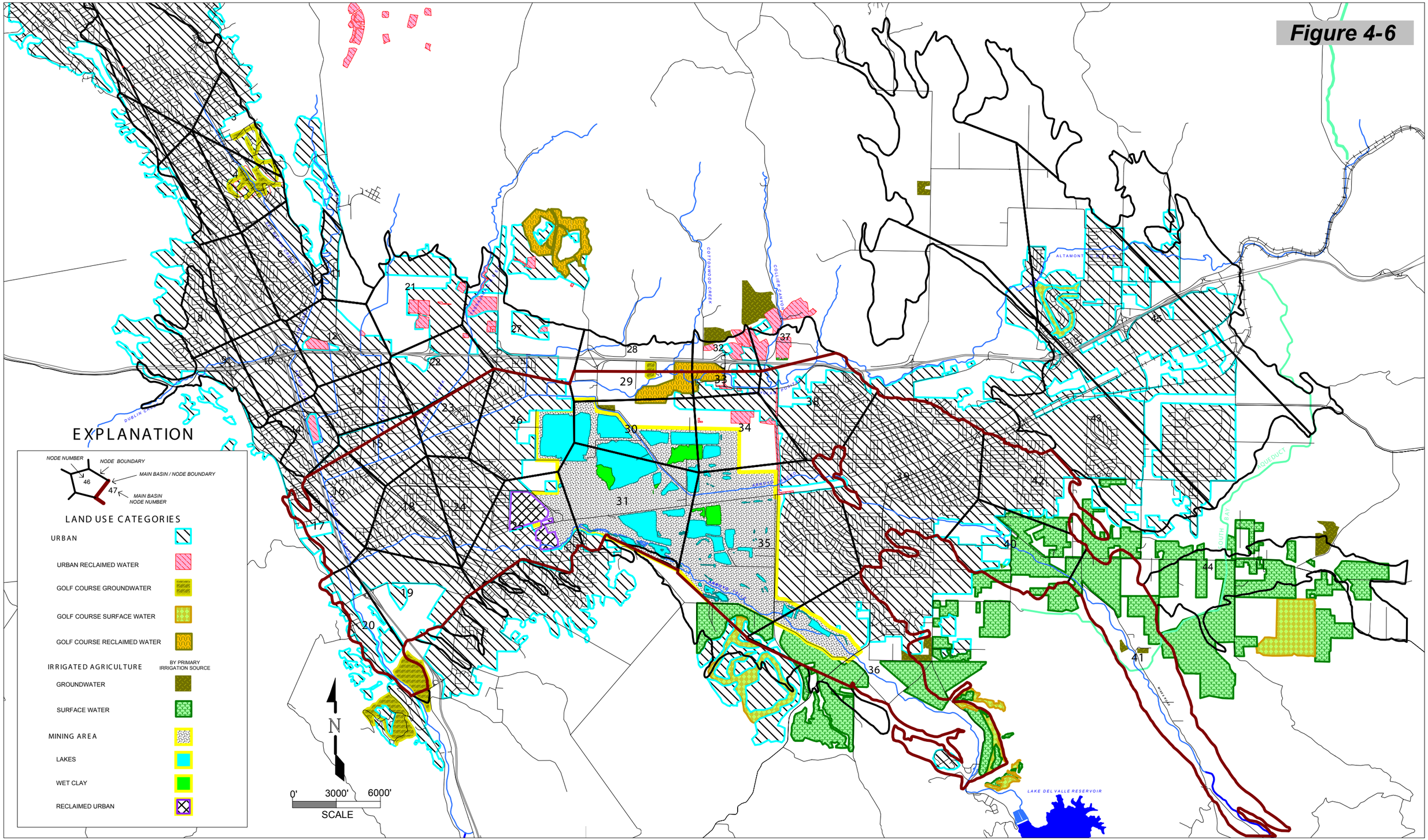


ZONE 7 WATER AGENCY
5997 PARKSIDE DRIVE PLEASANTON CA 94588

DRAWN	TODD WENDLER
DESIGNED	T.WENDLER
CHECKED	JARNAIL CHAHAL
APPROVED	

WATER RESOURCES
MINING AREA MONITORING PROGRAM
LOCATION OF GRAVEL MINING PITS

SCALE	1" = 2,000'
DATE	12 January 2003
FILE NO. B -	h:\ma\2003\maF03.mapinfo



ZONE 7 WATER AGENCY
5997 PARKSIDE DRIVE PLEASANTON CA 94588

DRAWN	TODD WENDLER
DESIGNED	TODD WENDLER
CHECKED	
APPROVED	

WATER RESOURCES
LIVERMORE VALLEY LANDUSE
2004 WATER YEAR

SCALE	1" = 6000'
DATE	29 November 2004
FILE NO.	B-140 | LU_04.WOR

- **Irrigated/Agriculture** land use consists of irrigated farmland such as vineyards, field crops, vegetable crops and pastures. Excluded from this category is agricultural land that is dry-farmed or minimally irrigated during the growing season. Irrigated areas, also shown in Figure 4-6, have been subdivided by primary water sources as groundwater or surface water. The vineyard areas are irrigated primarily with surface water obtained from the SBA. Some groundwater can be used in the vineyards to supplement the SBA water, but because the amount used is proportionally small, these areas are listed as surface water irrigated. Beginning in 2001, Zone 7 maps included agricultural lands irrigated with recycled water.
- **Gravel Mining Area** land use includes all lands that have been mined or are scheduled to be mined. Mining area "ponds" include all areas of ponded water or wet silt. The wet silt areas are counted as ponded area because evaporative losses from wet silt are similar to evaporation that occurs in open ponds. Mining area "reclaimed" includes all lands mined and refilled or partially refilled with clay. Mining area "urban" includes lands within the mining area that have been reclaimed and developed into industrial parks or similar urban uses. The "irrigated agriculture" category is located outside of the mining area. Mining area "other" includes excavations, earthworks, and undisturbed lands within the mining area that do not belong in any other mining area classification.

Land use data are derived from aerial photography (annual), interviews with landowners, and field observations. Land use changes are monitored and evaluated in a monthly site review report. This report tracks all new land use changes and is used to coordinate Zone 7 concerns to the land use planning agencies.

4.5.6.3 Reporting

The Livermore Valley Land Use Report is generated annually to display, review, and discuss changes in land use and water use that may impact the regional water supply or the groundwater basin. In addition, a site review report of all potential land use changes that may impact the groundwater basin is compiled and reviewed each month. The results of this program are used for the recharge calculations (of rainfall recharge and applied water recharge).

4.5.7 Groundwater Production

4.5.7.1 Background/Introduction

The extraction of groundwater for municipal, industrial, domestic and agricultural use represents more than 80% of the groundwater flow through the basin. Maintaining accurate records of the quantity and location of all groundwater extractions is critical for basin evaluations and modeling. This program compiles daily, monthly, and annual records of groundwater extraction

from all significant wells within the groundwater basin. More specifically, this program includes groundwater levels, monthly production amounts, and water quality analyses for all municipal supply wells to determine the amount and quality of water that is being extracted from the groundwater basin for municipal and/or agricultural use.

Accurate records have been kept on monthly production quantities since 1974. The records are vital to accounting of groundwater use and to the proper allocation of waters recharged artificially and subsequently pumped by Zone 7 versus waters naturally recharged into the groundwater basin and subsequently pumped by retailers or others.

Historical records prior to 1974 are incomplete and use prior to the 1960s must be estimated based on land use mapping and limited pumping records.

4.5.7.2 Program Description

Zone 7 collects and compiles monthly records for all large pumping wells within the Main Basin. Zone 7 meters all Zone 7 pumping and requires metered pumping records from all retailer wells. Records of other pumping wells are obtained from well owners when available. Pumping records from smaller wells or wells without meters are calculated from power records or from land use data. Zone 7 obtains these records as part of the land use mapping program and the groundwater level-monitoring program.

4.5.7.3 Reporting

Zone 7 tracks and reviews Zone 7 pumping each day and reports the amount in a daily production report. The Monthly Municipal Water Supply report compiles reviews of municipal pumping from all wells valley-wide. Any discrepancies or lapses in the data stream are resolved to prevent the loss of well pumping data. The records from local retailers are compared to contractual pumping limits (formerly referred to as Independent Quotas) and, in the event of overpumping, the retailers are billed for the excess water.

4.5.8 Wastewater and Recycled Water Monitoring

4.5.8.1 Background/Introduction

Wastewater disposal from domestic and commercial sites can have a significant impact on water resources and a groundwater basin. While wastewater disposal can contribute a significant quantity of water to recharging the basin, it can also be a potential source of contamination, primarily from salts, nitrates and chlorides.

Zone 7 completed numerous studies of wastewater disposal and water quality management including an early study entitled, "Water Quality Management Plan for the Alameda Creek Watershed above Niles," in September 1972. Subsequent joint studies by USGS and Zone 7, along with actions by the California Regional Water Quality Control Board—San Francisco Bay Region and the Zone 7 Board resulted in the creation of the Livermore Amador Valley Water Management Agency (LAVWMA) which eventually constructed an export pipe. Since 1979, the LAVWMA export pipe has exported most urban wastewater out of the watershed and into the San Francisco Bay. The remainder of the locally-sewered water receives tertiary treatment and is currently distributed as recycled water for landscape irrigation (for additional discussion of wastewater management, see Section 5.1.4.4).

Figure 4-7 shows the land use and wastewater disposal changes over the past 35 years. Note that prior to the LAVWMA pipeline construction, all urban wastewater was disposed in the valley with significant amounts of wastewater either flowing out of the basin via the local arroyos or percolating into the groundwater basin. The Wastewater Management policies established by Zone 7 in the 1970s successfully supported regional sewering for the majority of developed lands overlying the entire groundwater basin and for essentially all of the lands overlying the Main Basin. Thus wastewater from the majority of sewered areas is exported out of the basin via the LAVWMA export pipeline.

As discussed in Sections 3.5 and 5.1.4.4, there is a groundwater contamination plume containing high levels of nitrates existing in the eastern portion of the Main Basin. There have been several evaluations suggesting a variety of sources for these nitrates. There remain a few localized unsewered areas with a high density of residential septic tanks (i.e., Buena Vista Avenue near the upper end of this plume, along with both the Happy Valley and Sunol areas which are separate from the above-described plume) that may or may not be contributing to nitrate loading within the basin. Since these areas are relatively rural and are typified by various livestock (both currently and historically), nitrate remains a concern.

In some areas, large tracts of land have been dedicated as permanent open space, which is unlikely to generate much urban wastewater on site (although application of recycled water for landscape or agricultural irrigation is potentially possible, as are on-site septic tanks, fertilizer applications, winery wastes used to augment irrigation water, etc.). These lands include large regional parks and areas within agricultural land trusts. The other large area within the Main Basin that is excluded from significant in-valley wastewater disposal is the Mining Area, which will either be developed and sewered (with wastewater exported from watershed) or be left as permanent open space.

4.5.8.2 Program Description

Zone 7 currently tracks wastewater disposal on a monthly basis. NPDES permits for the City of Livermore and the DSRSD wastewater treatment plants are reviewed monthly. Flow and quality data are evaluated for impacts to the groundwater basin. In the future the wastewater flows will be tracked on a daily

basis so that the Concentrate from the Groundwater Demineralization projects can be coordinated with wastewater discharges into the LAVWMA pipeline. Recycled water use is also tracked monthly for water use, flow and location of use. Additional description of Zone 7's wastewater management program is contained in Section 5.1.4.4.

4.5.8.3 Reporting

The flow and quality data is compiled in a monthly Wastewater and Recycled Water Report for internal use by Zone 7 staff and the location of recycled water applications are mapped in the Land Use Annual Report. The data are used for hydrologic inventory calculations, salt balance calculations, and groundwater modeling.

4.6 Basin Evaluation Programs

4.6.1 Introduction

The data and results of Zone 7's monitoring programs are used to evaluate the conditions of the groundwater basin. This section of the GMP describes Zone 7's programs designed to evaluate the conditions of the basin using data collected from the monitoring described above. Following data collection and reporting for the monitoring programs, Zone 7 performs detailed evaluations and analyses that include data from more than one monitoring program. These data are described below and include:

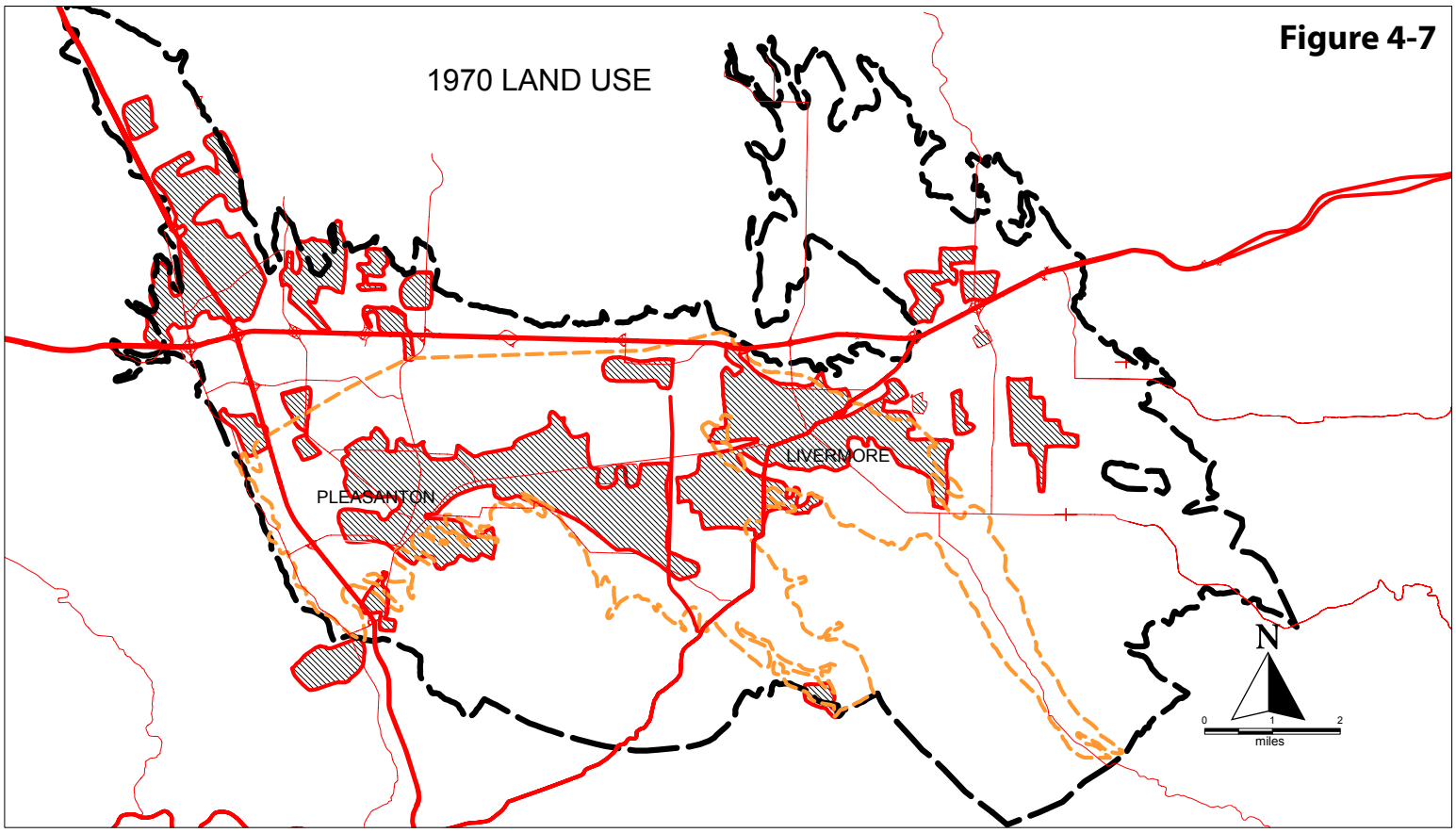
- recharge calculations,
- hydrologic inventory,
- groundwater basin storage,
- salt balance calculations, and
- municipal water supply.

4.6.2 Recharge Calculations

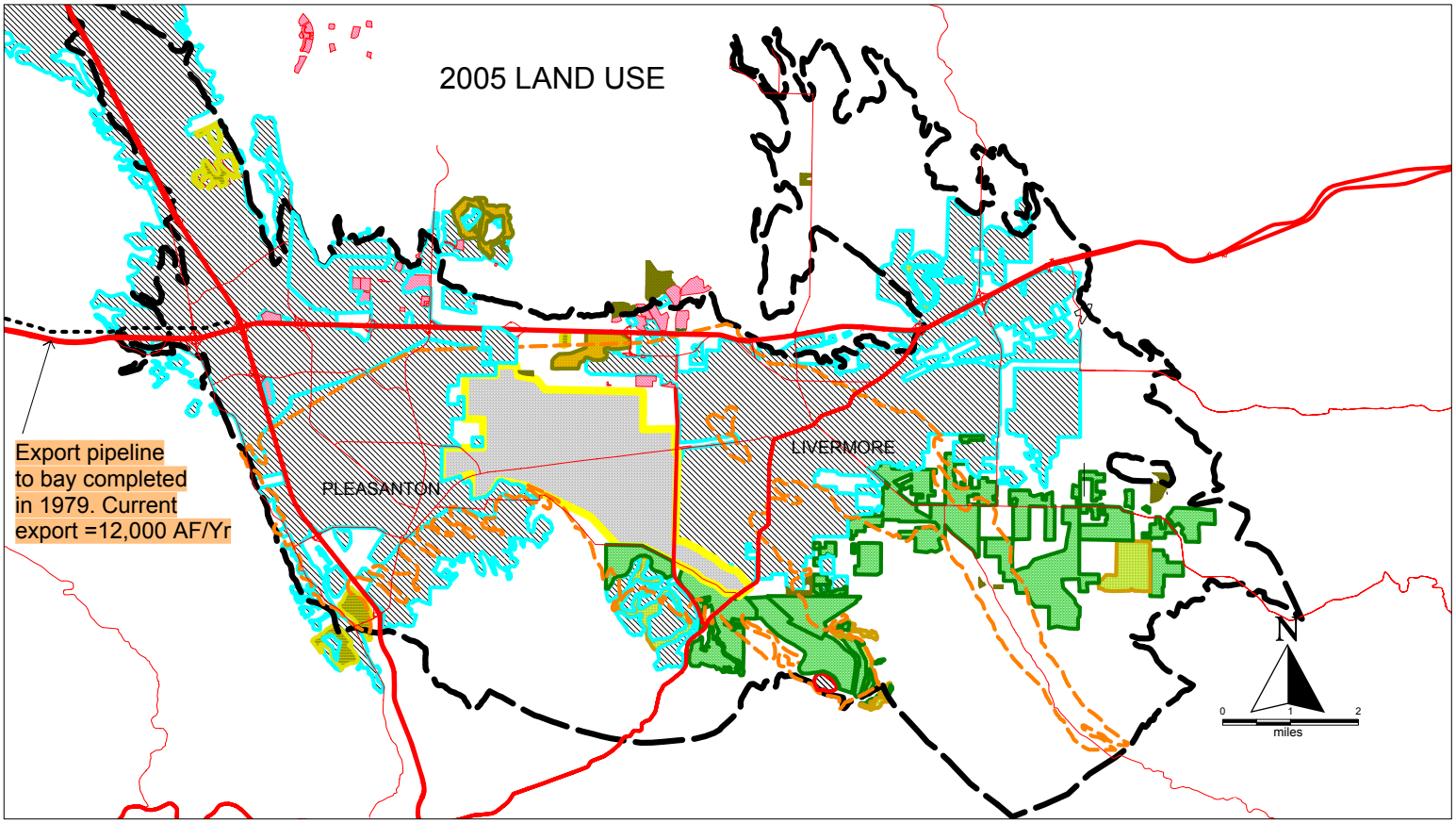
Groundwater recharge occurs from rainfall, applied water, and streams, all of which are calculated by Zone 7. In the future, Zone 7 also plans to use mining area lakes as recharge ponds.

Zone 7 has developed a recharge calculation model that calculates both rainfall and applied water recharge rates for all locations in the groundwater basin. The recharge model, which includes results from the climatological and land use monitoring programs, includes parameters for soil type and hydrologic conditions

LAND USE & WASTEWATER DISPOSAL CHANGES OVER 35 YEARS



SEWERED- In Valley Disposal | SEWERED- Exported from Watershed | DEDICATED OPEN SPACE | MINING AREA (OPEN SPACE)



throughout the valley. For modeling the groundwater basin, rainfall and applied recharge are combined as a real recharge.

Groundwater recharge from streams includes the following components:

- natural recharge—rain runoff into the streams, including both urban runoff from rainfall and upper watershed runoff that recharge into the streambeds;
- artificial recharge—SBA or Lake del Valle water that is released into the streams; and
- gravel-mining recharge/discharge—recharge from gravel mining pit discharges or discharges into the streams.

Stream recharge is calculated from daily streamflow and stream discharge records. The three primary recharge streams have upstream and downstream gages, and the recharge typically is calculated as the difference between upstream inflows and downstream outflows.

4.6.3 Hydrologic Inventory and Water Balance

Zone 7 compiles a detailed hydrologic inventory or water balance of monthly and annual supply and demand components for the Main Basin. The hydrologic inventory represents the water balance between groundwater supply and groundwater demand. The inflow and outflow components of the Main Basin budget are presented in Table 4-7. Monthly inventory summaries are compiled each quarter and reported in the quarterly water supply report that is presented to the Zone 7 Board each quarter. The hydrologic inventory is the easiest way to keep track of changes in groundwater storage. Experience gained through the analysis of the hydrologic inventory allows Zone 7 staff to predict and model long-term basin response to changing hydrologic conditions.

Table 4-7. Annual Supply and Demand

	2003 Water Year (acre-feet)	Normal Water Year (acre-feet)
Inflows		
Natural Stream Recharge	4,629	4,766
Artificial Stream Recharge	9,588	11,379
Rainfall Recharge	2,041	3,910
Applied Water Recharge	949	1,719
Subsurface Inflow	720	756
Inflow Total	17,926	22,530
Outflows		
Municipal Pumping	13,471	13,456
Agricultural Pumping	118	1,066
Mining Use	2,233	2,236
Subsurface Outflow	0	405
Outflow Total	15,822	17,163
Net Recharge (Inflow – Outflow)	**2,104**	**5,367**

4.6.4 Groundwater Basin Storage

The amount of water in storage is a critical component of water supply management and drought planning. Zone 7 computes groundwater storage using two methods. The inventory method uses the hydrologic inventory to calculate storage changes. The groundwater level method uses groundwater level data and geologic information on aquifer properties to compute storage. Zone 7 has been using both methods for more than 20 years, and they are in close correlation. Each year Zone 7 completes a storage report that reviews the storage calculation based on the inventory method and the groundwater level measurement. Zone 7's experience with these methods allows staff to report with confidence the amount of water within the basin. Knowledge of this information allows Zone 7 staff to plan for extracting a known volume of water without risking lowering the basin below historical lows.

4.6.5 Salt Balance

Saline waters can slowly degrade the quality of groundwater (represented by a rise in basin salinity and/or hardness) and ultimately render part or all of a groundwater basin unusable. In the semi-arid Livermore Valley, multiple sources can contribute to increased salinity in groundwater: use and reuse of the water supply, lateral or upward migration of saline water, downward seepage of industrial or agricultural water, downward seepage of mineralized surface water from streams or lakes, interaquifer migrations of saline water and especially the

evapotranspiration of irrigation water (some of which is relatively high TDS recycled water). The primary purpose of the salt balance evaluation is to investigate the change in the amount of salt in the basin and calculate the basinwide change in water quality.

The Livermore groundwater basin has been experiencing slowly degrading water quality each decade, as evidenced by increasing TDS levels. Preventing the buildup of salts (calcium, magnesium, sodium, chloride, and other minerals) is a key Zone 7 water quality objective. Zone 7 calculates a salt balance to determine whether it is meeting long-term water quality objectives of non-degradation. Under full implementation of the Salt Management Plan (SMP), Zone 7 will increase recharge, increase pumping and bring the salt balance into a non-degradation range.

A salt balance is a calculation of the amount of salts and minerals entering or leaving a groundwater basin. If the balance is positive, the regional water quality will degrade. If the balance is negative, then basin quality will improve. However, for decades, the Groundwater Basin Salt Balance has been positive, confirming the reason basin water quality has continued to decline. Multiple sources can contribute to increased salinity in groundwater. In the semiarid Livermore Valley, the evapotranspiration of irrigation water, especially higher-TDS recycled water, has been the greatest long-term concern from a salt-management perspective.

Currently, the salt balance calculations are based on results from:

1. 45 monitoring wells to track groundwater levels and quality.
2. Six surface water recorder stations to track streamwater flow and quality in three major waterways in the watershed (Arroyo Valle, Arroyo Mocho and Arroyo Las Positas).

Additional wells and surface water recorder stations are under consideration to improve Zone 7's understanding of salt migration from fringe basins and concentration in the Main Basin.

All wells and surface waters used for the evaluation are sampled and analyzed annually for major ions (e.g., Ca, Mg, Na, K, HCO_3, SO_4, Cl, NO_3, SiO_2), boron, manganese, selenium, chromium, arsenic, EC, pH, TDS, alkalinity, and hardness. As surface water monitoring stations are upgraded with automated water quality measuring instruments, EC, temperature, and pH will be recorded on a nearly continuous basis.[5]

Sources of salt loading to the main basin for the 1998 water year are shown in Table 4-8. The table shows that urban irrigation represents a significant portion of the potentially "controllable" portion of the total salt loading to the basin. There is a limit to which the other sources can be controlled, with the possible exception of shallow groundwater pumping that might reduce high TDS subsurface inflow and recharge on Las Positas.

[5] Zone 7 2004a.

Table 4-8. Main Basin Relative Salt Loading Sources, 1998 Water Year Controllable Portion of the Total Salt

Sources	Relative Salt Load on the Basin
Urban Irrigation	33%
Natural Recharge on Arroyo Mocho	18%
Subsurface Inflow	13%
Natural Recharge on Arroyo Las Positas	14%
Natural Recharge on Arroyo Valley	13%
Agricultural Irrigation	3%
Artificial Recharge	6%

Reports summarizing results of the salt balance evaluation are planned to be generated initially on a quarterly and annual basis. The data collected as part of the salt balance evaluation will be used to identify changes in groundwater quality throughout the watershed, to refine salt loading estimates, and to provide input to the water resource allocation and groundwater models.

Given that the salt balance evaluation program was established in part to identify and fill existing data gaps and to provide a venue to evaluate the long-term effectiveness of the SMP, an annual critique and refinement of the monitoring and data collection effort is anticipated.

Data collected as part of this evaluation will be used to critically evaluate the usefulness of the data collected relative to making salt management control measure decisions. The groundwater model and this monitoring program will be used in a complementary fashion, where monitoring program results are used as input to the model and the monitoring program subsequently uses the output from the model to help determine additional (or reduced) data needs. This approach will help achieve long-term SMP goals without consuming excessive resources that could otherwise be used directly to implement salt management measures.

4.7 Basin Management

4.7.1 Introduction

A groundwater basin is a large natural complex reservoir. Zone 7 regulates more than half of the inflow and outflow from the basin and strives to make the basin function indefinitely to provide a sustainable supply of high quality water to the residents of the Tri Valley.

The basin needs to be managed as a system in order to be operated in an optimal way but the groundwater basin is just a part of a larger complex system that includes the SWP, local watershed runoff, Semitropic storage and treatment

plants. A community of about 190,000 people depend upon optimal use and proper management of the groundwater basin.

Zone 7 uses the information and knowledge gained from monitoring and from conducting the basin evaluation programs to create several models. These models are used to evaluate different basin management scenarios and to test out strategies. Zone 7 then creates a basin management operations plan based on the results of two types of modeling: water operations modeling and groundwater modeling. The modeling uses water supply forecasts from:

- supply and demand modeling,
- groundwater modeling,
- water supply forecasts,
- data from basin evaluation programs,
- knowledge gained by decades of studying the basin, and
- forecasts of potential water supply and demand conditions.

The basin management operations plan is a part of water supply planning and is included in the Annual Water Operations Plan.

4.7.2 Key Wells

Zone 7 has identified key index wells in each significant water-producing region of the Main Basin as general indicators of groundwater levels in the Main Basin. The data from these wells are evaluated quarterly using monthly water level data. The results from this evaluation are assembled onto easy-to-read graphs that can be displayed to the general public (see Figure 4-8).

4.7.2.1 Groundwater Storage

Zone 7 actively monitors groundwater storage in the basin to ensure that future demands are met during dry years. Zone 7 keeps groundwater storage above the main basin historical low, preserving all groundwater underneath the historical low for emergency use. Zone 7 is able to keep the storage above the historical low by importing surface water. Groundwater storage calculations help Zone 7 determine the amount of existing groundwater availability, and future availability, thus providing vital information about the hydrologic inventory of the basin.

4.7.3 Supply and Demand Simulation Modeling

Zone 7's supply and demand simulation model, Z7sim can model the entire Zone 7 system over an 80-year hydrologic period to evaluate long-term strategies or

any deficiencies in resources that would limit providing a reliable supply of water.

The Zone 7 simulation model has a groundwater basin component that calculates the recharge and extraction and change of storage for the Main Basin. Calibrations are ongoing and involve matching model projections to actual groundwater recharge, storage change and groundwater levels.

Through groundwater elevation/storage monitoring and retailer demands, Zone 7 is able to predict the supply of the groundwater basin in relation to the current and future demand.

Zone 7 compiles a detailed hydrologic inventory of annual supply and demand components for the Main Basin and computes the end-of-year storage. The hydrologic inventory represents the water balance between groundwater supply and groundwater demand.

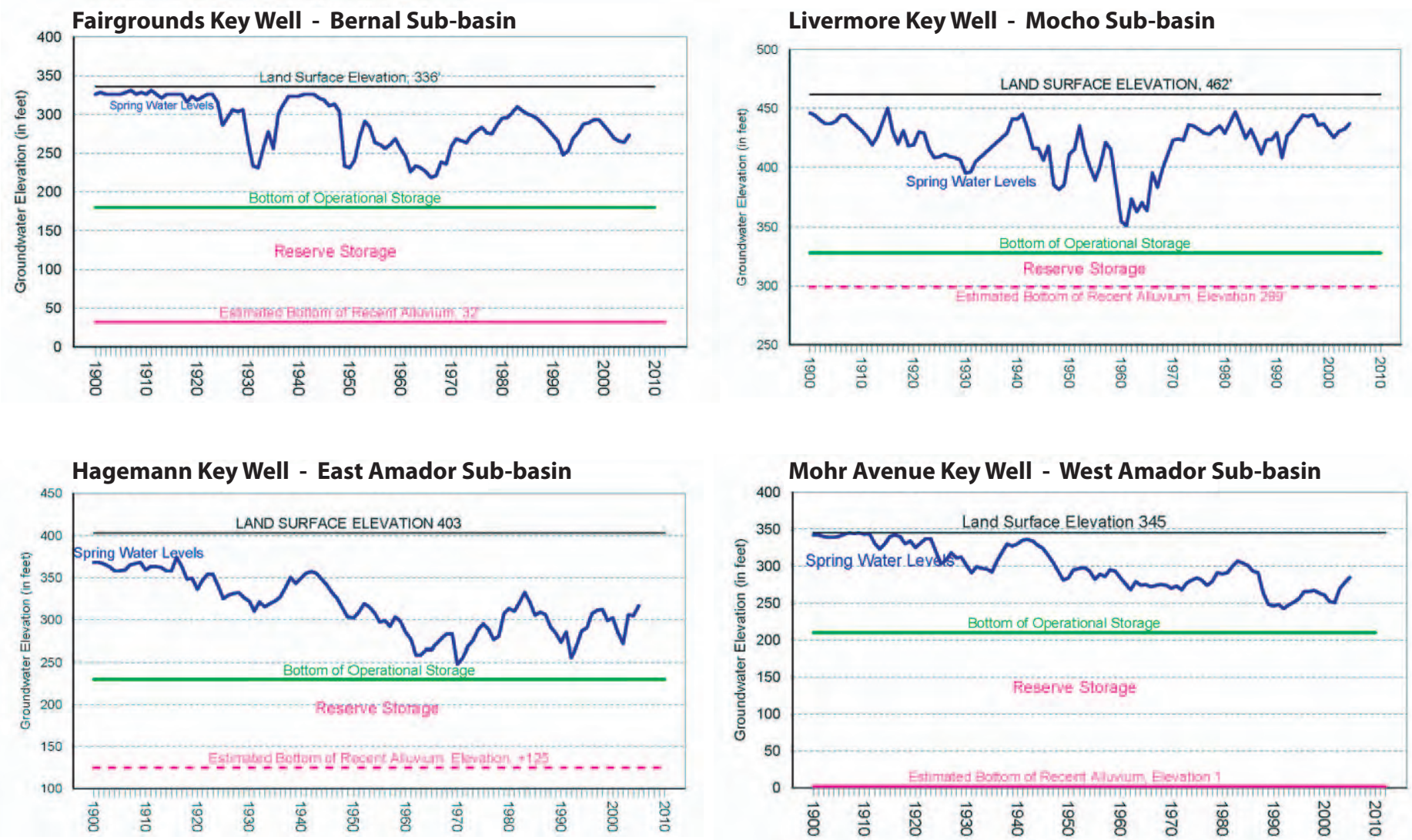
4.7.4 Groundwater Modeling

A groundwater model is a device that represents an approximation of a groundwater basin. Physical models such as laboratory sand tanks simulate groundwater flow directly. A mathematical groundwater model simulates groundwater flow indirectly by means of equations to represent the physical processes that occur in the groundwater basin. A mathematical model can be used analytically or numerically. As analytical solutions are not suitable because of complexities in the groundwater flow modeling, numerical groundwater modeling is more often used for groundwater basin modeling.

Groundwater models are useful for predicting the consequences of a proposed groundwater basin management action. Groundwater models can also be used to learn about the controlling parameters in a site-specific setting such as establishing locations and characteristics of aquifer boundaries.

The original Main Basin groundwater model was developed by Zone 7 and DWR in the 1970s and is documented in DWR Bulletin 118-2. Davies (a Stanford graduate student) developed a groundwater model of the Amador sub-basin in 1981. Danskin (another Stanford graduate student) extended this model into the Bernal sub-basin in December 1985 and calibrated the model for average fluxes for the period 1977–1981. Although these models and the associated documentation provided some useful technical information, Zone 7 did not use them for basin management studies.

In 1996, Zone 7 retained consultant CH2M Hill to assist Zone 7 Staff with the development of a groundwater flow and solute (salt) transport model for the main groundwater basin. The model was designed to be usable by Zone 7 Staff or evaluating alternative SMP strategies and future Main Basin management options. The model was originally developed using Visual MODFLOW for Windows version 2.61 by Waterloo Hydrologic, Inc. package and M+3D for



04727.04 GWMP (09/05)

Jones & Stokes

Figure 4-8
Key Index Wells

solute transport. In the late 1990s, the model was converted to Groundwater Vistas using MODFLOW-SURFACT for simulate groundwater flow and MT3D to simulate solute transport.

The model is currently being updated and recalibrated to include recent data sets. The original model was calibrated using data from 1974 to 1994; the updated includes data sets through 2004.

Chapter 5

Plan Implementation

5.1 Groundwater Management Program

5.1.1 Introduction

Zone 7 has been actively monitoring and managing the groundwater basin for more than 30 years. Many of the various policies guiding the groundwater program were formalized in the 1987 Statement on Zone 7 Groundwater Management, incorporated herein by reference and included in Appendix E. This plan was partially revised and updated as part of the development of Zone 7's SMP, which was formally adopted by Zone 7 and approved by the RWQCB in October 2004; the SMP is also incorporated herein by reference and a copy of the Executive Summary is included in one of the Appendices. This Groundwater Management Plan serves to document the various existing groundwater management program components and how they are being implemented.

5.1.2 Salt Management

5.1.2.1 Background/Introduction

Zone 7's Salt Management Plan (SMP) was designed to comply with the requirements of the Master Water Recycling permit, RWQCB Order No. 93-159, issued jointly to Zone 7, the City of Livermore, and Dublin San Ramon Services District.[1] In May 2004, Zone 7, in cooperation with others, published the SMP to address the increasing level of TDS in the main groundwater basin. The SMP was approved by the RWQCB in October 2004. The SMP is incorporated herein by reference and a copy of the Executive Summary is included in Appendix D.

Zone 7 has define potential salt management strategies to offset the calculated long-term average salt loading to the main groundwater basin of approximately 2,200 tons per year.[2] The available alternatives are defined as those capital facilities and/or operational strategies already included in Zone 7's capital

[1] Zone 7 2004a.
[2] Zone 7 2004a.

improvement program or under evaluation in the Facilities Master Plan, and the Well Master Plan. In addition Zone 7 operates the groundwater basin conjunctively to remove salts as well as to maintain reliability of its supply.

Zone 7 has historically managed water deliveries and artificial stream recharge in accordance with its water supply operations planning program that consists of the following three major components:

1. Five-Year Demand Projections and DWR delivery scheduling;
2. Annual Water Supply and Storage Probability Analysis (also called the water supply forecast); and
3. Annual and Monthly Water Supply Operations Plans.

The Water Supply Forecast is prepared in December of each year for the following calendar year. The Water Supply Forecast shows how Zone 7 would operate to make full deliveries under a wide range of hydrologic conditions ranging from critically dry to extremely wet.

The Water Supply Forecast provides the framework for water management decisions. The Water Supply Operations Plans provide additional guidance for monthly supply goals (i.e., balancing surface and groundwater supplies). Each year in July, Zone 7 prepares preliminary versions of the Water Supply Operations Plans for the following three years. In September of each year, these three-year Water Supply Operations Plans are updated to reflect the latest demand requests received from Zone 7's retail water supply agencies. In January of each year, the Water Supply Operations Plan for the current year is updated with more accurate DWR water supply projections for most probable conditions. In April of each year, after DWR has announced the firm rest-of-year deliveries, Zone 7 develops a Monthly Water Supply Operations Working Plan. This Monthly Plan is then updated monthly for the rest of the year with actual year-to-date data and, as such, reflects adjustments made to meet water supply operational objectives.

The primary goal of historic water supply planning efforts was to minimize operations and maintenance costs by delivering the maximum amount of surface water available and pumping groundwater only to supplement surface water supplies during peak demand and drought periods. This historic approach successfully provided sustainable water supply at a minimum cost but did not specifically address salt loading, groundwater quality or delivered water quality.

The Water Supply Operations Plans now incorporate the Salt Management Plan (SMP) goals and an adaptive management approach to selecting the combination of salt management strategies to be implemented in a given year. Zone 7 determines the optimum combination of strategies to use in a given year. Multiple variables are balanced in making decisions and variables change from year to year, hence the need for a so-called adaptive or iterative management approach.

Factors used to track salt loading include data and information collected from the various monitoring programs described in Chapter 4. The existing monitoring programs are sufficient for tracking salt loading from existing sources and for existing land use conditions. Future land use changes and any increase used of recycled water may require additional monitoring to track the resultant additional salt loading. The monitoring component of the SMP facilitates tracking any progress in salt removal. No significant change is anticipated until groundwater demineralization begins (anticipated in around 2009).

5.1.2.2 Demineralization

To maintain delivered water quality (i.e., acceptable total dissolved solids or "TDS" and hardness) during future periods of increased groundwater pumping, Zone 7 has plans for constructing groundwater demineralization facilities.[3] The primary advantages of wellhead demineralization are that significant salt loading benefits may be realized (by exporting the brine concentrate from the groundwater basin) while concurrently improving delivered water quality by lowering TDS and hardness. Depending on the capacity installed, wellhead demineralization allows one to "dial-in" desired delivered water quality (i.e., by adjusting flows between demineralization treatment unit and bypass to achieve target hardness and/or TDS levels) and to reduce seasonal and drought-related variability. The primary disadvantages of wellhead demineralization are the moderately high operations and management (O&M) costs for pumping energy and the costs for brine disposal.

Groundwater demineralization will also allow Zone 7 to pump from water-bearing zones containing higher levels of minerals (expressed as TDS and hardness). In addition, Zone 7 will be able to pump increased volumes of groundwater (taking advantage of "banked" water in the basin) without impacting delivered water quality.

Demineralization will use a reverse osmosis (RO) membrane-based treatment system producing product water with extremely low TDS. The demineralized water will then be blended with other groundwater (non-demineralized) and/or surface water prior to delivery to achieve a target delivered water TDS or hardness and to reduce aggressiveness to distribution lines. The brine concentrate from the RO process will be exported out of the watershed via the regional wastewater export pipeline operated by the LAVWMA.

5.1.3 Integrated Water Resources/ Conjunctive Use

Historically throughout California, surface water and groundwater have been managed as separate resources because water law treats groundwater and surface

[3] Zone 7 2004a.

water as two separate resources. Such management does not represent hydrologic reality. As a result, DWR recommends monitoring surface water and groundwater resources as an integrated program that includes conjunctively managing groundwater with surface water.

DWR provides examples of planning efforts that should be integrated with groundwater management. These might include surface water flow/quality monitoring, wellhead protection management, agriculture/salt management, urban water management, flood management, and toxic site management.

For many years, Zone 7 has actively embraced a conjunctive use program by integrating management of local and imported supplies. Natural and artificial recharge utilizing releases of surface water to recharging streams is a key component of this program. To track the conjunctive use effort, Zone 7 actively monitors all of the following components:

1. natural inflow, including groundwater seepage (i.e., rising groundwater);
2. releases of imported water from the SBA;
3. urban run-off;
4. groundwater discharges from aggregate mining operations;
5. flood control releases from Lake del Valle; and
6. discharges from other artificial releases, including LLNL treated groundwater, well tests, or treated water discharges.

Zone 7 monitors the quantity and quality of each of the previous components. EC, pH, and temperature are measured monthly at stream-gaging stations throughout the basin and daily at various SBA turnouts to the Zone 7 treatment plants. The EC measurements are used to estimate TDS content using the formula TDS = 0.56 x EC. Additionally, surface water samples are collected periodically and analyzed for major and total ion content.

5.1.4 Groundwater Resource Protection

Zone 7 considers groundwater resource protection to be one of the most critical components of ensuring and managing groundwater resources. This GMP identifies resource protection by preventing contaminants from entering the groundwater basin and remediation of existing contamination.

5.1.4.1 Protection of Supply

Zone 7 ensures adequate water supply by importing a large amount of surface water into the valley through the SWP. In 2004, Zone 7 had an annual maximum entitlement of 80,619 af/y. Zone 7 also has a contract with Byron-Bethany Irrigation District for an additional 2,000 acre-feet. Zone 7 has also purchased water storage rights (65 taf) in the Semitropic Water Storage District

groundwater basin located in south-central California near Bakersfield. Artificial recharge of available supply allows the main groundwater basin to remain above the historical low level with good quality water.

The natural supply of groundwater replenishment to the basin needs to be protected. Urban development can reduce the amount of water recharging the basin. If left unmitigated, the natural safe yield of the basin would decline. Zone 7 monitors the natural recharge and reviews development plans to evaluate any impacts on the recharge capacity of the basin.

Currently, the largest potential negative impacts to recharge are the operation of the Del Valle Dam and the extensive gravel mining activities. To mitigate the impacts of the construction of the Del Valle Dam, Zone 7 makes releases from below the dam to maintain the stream flow and recharge through stream beds that would have occurred had the dam not been constructed. These releases are called "Prior Rights Releases." To satisfy these prior rights requirements, Zone 7 evaluates the Pre-Del Valle Dam (Pre-Project) and Post-Del Valle Dam (Post-Project) recharge. Recharge releases are made into the Arroyo Valle to ensure that the same amount of water recharges the basin as would have recharged if the dam had not been constructed.

Regional gravel mining activities have a significant impact on stream recharge and on the loss of groundwater through evaporation and mining company discharges to the arroyos. The Mining Area Reclamation Plan calls for the creation of a Chain of Lakes (see Section 3.3) that will allow the recapture of some of the lost recharge capacity associated with the mining impacts on stream recharge. In addition the Chain of Lakes project will mitigate the impacts from the increased evaporative losses associated with the creation of large lakes within the basin.

When all mining activities are completed in 2030 Zone 7 will own the Chain of Lakes area in fee and will utilize the chain of lakes for water resources management purposes to protect the natural recharge capacity of the groundwater basin and to mitigate the loss of groundwater from evaporation and reduced stream recharge capacity. In these ways, Zone 7 protects the natural supply of groundwater which is then used primarily by the retailers to provide the water that they appropriate from the groundwater basin.

5.1.4.2 Wellhead Protection/Permit Program

DHS administers the Drinking Water Source Assessment and Protection Program that requires the identification of wellhead protection areas. A DWSAP evaluation has been conducted for all Zone 7 supply wells and will be conducted for all future Zone 7 supply wells. The DWSAP identifies areas of protection for each wellhead area. These areas are incorporated into other Groundwater Protection Programs of Zone 7, as discussed elsewhere in this chapter.

Both the County and the three local cities (Dublin, Livermore and Pleasanton) have well ordinances, all of which are administered by Zone 7 Water Agency by agreement. As a result of these Well Ordinances, any planned new well construction, soil-boring construction, or well destruction must be permitted by Zone 7 before the work is started. There is currently no fee for the Zone 7 permits. 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.

A copy of the Zone 7 drilling permit applications is available for download from the Zone 7 website. Zone 7 must receive permits at least 5 days prior to beginning any drilling. Well construction/ 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).

5.1.4.3 Water Conservation

Because water is a limited and precious resource that must be used wisely, Zone 7 makes water conservation an integral part of its daily operations and water management approach—not just an emergency response to recurring droughts.

Zone 7 promotes the Ultra-Low-Flow Toilet Rebate Program, which began in 1994, and is a water conservation success story for Zone 7 and Tri-Valley households. The program offers rebates to households when they replace their old toilets with new water-conserving ultra-low-flow toilets. Almost 11,000 ultra-low-flow toilets have been installed in the valley, for an annual water-savings of 480 acre-feet. Each ultra-low-flow toilet will save an estimated average of 38 gallons per day.

Zone 7 also promotes the Residential Clothes Washer Rebate Program, which involves the purchase of high-efficiency, Energy Star® labeled clothes washing machines. These high-efficiency washing machines use up to 50% less energy and up to one-third less water relative to most other new washers. Zone 7 has given out approximately 4,000 rebates since this program began in 1998. This program is a regional partnership with other Bay Area water agencies, including Alameda County Water District, Contra Costa Water District, East Bay Municipal Utility District, and Santa Clara Valley Water District.

5.1.4.4 Wastewater Management

Zone 7 Board of Directors adopted an interim policy on wastewater reclamation (Resolution No. 823, 1977) and a "Wastewater Management Plan for the Unsewered, Unincorporated Area of Alameda Creek Watershed Above Niles" (WMP) (Resolution No. 1037, 1982). (See Appendix E.) The 1982 WMP encompasses the unsewered, unincorporated area above Niles situated outside the sewered urban areas in the Livermore-Amador Valley. The primary purpose of this WMP was to identify, assess, and recommend solutions to local septic tank

problems, and recommend wastewater management policies to prevent degradation of surface waters and groundwater.[4] The recommended policies of the WMP were adopted along with the WMP, itself, by the Zone 7 Board of Directors in Resolution 1037 (see Appendix E). Among the most important is B.4 in the WMP: "If more intense development proposing septic tanks is to be authorized in any area and/or when land use zoning is changed to rural residential use with septic tanks: (a) the minimum generally acceptable lot size should be five (5) acres."

A separate policy was established that prohibits the use of septic tanks for new developments zoned for commercial or industrial uses (Resolution No. 1165, Appendix E). 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 and said septic tanks will be in compliance with all other conditions and provisions."

These policies have been adopted in large part to protect the groundwater basin from contamination from untreated sewage. For many years Zone 7 has been monitoring a persistent plume of high nitrate concentrations in the Main Groundwater Basin that extends from south Livermore six miles northeast to Livermore's airport. A preliminary study was conducted in April, 1980. Nitrate concentrations within this plume typically range from 30 mg/l to 65 mg/l and have been somewhat stable for the last three decades or more. The drinking water standard or maximum contaminant level (MCL) for nitrates (as nitrate or NO_3) is 45 mg/l. CWS operates several municipal supply wells within the affected area, however, the well water that contains nitrates greater than the MCL is blended with imported water to lower the nitrate concentrations below the MCL prior to distributing it to their customers.

In 2002, Zone 7's consultant, Raines, Melton & Carella, Inc. (RMC) conducted a reconnaissance level evaluation of the nitrate sources which may be responsible for the high nitrate concentrations found in the South Livermore area. In general, in this draft report RMC concluded that the rural residential livestock manure and septic tank leachate provide over 90% of the current nitrate loadings in the study area which was comprised of 670 acres of agricultural land and rural residential area. The study area is upgradient of the affected CWS wells, and currently includes approximately 100 rural homes along Buena Vista, Almond and East Avenues and Calvary Lane that use septic tank systems for sewage disposal. The majority of the homes are on Buena Vista Avenue. In addition, there are six wineries (including one with a full-scale restaurant), commercial and private horse stables, a dog kennel and approximately 460 acres of vineyards within the study area. Historically, there was extensive chicken and row crop farming along Buena Vista Avenue that continued until the 1950s.

RMC evaluated the potential nitrogen sources in the study area. Nitrogen loadings and losses from multiple sources were estimated to determine a net mass balance for nitrogen entering the groundwater. The volume of water recharged to the groundwater basin was estimated to determine the resulting concentration of

[4] Camp Dresser and McKee 1982.

nitrate in the groundwater. The nitrogen mass balance model predicts that livestock manure is providing 50–55% of the current nitrate loadings within the study area and that septic tank leachate is providing 40–45%. On the other hand, the nitrate contributions from winery process wastes and urban and agricultural fertilizers make up less than 10% of the total.

Zone 7 continues to work with the City of Livermore, Alameda County Planning Department, the Buena Vista and Almond Avenue residents and the property and business owners along Tesla Road, to develop strategies to mitigate the regional nitrate issues.

Recycled Water Use

Overall it is anticipated that use of recycled water for irrigation purposes will increase in the future. Within the Zone 7 service area, two retail water supply agencies (DSRSD and the City of Livermore) plan to use or are currently using recycled water for the following projects:

- **Livermore Golf Course**—The Livermore Airport and Golf Course use about 400 acre-feet of recycled water annually for irrigation. The current monitoring program consists of 10 wells installed jointly by Zone 7 and the USGS in the late 1970s. The collection and analysis of groundwater data were initially done by the USGS and Zone 7, but the collection was taken over by the City of Livermore in 1985. The RWQCB established monthly monitoring and reporting requirements in Water Reclamation Permit No. 90-102 issued to the Livermore Water Reclamation Plant. The requirements in Permit No. 90-102 were superseded in January 2005 when the RWQCB issued Livermore General Order 96-011. Order 96-011 does not contain groundwater monitoring requirements. However, Livermore continues to support Zone 7 in collection and analysis of groundwater samples. In 2003, four additional shallow monitoring wells were installed and are monitored by Zone 7 to help evaluate the effect of the recycled water use on groundwater. Three of the wells are located at the Livermore Golf Course, one upgradient of the irrigation area (to establish background water quality conditions) and the others downgradient. Zone 7 reviews the groundwater quality data submitted by the City of Livermore to the RWQCB and makes additional water level and groundwater quality measurements. Zone 7 maintains records on monthly recycled water use, recycled water quality, and the application areas and rates.
- **Public Parks**—It is recommended that two shallow wells be constructed at a large park, such as the Pleasanton Sports Park, Dublin Sports Grounds, or Emerald Glen Park, that is irrigated with recycled water. One upgradient well would monitor background conditions and the other downgradient well would monitor the effects of irrigation with recycled water. The wells would be monitored quarterly for approximately 1 year and then annually once baseline conditions were established.
- **Veterans Administration Hospital**—The Veterans Administration (VA) Hospital wastewater treatment system and percolation ponds are located at

the southern edge of the Main Basin. This system is also regulated by RWQCB Waste Discharge Requirements that include groundwater monitoring and reporting requirements. For consistency and completeness, it is recommended that the existing requirements be reviewed to evaluate the usefulness of the information being collected. As appropriate, recommendations could then be made for monitoring changes to best document the current and future impacts of percolation on groundwater quality.

5.1.4.5 Toxic Site Management

Background

Zone 7 documents and tracks sites across the groundwater basin that pose a potential threat to drinking water. Information on these sites is gathered from state, county, and local agencies, as well as from Zone 7's well permitting program. This tracking program is designated the "Toxic Site Surveillance Program" and a report is generated biannually to update the progress of investigations and clean-ups. Each site has been assigned a Zone 7 number, which corresponds to the file number containing reports or other information about the site. In addition, all sites are reviewed and given a ranking based on criteria used by the RWQCB and Alameda County Environmental Health (ACEH) that have been modified to meet Zone 7 standards.

Program Description

A GIS database and map was developed to show the locations of these sites and to provide basic information including; priority, status, owner/contact, contaminants of concern, concentrations of contaminants in groundwater, proximity to supply wells, lead agency and date last reviewed. This database is maintained by Zone 7 staff to help assess the potential threat to our drinking water posed by a given site.

Each site is assigned a priority designation of high, moderate or low. The priority can change as conditions change at the site. A site is designated as a high priority site if the following conditions occur:

1. contamination at the site is in groundwater at concentrations greater than the MCL, and
2. a water supply well is within 2,000 feet downgradient of the site, or
3. it is shown that drinking water will likely be impacted by the contamination at the site.

A secondary ranking is used to represent the remedial status of the site. These codes differ slightly from those used by ACEH and RWQCB to better meet the needs of Zone 7. For example, a closed case is listed as a Status "CL" in the Toxic Site program database, instead of the RWQCB's code of "9".

In general, the Toxic Site Surveillance Program has found two types of contamination threatening groundwater in the Livermore-Amador Valley Groundwater Basin: fuels and industrial chemicals

The petroleum-based fuel products include total petroleum hydrocarbon as gasoline (TPHg), TPH as diesel (TPHd), benzene, toluene, ethylbenzene, xylene (collectively known as BTEX), and oxygenates added to fuel including methyl tertiary-butyl ether (MtBE) and tertiary-butyl alcohol (TBA). California has assigned clean-up standards for the BTEX compounds and fuel oxygenates. However, a cleanup standard for total petroleum (TPHg or TPHd) has not officially been established.

The industrial chemical contaminants of concern are tetrachlorethylene (PCE), trichloroethylene (TCE), and their by-products and degradation products. This latter group of contaminants consists of chlorinated solvents. PCE is common in the dry cleaning business, and TCE is commonly used as a degreaser for electronics. Both PCE and TCE have an established MCL of 5 micrograms per liter (µg/l).

Zone 7 is currently tracking 76 active sites where contamination has been detected in groundwater across the groundwater basin. Ten of these sites are designated as high priority, five in Livermore, four in Pleasanton, and one in Sunol.

When there are sites that are of particular concern and/or are a potential threat to the drinking water supply staff will work closely with the lead agency (RWQCB or ACEH) to ensure that Zone 7's concerns are addressed.

Reporting

A report is generated biennially to update the status of the sites in the program. This report is submitted to the Zone 7 Board. The report includes a detailed summary of the background information of each high priority site along with any special notes and the current actions taking place at the site. In addition, a summary table of all the active sites is included in the biennial report. This table includes a brief summary of the current status of each active site. A map is generated for each main area within the groundwater basin, Livermore, Pleasanton, and Dublin, to show the site locations, their priority and their proximity to municipal supply wells (Figures A, B, and C in Appendix B).

5.2 Future Review of This Groundwater Management Plan

This GMP is the framework for regionally coordinated groundwater management efforts within the Livermore-Amador Valley. Many of the components described in this GMP will likely further evolve with future management efforts in the

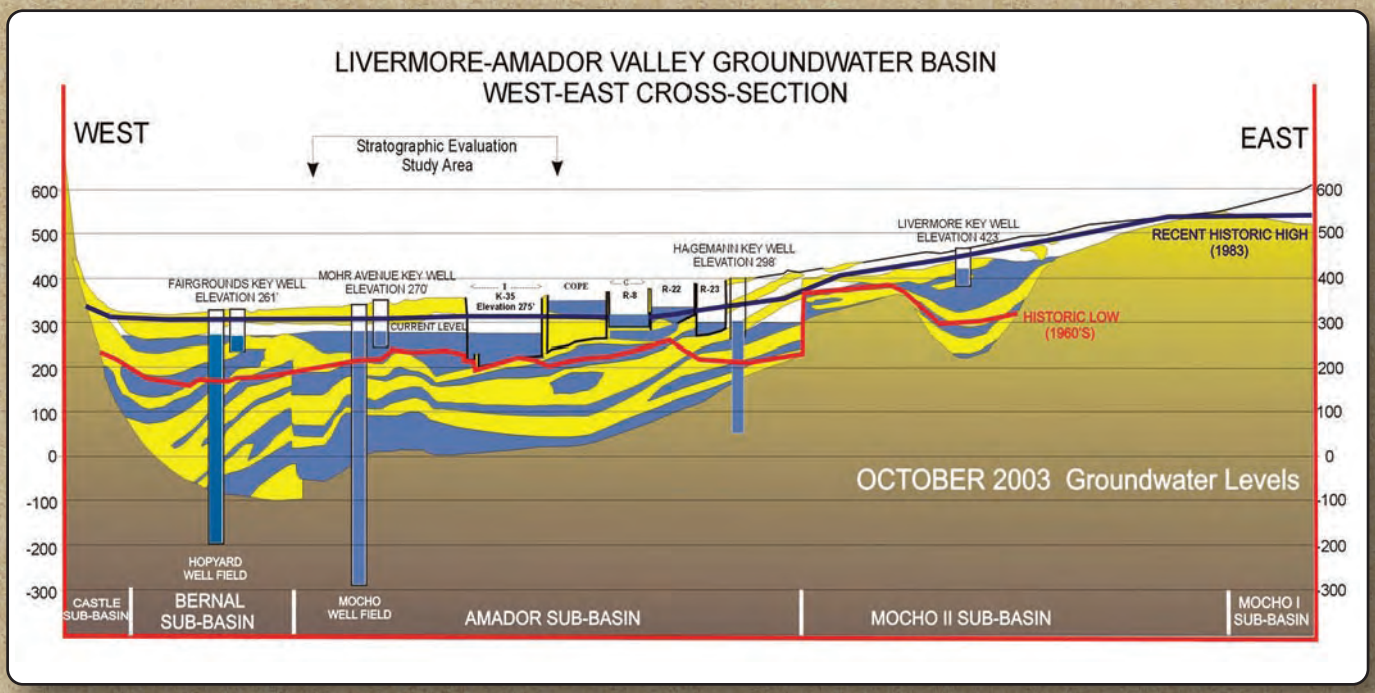
basin. Any such future changes will involve a collaborative effort involving Zone 7 and its four agencies (Dublin-San Ramon Services District, City of Pleasanton, City of Livermore and California Water Service Company), as well as the Tri-Valley Retailers Group, in which all four retailers participate. Key resources for evaluation are the annual monitoring and measurement reports described above. As a result, the GMP is intended to be a living document, where the components will be evaluated over time to determine whether they are meeting the overall goal of the plan, and revisions will be proposed and adopted, as appropriate.

5.3 Public Hearings and Plan Adoption

- Interim GMP presented at public meeting to Zone 7 Board in 1987.
- Original Groundwater Management Program adopted in 1987 following hearings, contributions from stakeholder-based groundwater advisory committee, etc. ("Statement on Zone 7 Groundwater Management," 8/19/87.)
- Groundwater Management Advisory Committee (GMAC) formed primarily in relation to the demonstration RO/groundwater injection project; however also assisted in evaluating the 1987 Statement on Zone 7 Groundwater Management and helping develop and review the salt management elements of a new plan reflected in the eventual adoption of the Salt Management Plan. (10 Citizen effort 1995–2002.)
- Salt Management Plan Outlining Conjunctive Use to Enhance Groundwater Quality (adopted by Zone 7 with stakeholder input via public interest group, the GMAC, as well as a Technical Advisory Group, discussions at public meetings and subsequent approval by RWQCB in October 2004).
- January 2004 Zone 7 Board notice of plan to review Groundwater Management Plan in a series of three public presentations.
- February, April, and August 2004 public presentations on groundwater basin supply, quality, and management.
- July 2005 distribution of Administrative Draft Groundwater Management Plan to Retail Water Agencies to solicit preliminary comments and input.
- August 3, 2005 meeting with retail water agencies (DSRSD, CWS, Livermore and Pleasanton) to review Administrative Draft Groundwater Management Plan.
- August 17, 2005 public hearing followed by adoption of Resolution of Intent to Adopt Groundwater Management Plan, completion of Draft Groundwater Management Plan and opening of public review and comment period (draft plan was made available to the public in area libraries and on the Zone 7 website), with all associated publications of notice.
- Receipt of comments followed by revisions to Draft Groundwater Management Plan to reflect input received.

5.4 Actions

The Zone 7 Board of Directors will be asked to adopt the Groundwater Management Plan following a public hearing at the September 21, 2005 Regular Board Meeting, following all required publications of notice.


LIVERMORE-AMADOR VALLEY GROUNDWATER BASIN
WEST-EAST CROSS-SECTION
WEST
EAST
Stratographic Evaluation
Study Area
600
500
400
300
200
100
0
-100
-200
-300
FAIRGROUNDS KEY WELL
ELEVATION 261'
MOHR AVENUE KEY WELL
ELEVATION 270'
CURRENT LEVEL
I
K-35
Elevation 275'
COPE
C
R-8
R-22
R-23
HAGEMANN KEY WELL
ELEVATION 298'
LIVERMORE KEY WELL
ELEVATION 423'
RECENT HISTORIC HIGH
(1983)
HISTORIC LOW
(1960'S)
OCTOBER 2003 Groundwater Levels
HOPYARD
WELL FIELD
MOCHO
WELL FIELD
CASTLE
SUB-BASIN
BERNAL
SUB-BASIN
AMADOR SUB-BASIN
MOCHO II SUB-BASIN
MOCHO I
SUB-BASIN